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Interventional Procedure Advisory Committee (IPAC)

IPG10405 (IP1890) In-situ normothermic regional perfusion of the abdomen for livers donated after controlled circulatory death - 1st meeting

Thursday 7th May 2026

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1. Cover sheet [No CON]
2. Final scope [PUB]
3. External Assessment Report (EAR) [No CON]
4. Patient survey responses [PUB]
5. Professional Expert Questionnaires [REDACTED]
6. Register of interests – as of 7 May 2026 [PUB]

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External assessment group document cover sheet

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Version tracking table

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IPG10405 In-situ normothermic regional perfusion of the abdomen for livers donated after controlled circulatory death

Interventional procedures external assessment report

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Purpose of the assessment report

Interventional procedures external assessment report: In-situ normothermic regional perfusion of the abdomen for livers donated after controlled circulatory death

Date: [April 2026]

The purpose of this assessment report is to summarise the procedure and review the key efficacy and safety evidence available for the procedure. NICE has commissioned an external assessment group (EAG) to complete this work and provided the template for the report. The report forms part of the papers considered by the Committee when it is making decisions about the interventional procedure.

Declared interests of the authors

None.

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- Dr Ian Currie, National Clinical Lead for Organ Retrieval, UK, and Consultant Liver Transplant Surgeon, NHS Blood and Transplant.
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Responsibility for report

The views expressed in this report are those of the authors and not those of NICE or the interventional procedures advisory committee. Any errors are the responsibility of the authors.

Contents

Table 1: Abbreviations

Abbreviation	Definition
aNRP	Abdominal Normothermic Regional Perfusion
ALT	Alanine Aminotransferase / Alanine Transaminase
AST	Aspartate Aminotransferase
BMI	Body Mass Index
cDCD	Controlled Donation after Circulatory Death
DBD	Donation after Brain Death
DCD	Donation after Circulatory Death
EAG	External Assessment Group
ICTRP	International Clinical Trials Registry Platform
ISRCTN	International Standard Randomised Controlled Trial Number
MHRA	Medicines and Healthcare products Regulatory Agency
MP	Machine Perfusion
NMP	Normothermic Machine Perfusion
NRP	Normothermic Regional Perfusion
OS	Overall Survival
RCT	Randomised Controlled Trial
RIFLE	Risk, Injury, Failure, Loss, End stage
SCS	Static Cold Storage
uDCD	Uncontrolled Donation after Circulatory Death

The procedure, condition, current practice and unmet need

The procedure

In-situ Normothermic Regional Perfusion (NRP) of the abdomen is a procedure that restores circulation to the abdominal organs of a donor after they have died from controlled circulatory death and before their liver is removed. During in-situ NRP, instead of immediately cold flushing the organ, the donor is first connected to a machine establishing an extracorporeal membrane oxygenation circuit. This machine is made up of a pump, oxygenator and heater. It perfuses the abdominal organs with an oxygenated blood supply at body temperature for about 2 hours after donor death. A clamp is placed across the descending thoracic aorta to prevent blood flow to the brain (UK NRP National Protocol. 2025). During the procedure, blood gas and biochemistry tests can be done to assess the function of the liver in real time before it is retrieved (Oniscu et al. 2014). After removal of the liver, the liver undergoes a period of static cold storage prior to transplantation. The aim of in-situ NRP is to reverse the ischaemic damage that occurs during the liver retrieval process and stop this damage becoming irreversible during the subsequent cold storage process. This means that the liver is recovered from ischaemic damage to its best possible condition before storage, ready for transplantation.

The condition

Liver transplant is a treatment option for people with end stage liver disease (for example, because of alcohol related liver disease, metabolic, autoimmune or infectious conditions), liver cancer or acute liver failure. A total of 785 whole liver transplants were done in the UK between April 2024 and March 2025. At the end

of March 2025 there were 584 adults still on the UK active liver transplant list (NHS Blood and Transplant. 2025). Most livers are donated as whole organs and come from donors who have died from either circulatory death (donation after circulatory death, DCD) or brain death (donation after brain death, DBD). In the UK, between April 2024 to March 2025, 433 adult livers were donated from donors who died from circulatory death and 602 from donors who died from brain death (NHS Blood and Transplant. 2025). Not all of these livers were able to be used for transplants. DCD can occur under controlled or uncontrolled circumstances. Controlled donation after circulatory death (cDCD) is where a person's organs are retrieved for transplant following planned withdrawal of life sustaining treatments (NHS Blood and Transplant. 2025). Uncontrolled donation after circulatory death (uDCD) involves sudden, out of hospital or unwitnessed cardiac arrests where resuscitation has failed (British Transplantation Society UK Guidelines. 2023). In line with the scope of this assessment, only evidence from cDCD populations will be considered.

Current practice

In the standard of care procedure, donor livers are usually preserved using static cold storage. This involves immediately flushing the donor liver with cold organ preservation solution and then placing it in a sterile bag in a cold storage icebox for transport. This process is done by a specially trained team and aims to minimise ischaemic damage to the donor liver. After removal, the liver is transferred to the selected hospital for transplant as soon as possible. Before livers are transplanted, they can be stored for about 8 to 12 hours in an icebox, depending on a variety of factors including the time taken to retrieve them (British Liver Trust 2022, British Transplantation Society 2023, NHS Blood and Transplant 2025).

The terminology for describing this standard of care procedure varies in the literature, with the terms ‘direct procurement’, ‘static cold storage’, ‘super rapid recovery’ and ‘standard rapid recovery’, used to describe the same procedure, depending on whether the study authors are placing emphasis on the organ procurement method or the preservation method being used. For clarity, this report will use the term ‘conventional static cold storage’ when referring to the standard of care procedure.

Where this report uses the term ‘static cold storage’, this refers to the preservation method alone, as opposed to the standard of care procedure. Specifically, this refers to putting the organs on ice after they have been retrieved by a different method, commonly a perfusion technique. For example, static cold storage may be used after normothermic regional perfusion (NRP), which is the intervention of interest in this assessment.

Normothermic Machine Perfusion (NMP) is an ex-situ preservation technique where the recovered liver is placed on a mechanical circuit that circulates oxygenated, blood based perfusate at body temperature. In clinical practice, and within the evidence base of this report, livers undergoing NMP are first retrieved using conventional static cold storage before being placed on the ex-situ circuit. NICE previously evaluated this procedure and issued a special arrangements recommendation in IPG633 (NICE. 2019), establishing it as a recognised clinical option within the NHS for the preservation of cDCD livers. It is therefore a necessary comparator for evaluating the efficacy of in-situ NRP in this assessment.

Unmet need

There is a shortage of organs available that are suitable for transplant in the UK and a high demand for donor livers (NHS Blood and Transplant. 2025). This

demand is rising because of an increasing prevalence of chronic liver diseases in the general population (British Liver Trust. 2024). The shortage of suitable donor livers can result in longer waiting times for people on the waiting list for a liver transplant, which is associated with complications, worsening symptoms and death. Two year follow up data of people registered on the waiting list between April 2022, and March 2023 indicated that 11.0% died before receiving a liver transplant and a further 11.0% were still waiting (NHS Blood and Transplant. 2025). Livers from donors who have died from controlled circulatory death are at risk of ischaemic damage. This damage occurs because of interrupted blood flow to the liver when the donor dies. Further ischaemic damage can occur when the liver undergoes a period of static cold storage prior to transplantation. The damage becomes irreversible during the cold storage process. As a result, livers retrieved from donors who have died from controlled circulatory death can be unsuitable for transplantation (Mastrovangelis et al. 2024). In the UK, many donor livers with ischaemic damage are not used in transplants because of the risk of worse transplant outcomes and uncertainty about liver viability (Eden et al. 2023). This includes livers that have declined either before retrieval or after they have been retrieved. Between April 2024 to March 2025, out of 727 livers donated after controlled circulatory death, 309 were transplanted, which means that 58.0% of the donated livers were not used for transplant (NHS Blood and Transplant. 2025).

Current known use of the procedure

In-situ NRP of the abdomen is part of the NHS Blood and Transplant framework, which recommends it for use alongside static cold storage for retrieving livers after controlled circulatory death of the donor (UK NRP National Protocol. 2025). While conventional static cold storage remains standard practice, the use of NRP has expanded. Based on 2023 data, 6 out of the 10 organ retrieval centres in the

UK were capable of performing NRP, and it was regular practice in at least 3 centres (Eden et al. 2023).

Outcome measures

The main efficacy outcomes included recipient survival, graft survival, transplant utilisation, primary non-function of the graft, and early allograft dysfunction. Safety outcomes included NRP procedure related adverse events, biliary complications, recipient hospitalisation and renal complications.

Efficacy outcomes

- Primary non-function: primary non-function refers to the irreversible graft failure of the transplanted liver in the immediate post operative period. While definitions vary across the literature, the studies included in this assessment generally characterised primary non-function as graft failure requiring retransplantation within 7 days post transplant, or recipient death occurring within the same 7 day period (Neves et al. 2016).

- Early allograft dysfunction: early allograft dysfunction is a measure used to evaluate the immediate performance of the transplanted liver. The included studies primarily measured early allograft dysfunction using the Olthoff Criteria or model for early allograft function score, both of which are defined below:

    - Olthoff criteria: the presence of one or more of the following postoperative laboratory analyses reflective of liver injury and function: bilirubin more than or equal to 10 milligrams per decilitre on day 7, international normalised ratio of 1.6 or more on day 7; or alanine aminotransferase (ALT) or aspartate aminotransferase

(AST) more than 2000 international units per litre within the first 7 days of transplantation (Olthoff et al. 2010).

  - Model for early allograft function score: a continuous score from 0 to 10. It is calculated based on peak bilirubin, international normalised ratio (a standard laboratory measure of blood clotting), and alanine aminotransferase levels recorded in the first 3 days post transplant. It is a validated tool that correlates with graft loss in cDCD liver transplantation (Pareja et al. 2015).

- Graft survival and graft loss: graft survival refers to the continued functioning of the transplanted liver. Conversely, graft loss is defined as the irreversible failure of the organ, which results in the recipient requiring another transplant (retransplantation), or recipient death.

- Transplant utilisation and discard rate: these 2 outcomes are obverse measures of the same concept. Transplant utilisation represents the proportion of donated organs that are successfully transplanted into recipients. Conversely, the discard rate refers to livers deemed unsuitable and not utilised post procurement (Watson et al. 2018).

- Recipient survival: defined as time from the primary transplantation to the date of death from any cause.

Safety Outcomes

- Recipient hospitalisation: the duration of the initial inpatient stay required for recovery after the transplant procedure. It may also include any subsequent hospital admissions occurring within the first year of transplantation.

- Biliary complications: a collection of complications affecting the biliary system, which are sometimes reported separately (Esser et al. 2025). These include:
    - Biliary strictures: the narrowing of an area in the biliary system which causes an obstruction of the bile flow and can lead to dilation of the ducts (Rodrigues et al. 2021).
    - Anastomotic strictures: a specific subset of biliary strictures occurring at the surgical connection point (the anastomosis) (Verdonk et al. 2006).
    - Biliary leaks: the escape of bile from any part of the biliary tree (Tringali et al. 2025).
    - Non-anastomotic strictures: the presence of narrowing, dilation, or irregularity of the bile ducts located at least 5 to 10 millimetres away from the surgical connection point (Verdonk et al. 2006).
- Ischemic cholangiopathy: the clinical manifestation of non-anastomotic strictures where the hepatic artery remains open on imaging. The damage is severe enough to cause cholestasis requiring therapeutic intervention (Foley et al. 2011).
- Hepatic artery thrombosis: the formation of a blood clot in the hepatic artery, which is the main blood vessel that delivers oxygenated blood to the transplanted liver. This can lead to severe organ damage or graft loss.
- Renal complications: these include 2 primary measures of kidney function:

  - Post transplant acute kidney injury: this refers to a sudden reduction in kidney function. It is defined according to the Risk, Injury, Failure, Loss, End stage (RIFLE) criteria as a peak serum creatinine level within the first 7 days after transplantation, that is 2 times the value measured immediately before the operation (preoperative), or the requirement for renal replacement therapy (Arnaoutakis et al. 2011).

  - Chronic kidney disease: this refers to a long term reduction in kidney function. It is defined according to the National Kidney Foundation Kidney Disease Outcomes Quality Initiative and the Kidney Disease Improving Global Outcomes Guidelines, as an estimated glomerular filtration rate of less than 60 millilitres per minute per 1.73 square metres, for more than 3 months (Levey et al. 2002).

- NRP procedure related adverse events: these are technical or medical complications that occur during the regional perfusion process in the donor. Examples include technical failure of the circuit, injury to the blood vessels during preparation, risks associated with inserting the tubes (cannulation), and inadvertent blood flow to the donor's brain. It also includes ischaemia reperfusion injury, which is the tissue damage caused when blood supply returns to the donor liver after a period of lack of oxygen.

Evidence summary

Population and studies description

This interventional procedures assessment report on in-situ NRP of the abdomen for livers donated after controlled circulatory death is based on 8 prioritised studies. This includes 3 systematic reviews and meta analyses (Liang et al. 2023, Mastrovangelis et al. 2024, Patrono et al. 2025), and 5 observational retrospective comparative primary studies (Gaurav et al. 2022, Hessheimer et al. 2022, Mohkam et al. 2022, Puttappa et al. 2025, Watson et al. 2019). Across the 3 prioritised systematic reviews, a total of 29 individual studies relevant to the scope of the assessment report are included. Four of the prioritised primary observational comparative studies are also included in the 3 systematic reviews (Gaurav et al. 2022, Hessheimer et al. 2022, Mohkam et al. 2022, Watson et al. 2019), with Gaurav et al. (2022) being the only study included in all 3.

The 5 primary observational comparative studies were all done in Europe. Three studies were done in the UK (Gaurav et al. 2022, Puttappa et al. 2025, Watson et al. 2019). One large registry based multicentre study was done in Spain (Hessheimer et al. 2022). One international observational study compared NRP procedures done in France against matched control procedures across the UK, Germany, Spain, and Belgium (Mohkam et al. 2022).

In total, 934 people underwent NRP across the 5 primary studies. The 3 systematic reviews included a cohort of 2,456 people receiving the intervention; however, this cumulative figure likely represents overlapping populations, as 5 primary studies were included in more than 1 review.

The prioritised studies all included adults (aged 18 years or more, with the exception of Gaurav et al. 2022, which included those aged 16 years or more)

who underwent liver transplantation from cDCD donors. The evidence specifically focuses on donors meeting Maastricht category III and IV criteria. In the UK, nearly all DCD organs are retrieved from donors who have died from controlled circulatory death (British Transplantation Society UK guidelines. 2023).

Maastricht category III refers to organ donation following the planned withdrawal of life sustaining treatment and is the most common form of cDCD in the UK. Although the use of NRP has expanded nationally, the routine procurement of Maastricht category III livers using this procedure is currently limited to a few specialised centres (Eden et al. 2023).

Studies involving uncontrolled donation after circulatory death livers, categorised as Maastricht category I and II, were excluded from this assessment, or were reviewed at full-text and not prioritised. These cases involve sudden, out of hospital or unwitnessed cardiac arrests where resuscitation has failed (British Transplantation Society UK Guidelines. 2023).

To evaluate the efficacy and safety of the intervention, the included studies compared in-situ NRP against alternative organ retrieval and preservation techniques:

- **Conventional static cold storage:** conventional static cold storage is the term is used throughout the report to describe the standard of care procedure, encompassing both the rapid in-situ cold flush and extraction, and the subsequent period of static cold storage. Conventional static cold storage is currently considered the standard of care in the UK NHS (NHS Blood and Transplant. 2025).

- **Ex-situ machine perfusion:** ex-situ machine perfusion preserves the donor liver outside the body. The donor liver is placed in a perfusion machine which is used to deliver an oxygenated perfusate after the liver has been procured using the conventional static cold storage procedure. There are 2 distinct types of ex-situ machine perfusion evaluated in the included literature: normothermic machine perfusion (NMP), which maintains the organ at physiological temperatures, and hypothermic oxygenated machine perfusion, which maintains the organ at cold temperatures (NICE. 2019).

The primary studies included in this assessment reported significant variation, with follow up periods across cohorts ranging from a minimum of 6 months to a maximum of 70 months. Within the primary studies, demographics between study cohorts were similar.

Overall, the age distribution across the NRP cohorts were consistent, reflecting a middle aged to older adult population. Most studies reported median or mean ages clustered between 56 and 59 years (Gaurav et al. 2022, Hessheimer et al. 2022, Puttappa et al. 2025). However, Mohkam et al. (2022) represented the youngest average cohort with the average reported age of 49 years.

Across all study cohorts, most participants were male, ranging from 64.0% in Hessheimer et al. (2022) to 70.0% reported in both Gaurav et al. (2022) and Mohkam et al. (2022).

This is a rapid review of the literature, and a flow chart of the complete selection process is shown in figure 1. This assessment report presents 8 studies as the key evidence in table 2 and table 3, and lists 67 other relevant studies and the rationale for not prioritising them in appendix B, table 5.

There were 3 systematic reviews which were prioritised.

- **Liang et al. (2023):** this systematic review and meta analysis included a broad evidence base of 39 studies, but only 3 studies which investigated NRP and conventional static cold storage in cDCD grafts, were relevant to this assessment. The remaining studies focused on hypothermic oxygenated machine perfusion, NMP, or compared NRP in cDCD or uncontrolled donation after circulatory death grafts against NRP in donors after brain death. The literature search for the review was done in April 2023. The review reports on clinical outcomes including early allograft dysfunction, 1 year graft survival, 1 year recipient survival, and primary non-function. Safety outcomes include non-anastomotic strictures.

  In the review, the risk of bias was assessed independently by 2 reviewers. For non-randomised cohort studies, the ROBINS-I tool was used. All 3 NRP studies relevant to this assessment were judged to have a moderate risk of bias.

- **Mastrovangelis et al. (2024):** this systematic review and meta analysis included 11 observational cohort studies, but only 4 of them are relevant to this assessment. These studies are grouped within the systematic review into an NRP versus non-NRP group. The NRP group includes the use of NRP, with or without subsequent dual hypothermic oxygenated machine perfusion. These are compared against other cDCD graft techniques, including conventional static cold storage, NMP, conventional static cold storage followed by NMP, or combinations such as conventional static cold storage with or without dual hypothermic oxygenated machine perfusion. The literature search for the review was done in June 2023. The clinical outcomes included in this review include overall incidence of

primary non-function, graft loss, early allograft dysfunction, hepatic artery thrombosis, and liver discard rates. The safety outcomes include ischaemic cholangiopathy, and other biliary complications. Follow up was up to 38 months.

In the review, the risk of bias was assessed independently by 2 authors. Authors used the Newcastle Ottawa Scale for cohort studies. Of the studies that compared NRP versus non-NRP for cDCD, 3 were rated as poor and 1 as good.

- **Patrono et al. (2025):** this systematic review and meta analysis included 31 studies. Five of these, which compared NRP against conventional static cold storage, were relevant to this assessment. This review offers the most up to date evidence base, with a literature search date of November 2024. The meta analysis focused on the incidence of ischaemic cholangiopathy and graft survival, which are 2 priority outcomes of this assessment.

  In the review, the risk of bias was assessed using the Newcastle Ottawa Scale for cohort studies. Among the 5 studies that assessed NRP versus conventional static cold storage, 3 of the studies received the overall score of 7 on the Newcastle Ottawa Scale and 2 the overall score of 9.

The interventions and comparators for the 8 prioritised studies are summarised below:

- **NRP versus conventional static cold storage**: two systematic reviews and meta analyses (Liang et al. 2023, Patrono et al. 2025) and two primary studies (Hessheimer et al. 2022, Watson et al. 2019) compared NRP against conventional static cold storage.

- **NRP versus NMP**: one primary study (Mohkam et al. 2022) directly compared NRP against NMP.
- **NRP versus mixed non-NRP:** The systematic review by Mastrovangelis et al. (2024) evaluated NRP against a single, pooled mixed non-NRP control arm, which included conventional static cold storage, NMP and hypothermic oxygenated machine perfusion.
- **Three arm comparisons:** two primary studies (Gaurav et al. 2022, Puttappa et al. 2025) evaluated NRP against both conventional static cold storage and NMP within the same study design.

Figure 1 Flow chart of study selection

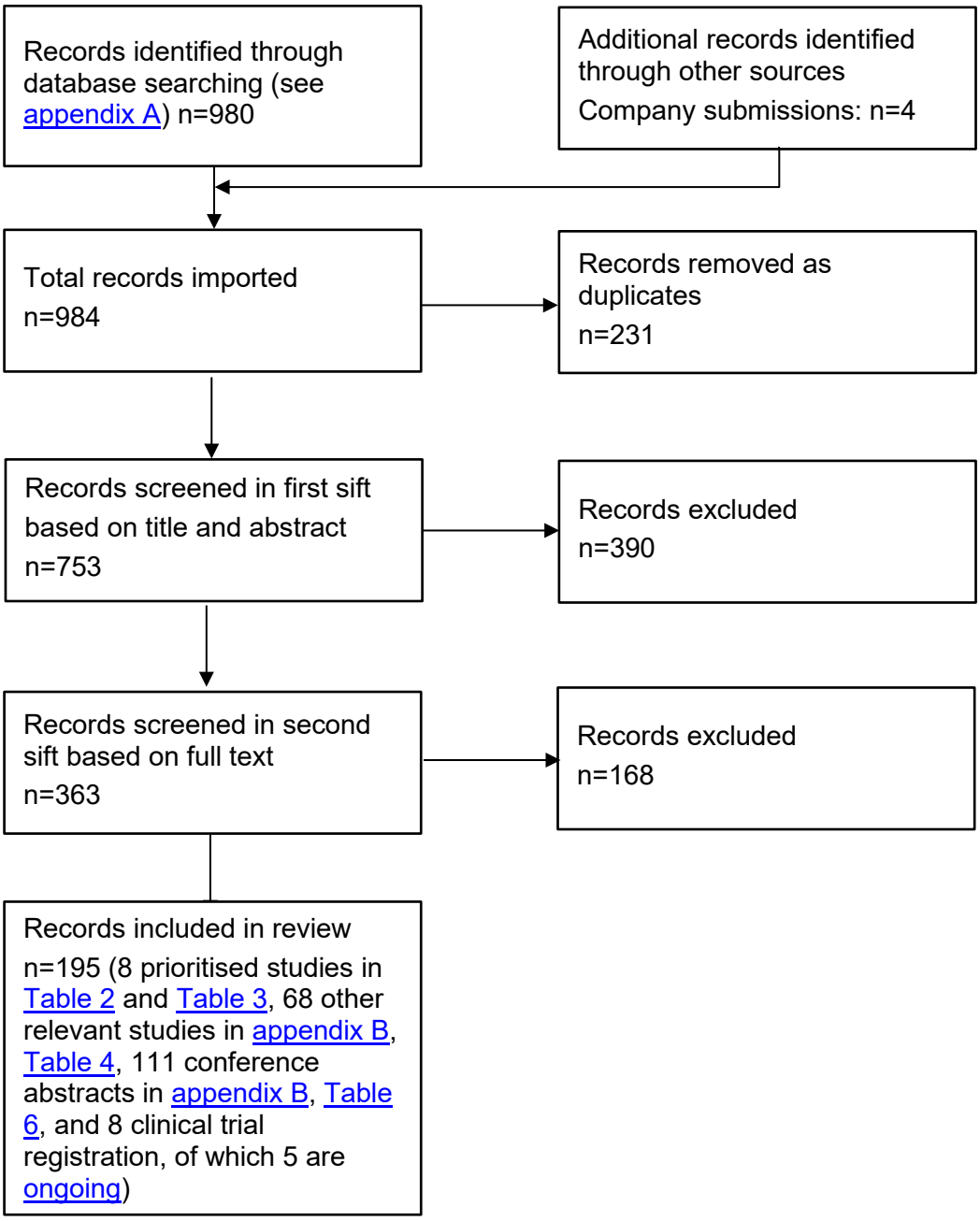

Table 2: Study details

Study no.	Study or author name, date, country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention and comparator	Follow up
1	Liang et al. 2023 Countries: UK n=1, Spain n=6, France n=2, The Netherlands n=1	Studies included: n=39 Livers with NRP included in these studies: n=968 Studies investigating conventional static cold storage with cDCD and conventional static cold storage with DBD: n=10 Studies investigating NRP in cDCD: n=7 Studies investigating conventional static cold storage as controls: n=3	Systematic review and meta analysis The NRP studies have a cohort study design Search date: April 2023	Adult liver transplant studies (including randomised controlled trials, case control studies, prospective and retrospective cohort studies) comparing the outcomes of hypothermic oxygenated machine perfusion, NMP, or NRP versus conventional static cold storage were included	Intervention: NRP Comparator: Conventional static cold storage cDCD Conventional static cold storage DBD (out of scope)	Follow up: not reported

Study no.	Study or author name, date, country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention and comparator	Follow up
2	Mastrovangelis et al. 2024 Countries: Spain n=7, UK n=1, France n=1, France and Switzerland n=1, The Netherlands n=1	Cohort studies: n=11 Studies investigating NRP versus mixed non-NRP for cDCD: NRP livers: n=702 Non-NRP livers: n=505 Studies investigating cDCD with NRP versus DBD (out of scope): NRP livers: n=402 DBD livers: n=1,037	Systematic review and meta analysis Multicentre studies: n=6 Single centre studies: n=5 All studies were observational Search date: June 2023	Randomised controlled trials or cohort studies of adult recipients of cDCD livers that had undergone NRP Comparator groups of cDCD livers with conventional static cold storage plus or minus non-NRP machine perfusion, or DBD livers with conventional static cold storage plus or minus non-NRP machine perfusion	Intervention: NRP in cDCD donors Comparators: Comparator groups involving cDCD donors (n=3): conventional static cold storage: n=2, NMP: n=2, conventional static cold storage plus or minus dual hypothermic oxygenated machine perfusion in either arm: n=1 Comparator groups involving DBD donors (n=3): conventional st	Follow up (median): From 6 months to 38 months

Study no.	Study or author name, date, country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention and comparator	Follow up
					atic cold storage: n=6, conventiona l static cold storage, where h ypothermic oxygenated machine perfusion is added to NRP interventi on arm: n=1, conventiona l static cold storage plus or minus dual hypothermic oxygenated machine perfusion in either arm: n=1 (out of scope)	
3	Patrono et al. 2025 Countries: Not reported	Studies included: n=31 (in scope n=5, out of scope n=26)	Systematic review and meta analyses Search date: November 2024	Randomised controlled studies and cohort studies reporting on clinical data	Intervention and comparator groups: NRP compared to conventional	Follow up (median): not reported

Study no.	Study or author name, date, country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention and comparator	Follow up
		NRP versus conventional static cold storage (n=5): NRP: n=786 Conventional static cold storage: n=700 Weighted median of age (interquartile range) Donor age: 53 years (46 to 56) Recipient age: 58 (57 to 59) years Studies (n=11) investigating hypothermic oxygenated machine perfusion and dual hypothermic oxygenated machine perfusion or both versus conventional static	NRP versus conventional static cold storage studies: Cohort studies n=5 (retrospective multicentre n=4, retrospective single centre n=1) Studies comparing NMP to conventional static cold storage (out of scope): n=9 (randomised controlled trials n=4, cohort studies n=5) Studies comparing hypothermic oxygenated machine perfusion to conventional static cold storage (out of scope): n=11 (randomised	were considered eligible for inclusion Only studies on the use of NRP in cDCD donors were included in the relevant meta analysis (NRP versus conventional static cold storage)	static cold storage NMP compared to conventional static cold storage (out of scope) Hypothermic oxygenated machine perfusion compared to conventional static cold storage (out of scope)	

Study no.	Study or author name, date, country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention and comparator	Follow up
		cold storage (out of scope): Hypothermic oxygenated machine perfusion: n=714 Conventional static cold storage: n=1392 Donor age: 55 (53 to 72) Recipient age: 58 (57 to 60) Studies (n=9) investigating NMP versus static cold storage (out of scope): NMP: n=652 Conventional static cold storage: n=993 Donor age: 52 (44 to 55) Recipient age: 58 (57 to 59)	controlled trials n=6, cohort studies n=5) NRP versus DBD studies (out of scope)**:** Cohort studies: n=6 No randomised controlled trial compared NRP to conventional static cold storage Incidence of ischaemic cholangiopathy and graft survival were the 2 outcomes used for meta analysis			

Study no.	Study or author name, date, country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention and comparator	Follow up
4	Gaurav et al. 2022 Country: UK	cDCD liver transplants: n=233 Using conventional static cold storage: n=97, NRP: n=69, NMP: n=67 Recipient characteristics: Median age (years) Conventional static cold storage: 56 (interquartile range: 50 to 62) NRP: 56 (interquartile range: 48 to 63) NMP: 59 (interquartile range: 51 to 63) Sex (male) Conventional static cold storage: n=56 (58.0%) NRP: n=48 (70%.0)	Single centre retrospective analysis study (from 1st January, 2013, to 31st October, 2020)	Consecutive adult participants (aged 16 years or older) who underwent orthotopic liver transplantation from cDCD (Maastricht category III and IV) donors Livers with sequential NRP and NMP were excluded from the analysis: n=9	Intervention: NRP Comparators: Conventional static cold storage, NMP	Follow up (minimum): 6 months. Follow up (median): 38 months Conventional static cold storage: 54 months NRP: 28 months NMP: 24 months

Study no.	Study or author name, date, country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention and comparator	Follow up
		NMP: n=45 (67.0%) Median body mass index (BMI; kg/m^2) Conventional static cold storage: 26 (interquartile range: 24 to 29) NRP: 28 (interquartile range: 24 to 33) NMP: 28 (interquartile range: 24 to 33) Prior liver transplant: Conventional static cold storage: n=1 (1.0%) NRP: n=8 (12.0%) NMP: n=3 (5.0%)				
5	Hessheimer et al. 2022 Country: Spain	Sample Size: Livers from cDCD donors: n=1384 Evaluated in-situ: n=1165	Observational cohort study (from 2012 to 2019) with 86 hospitals included in the study	All cDCD liver transplants done in Spain between 2012 to 2019 were analysed	Intervention: NRP Comparator: Conventional	Follow up (median): 31 months

Study no.	Study or author name, date, country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention and comparator	Follow up
		Total livers transplanted: n=803 NRP: n=545 Conventional static cold storage: n=258 Donor characteristics NRP: Median age (years): 59 (interquartile range: 49 to 67) Median BMI (kg/m^2): 26.5 (interquartile range: 24.2 to 28.9) Sex (male): n=351 (64%) Static cold storage: Median age (years): 58 (interquartile range: 48 to 67) Median BMI: 26.2 (interquartile range: 24.2 to 28.2) Sex (male): n=167 (65.0%)	Study data from the Spanish liver transplant registry		static cold storage	

Study no.	Study or author name, date, country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention and comparator	Follow up
		Recipient characteristics: NRP: Median age (years): 59 (interquartile range: 53 to 63) Median BMI (kg/m$^{2)}$: 26.9 (interquartile range: 23.8 to 30.1) Sex (male): n=431 (79%) Static cold storage: Median age (years): 58 (interquartile range: 53 to 63) Median BMI (kg/m^2): 26.7 (interquartile range: 23.4 to 29.4) Sex (male): n=213 (83%)				
6	Mohkam et al. 2022 Country: International	cDCD donors: n=264 NRP procedures: n=224	Retrospective international observational study	NRP procedures done between February 2015 to December 2019	Intervention: NRP Comparator: NMP	Follow up (median, p=0.75) NRP group: 22 months

Study no.	Study or author name, date, country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention and comparator	Follow up
	NRP procedures done in French centres: n=6, NMP procedures done in centres in UK, Germany, Spain and Belgium: n=6	NMP procedures: n=40 After propensity score matching: n=34 NMP recipients were matched with n=68 NRP recipients After matching, the 2 groups became well balanced for all variables included in the UK DCD risk score, except for cold ischaemia time. After propensity score matching: Median donor age (years): NMP: 48 (interquartile range: 33 to 62)		NMP procedures done between August 2014 to March 2016		(interquartile range: 14 to 32) NMP group: 24 months (interquartile range: 23 to 24)

Study no.	Study or author name, date, country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention and comparator	Follow up
		NRP: 49 (interquartile range: 37 to 60) Donor sex: (male: female, p=0.235) NMP: Male: n=20 Female: n=14 NRP: Male: n=48 Female: n=20 Median donor BMI (kg/m^2, p=0.845) NMP: 25 (interquartile range: 23 to 29) NRP: 25 (interquartile range: 23 to 29)				
7	Puttappa et al. 2025 Country: UK	cDCD liver recipients: n=238 Donor age (years, p=0.055):	Single centre retrospective comparative study	Consecutive adult recipients (18 years or older) of cDCD transplants (Maastricht	Intervention: NRP Comparators:	Follow up (median): NRP: 30 months

Study no.	Study or author name, date, country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention and comparator	Follow up
		Conventional static cold storage: 50 (36 to 58) NRP: 55 (42 to 60) NMP: 46 (28 to 59) Recipient age: (years, p=0.943) Conventional static cold storage: 56 (49 to 62) NRP: 57 (48 to 62) NMP: 56 (49 to 61) Recipient Sex: (male, p=0.012) Conventional static cold storage: n=31 (53%) NRP: n=73 (72%) NMP: n=56 (72%) Recipient BMI: (kg/m^2, mean, p=0.077)	The study evaluated n=238 recipients of cDCD livers, divided into 3 main comparative groups based on their preservation method: NRP: n=101 livers NMP n=78 livers Conventional static cold storage: n=59 livers Note: Of the n=101 livers recovered with NRP, n=70 were recovered strictly using abdominal NRP. The remaining n=31 livers were recovered using thoracoabdominal NRP (n=14) and simultaneous procurement of the	category III & IV) from January 2015 to December 2022 Excluded recipients with sequential NRP and NMP livers and those requiring venovenous bypass during the transplant	NMP, conventional static cold storage	NMP: 39 months Conventional static cold storage: 70 months

Study no.	Study or author name, date, country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention and comparator	Follow up
		Conventional static cold storage: 26.6 NRP: 28.6 NMP: 28.1	thoracic organs (heart and lungs or both) (n=17). The study does not separate the post transplant outcomes for these subgroups			
8	Watson et al. 2019 Country: UK	NRP non-liver donors: n=27 NRP liver donors: n=43 Thoracoabdominal NRP (TA-NRP): n=10 (out of scope) Conventional static cold storage: n=187 Median donor age: (range, interquartile range, p=0.1317) NRP: n=41 (33 to 57, 16 to 69) Conventional static cold storage: n=50 (37 to 58, 11 to 76)	Retrospective observational cohort study Prospectively collected data from UK Transplant Registry and hospital records NRP was undertaken in 2 contexts, one to assess and retrieve the abdominal organs alone, and the other to also assess and recover the heart for transplantation	cDCD donors (Maastricht III) within 2 centres between 2011 and 2017 Livers that underwent ex-situ machine perfusion were excluded	Intervention: NRP Comparator: Conventional static cold storage (All cDCD liver transplants done at both centres since the start of the NRP program in January 2011)	Follow up: 90 days (outcome specific follow up)

Study no.	Study or author name, date, country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention and comparator	Follow up
		UK donor liver index: (range, interquartile range) NRP: 1.9 (1.7 to 2.2) Conventional static cold storage: 1.9 (1.6 to 2.2) Median recipient age (interquartile range, range, p=0.3192) NRP: 60 (51 to 64, 34 to 73) Conventional static cold storage: 57 (51 to 63,18 to 72)				

Terminology notes: To align with the comparators defined in the NICE scope, study specific intervention nomenclature has been standardised across the report. The terminology used to refer to the standard of care control arms varied across the included literature and has all been standardised to 'conventional static cold storage'. Specifically, this applies to the DCD-DP-SCS cohort in Puttappa et al. (2025); the 'non-NRP' group in Watson et al. (2019); the 'standard rapid recovery' arm in Hessheimer et al. (2022), and the 'super rapid recovery' arm in Patrono et al. (2025). In all instances where organs underwent in-situ NRP followed by a period of static cold storage (the preservation technique), the intervention arm is referred to simply as 'NRP'. Similarly, in all instances where organs underwent conventional static cold storage prior to ex-situ normothermic machine perfusion, the arm is referred to simply as 'NMP'.

Abbreviations: BMI: Body mass index; cDCD: controlled donation after circulatory death; DBD: donation after brain death; DCD: donation after circulatory death; NMP: Normothermic machine perfusion; NRP: normothermic regional perfusion; TA-NRP: Thoracoabdominal normothermic regional perfusion; uDCD: Uncontrolled donation after circulatory death.

Table 3: Study outcomes

First Author, date	Efficacy outcomes	Safety outcomes
Liang et al. 2023	**NRP versus conventional static cold storage** **Primary non-function** Odds ratio = 0.43 (95% confidence interval [CI] 0.22 to 0.85, p=0.01, favouring the NRP group) **Early allograft dysfunction** Odds ratio = 0.58 (95% CI 0.42 to 0.80, p<0.01, favouring the NRP group) **1 year graft survival** Odds ratio = 2.40 (95% CI 1.65 to 3.49, p<0.01, favouring the NRP group) **1 year recipient survival** Odds ratio = 1.15 (95% CI 0.53 to 2.46, p=0.73, no statistically significant difference)	**NRP versus conventional static cold storage** **Non-anastomotic stricture** Odds ratio = 0.27 (95% CI 0.11 to 0.68, p<0.01, favouring the NRP group)

First Author, date	Efficacy outcomes	Safety outcomes
Mastrovangelis et al. 2024	**NRP versus mixed non-NRP** **Incidence of primary non-function** Relative risk = 0.51 (95% CI 0.27 to 0.97, p=0.04, favouring the NRP group) NRP: 1.4%, n=17 (95% CI 0.3% to 3.0%) Non-NRP: 3.5%, n=22 (95% CI 1.7% to 6.0%) **Organ discard rate** NRP: 30.0% Non-NRP: 31.0% (No statistically significant difference) **Recipient mortality** Hazard ratio = 0.50 (95% CI 0.36 to 0.69, p<0.0001, favouring the NRP group) **Graft loss** Hazard ratio = 0.44 (95% CI 0.33 to 0.58, p<0.00001, favouring the NRP group) **Early allograft dysfunction** Relative risk = 0.78 (95% CI 0.51 to 1.21, p=0.27, no statistically significant difference)	**NRP versus mixed non-NRP** **Ischaemic cholangiopathy** Relative risk = 0.23 (95% CI 0.11 to 0.49, p=0.0002, favouring the NRP group) Ischaemic cholangiopathy overall incidence NRP group: n=13, 2.6% (95% CI 0.1% to 6.9%) Ischaemic cholangiopathy overall incidence non-NRP: n=68, 13.2% (95% CI 7.3% to 21.0%) **Hepatic artery thrombosis** Relative risk = 0.53 (95% CI 0.31 to 0.92, p=0.02, favouring the NRP group) **Other biliary complications** Relative risk = 0.61 (95% CI 0.44 to 0.84, p=0.003 favouring the NRP group)

First Author, date	Efficacy outcomes	Safety outcomes
Patrono et al. 2025	**NRP versus conventional static cold storage** **Graft survival (using meta analysis)** Relative risk = 1.11 (95% CI 1.05 to 1.17, p=0.0001, favouring the NRP group)	**NRP versus conventional static cold storage** **Ischaemic cholangiopathy (using meta analysis)** Relative risk = 0.10 (95% CI 0.05 to 0.21, p<0.0001, favouring the NRP group)
Gaurav et al. 2022	**NRP versus NMP versus conventional static cold storage** **Overall graft loss, 6 months** Total n=17 (7.3%) NRP: n=2 (3.0%) NMP: n=6 (9.0%) Conventional static cold storage: n=9 (9.0%) (p=0.246, no statistically significant difference) **Primary non-function** NRP: n=0 (0.0%) NMP: n=1 (1.5%) Conventional static cold storage: n=5 (5.0%) (No statistically significant difference) **Early allograft dysfunction (Olthoff criteria)** NRP: n=10 (14.0%)	**NRP versus NMP versus conventional static cold storage** **Acute kidney injury** NRP: n=27 (39.0%) NMP: n=26 (40.0%) Conventional static cold storage: n=53 (55.0%) (p=0.08, no statistically significant difference) **Chronic kidney disease incidence at 6 months** NRP: n=20 (31.0%) NMP: n=15 (25.0%) Conventional static cold storage: n=28 (33.0%) (p=0.60, no statistically significant difference) **Overall biliary complications** NRP: n=15 (22.0%) NMP: n=23 (37.0%)

First Author, date	Efficacy outcomes	Safety outcomes
	NMP: n=7 (11.0%) Conventional static cold storage: n=19 (21.0%) (p=0.20, no statistically significant difference) **Model for early allograft function scores** NRP: Median 4.1 (interquartile range: 2.5 to 5.6) NMP: Median 3.7 (interquartile range:2.6 to 5.7) Conventional static cold storage: Median 5.5 (interquartile range: 4.3 to 7.0) (p<0.001, statistically significant difference between groups) **Utilisation** NRP: n=83 out of 120 livers transplanted, 69.0% utilisation rate (n=5 transplanted outside of Cambridge so excluded from analysis) NMP: n=76 out of 99 livers transplanted, 77.0% utilisation rate Conventional static cold storage: Not reported **6 month and 3 year transplant survival rates (defined as graft survival non-censored for death)** NRP: 94.0% and 90.0% NMP: 90.0% and 76.0%	Conventional static cold storage: n=38 (42.0%) (p=0.024, statistically significant difference between groups) **Overall non-anastomotic strictures** NRP: n=4 (6.0%) NMP: n=12 (19.0%) Conventional static cold storage: n=22 (25.0%) (p=0.009, Statistically significant difference between groups) **Clinically significant non-anastomotic stricture** NRP: n=0 (0.0%) NMP: n=7 (11.0%) Conventional static cold storage: n=12 (14.0%) (p=0.009, statistically significant difference between groups) Odds ratio = 0.20 (95% CI 0.06 to 0.72, p=0.01, favouring the NRP group) **Severe postoperative complications (Clavien Dindo classification)** NRP: n=41 (59.0%) NMP: n=39 (58.0%)

First Author, date	Efficacy outcomes	Safety outcomes
	Conventional static cold storage: 87.0% and 76.0% (p=0.114, no statistically significant difference) **3 year recipient survival** NRP: 94.0% NMP: 90.0% Conventional static cold storage: 88.0% (p=0.665, no statistically significant difference) **6 month risk adjusted Cox proportional hazard for transplant failure** Hazard ratio = 0.3 (95% CI 0.08 to 1.05, p=0.06, no statistically significant difference) **Risk adjusted estimated reduction in the mean model for early allograft function score** NRP: 1.52 NMP: 1.19 (p<0.001) **Retransplantation rate** NRP: n=3 (4.0%) NMP: n=8 (12.0%)	Conventional static cold storage: n=66 (68.0%) **Initial hospital stay from transplant surgery to first discharge (median days)** NRP: 15 (interquartile range: 13 to 23) NMP: 19 (interquartile range: 13 to 29) Conventional static cold storage: 18 (interquartile range: 15 to 30) (p=0.05, statistically significant difference between groups) **Hepatic artery thrombosis** NRP: n=1 (1.0%) NMP: n=5 (8.0%) Conventional static cold storage: n=7 (8.0%) (p=0.18, no statistically significant difference)

First Author, date	Efficacy outcomes	Safety outcomes
	Conventional static cold storage n=17 (18.0%) (p=0.04, statistically significant difference between groups)	
Hessheimer et al. 2022	**NRP versus conventional static cold storage** **Utilisation** NRP: n=315 out of 545 recovered = 57.8% utilisation, 42.2% discard rate Conventional static cold storage: n=126 out of 258 recovered = 48.8% utilisation, 51.2% discard rate (p=0.015, favouring the NRP group) **Observed early allograft dysfunction** NRP: n=81 (15.0%) Conventional static cold storage: n=60 (23.0%) Odds ratio = 0.562 (95% CI 0.363 to 0.871, p=0.010, favouring the NRP group) **Observed primary non-function** NRP: n=16 (3.0%) Conventional static cold storage: n=15 (6.0%) Odds ratio = 0.573 (95% CI 0.252 to 1.303, p=0.184, no statistically significant difference)	**NRP versus conventional static cold storage** **Overall biliary complications** NRP: n=63 (12.0%) Conventional static cold storage: n=75 (29.0%) Odds ratio = 0.320 (95% CI 0.211 to 0.485, p<0.001, favouring the NRP group) **Observed ischaemic type biliary lesions** NRP: n=6 (1.0%) Conventional static cold storage: n=24 (9.0%) Odds ratio = 0.111 (95% CI 0.040 to 0.309, p<0.001 favouring the NRP group) **Observed hepatic artery thrombosis (p=0.032)** NRP: n=22 (4.0%) Conventional static cold storage: n=19 (7.0%) Odds ratio = 0.452 (95% CI 0.219 to 0.932, favouring the NRP group) **Number of discarded livers (inverse of utilisation):**

First Author, date	Efficacy outcomes	Safety outcomes
	Retransplantation NRP: n=19 (3.5%) Conventional static cold storage: n=31 (12.0%) Odds ratio = 0.279 (95% CI 0.147 to 0.531, p<0.001, favouring the NRP group) **Overall graft loss** NRP: n=77 (14.0%) Conventional static cold storage: n=88 (34.0%) Adjusted hazard ratio = 0.435 (95% CI 0.316 to 0.601, p<0.001, favouring the NRP group) **Recipient mortality** NRP: n=65 (12.0%) Conventional static cold storage: n=66 (26.0%) Adjusted hazard ratio = 0.517 (95% CI 0.354 to 0.755, p=0.001, favouring the NRP group) **1 and 3 year recipient survival rates** NRP: 92.0% and 89.0% Conventional static cold storage: 86.0% and 76.0%	NRP: n=230 out of 775 (29.7%) Conventional static cold storage: n=132 out of 390 (31.5%) **Reasons for discarding cDCD livers for transplantation:** **Technical problems (n=27)** NRP: n=10 (1.0%) Conventional static cold storage: n=17 (4.0%) (p=0.003, favouring the NRP group) **NRP failure** NRP: n=1 (0.1%) Conventional static cold storage: n=0 (0.0%) (p=0.448, no statistically significant difference) **Poor macroscopic aspect at recovery** Total: n=245 NRP: n=151 (19.0%) Conventional static cold storage: n=94 (24.0%) (p=0.276, no statistically significant difference) **Altered laboratory values**

First Author, date	Efficacy outcomes	Safety outcomes
		NRP: n=21 (3.0%) Conventional static cold storage: n=2 (0.5%) (p=0.04, favouring the conventional static cold storage group) **Prolonged donor warm ischaemia time** NRP: n=8 (1.0%) Conventional static cold storage: n=10 (3.0%) (p=0.084, no statistically significant difference) **Pathological liver biopsy** NRP: n=10 (1.0%) Conventional static cold storage: n=4 (1.0%) (p=0.531, no statistically significant difference) **Previously undiagnosed donor malignancy** NRP: n=13 (2.0%) Conventional static cold storage: n=0 (0.0%) (p=0.005, favouring the static cold storage group) **Calcified hepatic artery** NRP: n=5 (0.6%) Conventional static cold storage: n=1 (0.3%)

First Author, date	Efficacy outcomes	Safety outcomes
		(p=0.310, no statistically significant difference) **Active untreated infection** NRP: n=2 (0.3%) Conventional static cold storage: n=2 (0.5%) (p=0.571, no statistically significant difference) **Other reasons for discard (not described)** NRP: n=9 (1.0%) Conventional static cold storage: n=2 (0.5%) (p=0.201, no statistically significant difference)
Mohkam et al. 2022	**NRP versus NMP** **Transplant utilisation** NRP: n=193 livers procured n=157 used in transplants (70.0% utilisation) NMP: n=34 used in transplants (85.0% utilisation) (p=0.052, no statistically significant difference) **Early allograft dysfunction**	**NRP versus NMP** **Hospital stay (median days)** NRP: n=16 (interquartile range: 13 to 20) NMP: n=14 (interquartile range: 8 to 17) (p=0.018, favouring the NMP group) **Any type of biliary strictures (clinically manifest)** NRP: n=8 (11.8%) NMP: n=7 (20.6%) (p=0.249, no statistically significant difference)

First Author, date	Efficacy outcomes	Safety outcomes
	NRP: n=14 (20.6%) NMP: n=3 (8.8%) (p=0.133, no statistically significant difference) **Aspartate aminotransferase peak 7 day (median international units per litre)** NRP: 872 (interquartile range: 538 to 1281) NMP: 344 (interquartile range: 216 to 701) (p<0.001, favouring the NMP group) **Alanine aminotransferase peak 7 day (median international units per litre)** NRP: 725 (interquartile range: 400 to 1304) NMP: 311 (interquartile range: 186 to 590) (p=0.001, favouring the NMP group) **30 day graft loss** NRP: n=3 (4.4%) NMP: n=3 (8.8%) (p=0.398, no statistically significant difference) **30 day recipient death** NRP: n=0 (0.0%)	**Anastomotic stricture (clinical and/or on imaging)** NRP: n=7, (10.3%) NMP: n=13 (38.2%) (p<0.001, favouring the NRP group) **Non-anastomotic stricture (clinical and/or on imaging)** NRP: n=2 (2.9%) NMP: n=3 (8.8%) (p=0.330, no statistically significant difference) **Hepatic artery thrombosis** NRP: n=2 (2.9%) NMP: n=1 (2.9%) (p>0.99, no statistically significant difference)

First Author, date	Efficacy outcomes	Safety outcomes
	NMP: n=2 (5.9%) (p=0.109, no statistically significant difference) **Graft survival** **1 year** NRP: 93.9% NMP: 88.2% **2 years** NRP: 89.4% NMP: 88.2% (p=0.516, all timepoints no statistically significant difference) **Tumour censored graft survival rates** **1 year** NRP: 94.1% NMP: 88.2% **2 years** NRP: 91.5% NMP: 88.2%	

First Author, date	Efficacy outcomes	Safety outcomes
	(p=0.523 all timepoints, no statistically significant difference) **Recipient survival** **1 year** NRP: 98.5% NMP: 94.1% **2 years** NRP: 96.4% NMP: 90.9% (p=0.275, no statistically significant difference) **Tumour censored recipient survival rates** **1 year** NRP: 100.0% NMP: 94.1% **2 years** NRP: 97.9% NMP: 94.1% (p=0.255, all timepoints, no statistically significant difference)	

First Author, date	Efficacy outcomes	Safety outcomes
Puttappa et al. 2025	**NRP versus NMP versus conventional static cold storage** **Primary non-function** NRP: n=0 (0.0%) NMP: n=1 (1.0%) Conventional static cold storage: n=2 (3.0%) **Peak alanine aminotransferase (median, interquartile range)** NRP: 508 (328 to 970) NMP: 360 (208 to 621) Conventional static cold storage: 697 (451 to 1277) (p<0.001, statistically significant difference between groups) **1 year transplant survival** NRP: 94.0% NMP: 94.0% Conventional static cold storage: 90.0% **5 year transplant survival** NRP: 85.0%	**NRP versus NMP versus conventional static cold storage** **Hospital stay (median days)** NRP: 17 (interquartile range: 13 to 24) NMP: 19 (interquartile range: 12 to 28) Conventional static cold storage: 16 (interquartile range: 13 to 24) (p=0.890 no statistically significant difference) **Acute kidney injury equal to or more than stage 2 (median)** NRP: n=29 (29.0%) NMP: n=22 (28.0%) Conventional static cold storage: n=28 (47.0%) (p=0.033, statistically significant difference between groups)

First Author, date	Efficacy outcomes	Safety outcomes
	NMP: 84.0% Conventional static cold storage: 69.0% **5 year transplant survival (NRP versus conventional static cold storage)** Hazard ratio = 2.4 (95% CI 1.1 to 5.4, p=0.028, favouring the NRP group) **Model for early allograft function scores (median)** NRP: 4.1 (2.8 to 5.4) NMP: 3.3 (2.1 to 5.2) Conventional static cold storage: 5.8 (4.8 to 7.0) (p<0.01, statistically significant difference between groups)	
Watson et al. 2019	**NRP versus conventional static cold storage** **Early allograft dysfunction** NRP: n=5 (12.0%) Conventional static cold storage: n=55 (32.0%) (p=0.0076, favouring the NRP group) **Graft loss** **Primary non-function**	**NRP versus conventional static cold storage** **Bile duct complications** **Biliary leak** NRP: n=3 (7.0%) Conventional static cold storage: n=18 (10.0%) (p=0.7731, no statistically significant difference) **Anastomotic stricture**

First Author, date	Efficacy outcomes	Safety outcomes
	NRP: n=0 (0.0%) Conventional static cold storage: n=13 (7.0%) (p=0.1347, no statistically significant difference) **Graft loss because of ischaemic cholangiopathy** NRP: n=0 (0.0%) Conventional static cold storage: n=11 (6.0%) (p=0.2253, no statistically significant difference) **Graft loss at 30 days** NRP: 2.0% Conventional static cold storage: 12.0% (p=0.0559, no statistically significant difference) **Graft survival at 90 days** NRP: 97.7% (95% CI 84.6 to 99.7) Conventional static cold storage: 89.8% (95% CI 84.5 to 93.4) (p=0.1019 no statistically significant difference) **Recipient survival at 90 days** NRP: 100%	NRP: n=3 (7.0%) Conventional static cold storage: n=46 (27.0%) (p=0.0041, favouring the NRP group) **Overall incidence of ischaemic cholangiopathy** NRP: n=0 (0.0%) Conventional static cold storage: n=47 (27.0%) (p<0.0001, favouring the NRP group) **Hepatic artery thrombosis in first 28 days** NRP: n=1 (2.0%) Conventional static cold storage: n=5 (3.0%) (p>0.99, no statistically significant difference) **Renal complications, change in estimated glomerular filtration rate** NRP: median fall of 13 Conventional static cold storage: median fall of 26 (p=0.6229, no statistically significant difference) **Procedure related or retrieval damage** NRP: n=5 (11.6%) Conventional static cold storage: n=48 (25.7%)

First Author, date	Efficacy outcomes	Safety outcomes
	Conventional static cold storage: 97.3% (95% CI 93.7 to 98.9) (p=0.2810, no statistically significant difference) **Peak alanine aminotransferase in first 7 days** NRP (median, interquartile range): 633 (319 to 1070) Conventional static cold storage (median, interquartile range): 1154 (667 to 2099) (p<0.0001, favouring the NRP group) **Model for early allograft function** NRP (median, interquartile range): 3.5 (2.4 to 5.1) Conventional static cold storage (median, interquartile range): 5.0 (3.8 to 6.6) (p<0.0001, favouring the NRP group)	(p=0.0689, no statistically significant difference)

Abbreviations: CI: Confidence interval; cDCD: Controlled donation after circulatory death; DCD: Donation after circulatory death; NMP: Normothermic machine perfusion; Non-NRP: Non-normothermic regional perfusion; NRP: Normothermic regional perfusion.

Procedure technique

Procedural techniques were detailed in all 5 primary studies, with 2 studies Puttappa et al. (2025) and Watson et al. (2019) explicitly identifying the specific NRP device used (Maquet Cardiohelp). None of the 3 systematic reviews reported on the specific NRP devices or procedural techniques employed.

Efficacy

Note on terminology: As noted previously, the terminology for describing this standard of care procedure varies in the literature, with the terms ‘direct procurement’, ‘static cold storage’, ‘super rapid recovery’ and ‘standard rapid recovery’, used to describe the same procedure, depending on whether the study authors are placing emphasis on the organ procurement method or the preservation method being used. For clarity, the term ‘conventional static cold storage’ is used when referring to the standard of care procedure.

Where the term ‘static cold storage’ is used, this refers to the preservation method alone, as opposed to the standard of care procedure. Specifically, this refers to putting the organs on ice after they have been retrieved by a different method, commonly a perfusion technique. For example, static cold storage may be used after normothermic regional perfusion (NRP), which is the intervention of interest in this assessment.

Handling pooled control arms: Where systematic reviews (e.g., Mastrovangelis et al. 2024) have pooled completely different preservation methods (such as conventional static cold storage, NMP and hypothermic oxygenated machine perfusion) into a single control arm, this assessment refers to this as a ‘mixed non-NRP’ group. This ensures accuracy and distinguishes these pooled cohorts from conventional static cold storage only comparators.

Primary non-function

The incidence of primary non-function was reported in 6 studies, including 2 systematic reviews.

- **NRP versus mixed non-NRP**
  Because primary non-function is a relatively rare clinical event, individual cohort studies often lack the statistical power to demonstrate significance independently, however, pooled systematic review data confirms the benefit.

  In their systematic review, Mastrovangelis et al. (2024) reported an incidence of primary non-function of 1.4% in the NRP group compared with 3.5% in the mixed non-NRP group, with a statistically significant reduction (relative risk 0.51, 95% CI 0.27 to 0.97, p=0.04).

- **NRP versus conventional static cold storage**
  NRP was consistently associated with a reduced risk of primary non-function when compared with conventional static cold storage. Liang et al. (2023) similarly demonstrated a statistically significantly lower risk of primary non-function for NRP versus conventional static cold storage (odds ratio 0.43, 95% CI 0.22 to 0.85, p=0.01).

  Within individual cohorts, Watson et al. 2019 reported a primary non-function rate of 0.0% in the NRP group compared with 7.0% in the conventional static cold storage group, although this difference was not statistically significant (p=0.1347). Hessheimer et al. (2022) reported a primary non-function rate of 3.0% for NRP compared with 6.0% for conventional static cold storage, which was not statistically significant (odds ratio 0.57, 95% CI 0.25 to 1.30, p=0.184). Gaurav et al. (2022)

reported a 0.0% primary non-function rate for NRP compared with 5.0% for conventional static cold storage (p=0.246, not statistically significant). Similarly, Puttappa et al. (2025) reported a 0.0% primary non-function rate for NRP, compared with 3.0% for conventional static cold storage.

- **NRP versus NMP**
  Primary non-function rates for NRP were low, with Gaurav et al. (2022) reporting 0.0% for NRP versus 1.5% for NMP, and Puttappa et al. (2025) reporting 0.0% for NRP versus 1.0% for NMP.

Early allograft dysfunction

Early allograft dysfunction was reported in 7 studies, including 2 systematic reviews.

- **NRP versus mixed non-NRP**
  Mastrovangelis et al. (2024) found no statistically significant difference in early allograft dysfunction rates between NRP and their mixed non-NRP group in their systematic review (relative risk 0.78, 95% CI 0.51 to 1.21, p=0.27).

- **NRP versus conventional static cold storage**
  When compared with conventional static cold storage, results were generally favourable for NRP. Liang et al. (2023) found that NRP carried a statistically significantly lower risk of early allograft dysfunction compared with conventional static cold storage (odds ratio 0.58, 95% CI 0.42 to 0.80, p<0.010). Hessheimer et al. (2022) reported statistically significantly lower early allograft dysfunction in the NRP group (15.0%) compared to the conventional static cold storage group (23.0%) (odds ratio 0.56, 95% CI 0.36 to 0.87, p=0.010). Gaurav et al. (2022) noted a rate of 14.0% for NRP

compared with 21.0% for conventional static cold storage, although this was not statistically significant between cohorts (p=0.20). However, the incidence of early allograft dysfunction was statistically significantly lower in the NRP group compared with the conventional static cold storage group (12.0% compared with 32.0%, p=0.0076) in the Watson et al. (2019) study.

Gaurav et al. (2022) reported that NRP was associated with statistically significantly lower model for early allograft function scores (median: 4.1, interquartile range: 2.5 to 5.6), compared with the conventional static cold storage group (median: 5.5, interquartile range: 4.3 to 7.0). After risk adjustment, NRP was associated with an estimated mean reduction in the model for early allograft function score of 1.52 points compared to the conventional static cold storage cohort (p<0.001), indicating improved early allograft function. Puttappa et al. (2025) similarly reported median scores of 4.1 for NRP compared with 5.8 for conventional static cold storage (p<0.001). Watson et al. (2019) noted statistically significantly lower scores for NRP (3.5) compared with conventional static cold storage (5.0) (p<0.001).

- **NRP versus NMP**

  Evidence comparing early allograft dysfunction between NRP and NMP is mixed. Compared against NMP, Mohkam et al. (2022) reported that early allograft dysfunction rates were higher for the NRP group (20.6%) than the NMP group (8.8%), though this difference was not statistically significant (p=0.133). Gaurav et al. (2022) observed similar rates between NRP (14.0%) and NMP (11.0%) (p=0.20 between cohorts), and comparable model for early allograft function scores (4.1 compared with 3.7; p<0.001), indicating a statistically significant difference between NRP, NMP and

conventional static cold storage). Puttappa et al. (2025) reported model for early allograft function scores of 4.1 for NRP compared with 3.3 for NMP.

Graft survival or loss

Graft survival or loss was evaluated in all 8 of the prioritised studies.

- **NRP versus mixed non-NRP**
  The systematic review by Mastrovangelis et al. (2024) found that NRP was associated with statistically significantly lower rates of graft loss compared with mixed non-NRP modalities (hazard ratio 0.44, 95% CI 0.33 to 0.58, p<0.00001).

- **NRP versus conventional static cold storage**
  Against conventional static cold storage, the evidence favours NRP for graft survival. In the Patrono et al. (2025) study, the meta analysis showed that NRP statistically significantly improved graft survival compared with conventional static cold storage (relative risk 1.11, 95% CI 1.05 to 1.17, p=0.0001) with low cross study heterogeneity. Liang et al. (2023) similarly reported statistically significantly improved 1 year graft survival for NRP grafts compared to conventional static cold storage (odds ratio 2.40, 95% CI 1.65 to 3.49, p<0.01).

  Within individual studies, Watson et al. (2019) reported a 30 day graft loss of 2.0% in the NRP group compared with 12.0% in the conventional static cold storage group (p=0.0559), and a 90 day graft survival of 97.7% and 89.8% respectively (p=0.1090). Gaurav et al. (2022) reported that transplant survival (defined as graft survival non-censored for death) at 6 months was 94.0% for NRP compared with 87.0% for conventional static cold storage, and at 3 years was 90.0% for NRP compared with 76.0% for

conventional static cold storage; there was no statistically significant difference between the cohorts (p=0.114). Puttappa et al. (2025) reported 5 year transplant survival at 85.0% for NRP compared with 69.0% for conventional static cold storage, representing a statistically significant improvement (hazard ratio 2.4, 95% CI 1.1 to 5.4, p=0.028). Similarly, Hessheimer et al. (2022) observed statistically significantly lower graft loss in the NRP group (14.0%) compared with the conventional static cold storage group (34.0%) (adjusted hazard ratio 0.371, 95% CI 0.316 to 0.601, p<0.001).

- **NRP versus NMP**
  When evaluating NRP against NMP, outcomes are similar. Mohkam et al. (2022) reported comparable 2 year graft survival rates of 89.4% for NRP and 88.2% for NMP, with no statistically significant difference (p=0.516). Gaurav et al. (2022) reported a 3 year transplant survival (non-censored for death) of 90.0% in the NRP group compared with 76.0% in the NMP group, which was not statistically significant between the cohorts (p=0.114).

Transplant utilisation and discard rate

Transplant utilisation and discard were reported across 4 studies, including 1 systematic review. Overall, the evidence regarding transplant utilisation is mixed and dependent on the comparator technique.

- **NRP versus mixed non-NRP**
  The systematic review by Mastrovangelis et al. (2024) observed that the organ discard rate (the inverse of utilisation) was comparable between the

cohorts, reported at 30.0% for the NRP group and 31.0% for the mixed non-NRP group.

- **NRP versus conventional static cold storage**
  When NRP is compared against conventional static cold storage, a clear statistical benefit is observed. The observational cohort by Hessheimer et al. (2022) demonstrated a statistically significant reduction in discarded livers, noting that 42.2% (230 out of 545) were discarded in the NRP group, compared with 51.2% (132 out of 258) in the conventional static cold storage group (p=0.015).

- **NRP versus NMP**
  In comparisons of NRP against NMP, individual cohort studies indicated lower utilisation rates with NRP compared with NMP. Gaurav et al. (2022) reported utilisation at 69.0% for NRP compared with 77.0% for NMP, while Mohkam et al. (2022) observed rates of 70.0% and 85.0%, respectively, although this difference was not statistically significant (p=0.052).

Recipient mortality and survival

Recipient mortality and survival were reported in 6 studies, which included 2 systematic reviews.

- **NRP versus mixed non-NRP**
  Mastrovangelis et al. (2024) reported that NRP was associated with statistically significantly lower recipient mortality than mixed non-NRP (hazard ratio 0.50, 95% CI 0.36 to 0.69, p=0.0001).

- **NRP versus conventional static cold storage**

Evidence is mixed when comparing NRP to conventional static cold storage. The systematic review by Liang et al. (2023) found no statistically significant difference in the 1 year recipient survival between the NRP and conventional static cold storage groups (odds ratio 1.15, 95% CI 0.53 to 2.46, p=0.73).

Results of the primary studies broadly aligned with the Mastrovangelis et al. (2024) findings: Watson et al. (2019) reported 90 day survival rates of 100.0% in the NRP group and 97.3% in the conventional static cold storage group, but the difference was not statistically significant (p=0.2810). Gaurav et al. (2022) reported 3 year recipient survival of 94.0% for NRP compared with 81.0% for conventional static cold storage, with no statistically significant difference between the cohorts (p=0.665). In contrast, Hessheimer et al. (2022) reported statistically significantly lower recipient death with NRP (12.0%) compared with conventional static cold storage (26.0%) (adjusted hazard ratio 0.517; 95% CI 0.354 to 0.755, p<0.001), and a superior 3 year survival of 89.0% compared with 76.0%.

- **NRP versus NMP**

  Mohkam et al. (2022) reported comparable 2 year recipient survival of 96.4% for NRP compared with 90.9% for NMP, with no statistically significant difference (p=0.275). Gaurav et al. (2022) found comparable 3 year recipient survival between the NRP (94.0%) and NMP (90.0%) cohorts (p=0.665).

Retransplantation

Retransplantation rates were reported in 2 individual cohort studies.

- **NRP versus conventional static cold storage**

Compared to conventional static cold storage, Hessheimer et al. (2022) found that retransplantation rates were statistically significantly lower for the NRP cohort (3.5%) than for the conventional static cold storage cohort (12.0%) (odds ratio 0.258; 95% CI 0.135 to 0.494; p<0.001). Gaurav et al. (2022) reported a retransplantation rate of 4.0% for the NRP group, compared with 18.0% for the conventional static cold storage group, representing a statistically significant difference between cohorts (p=0.04).

- **NRP versus NMP**
  When comparing NRP directly with NMP, Gaurav et al. (2022) also noted a lower rate of retransplantation with NRP (4.0%) compared with NMP (12.0%) (p=0.04 between cohorts).

Safety

Recipient hospitalisation

Hospital length of stay was reported in 3 cohort studies. Overall, the evidence regarding recipient hospitalisation is mixed, with results varying between studies and comparators.

- **NRP versus conventional static cold storage**
  Length of stay was slightly shorter for NRP in some studies. Gaurav et al. (2022) reported a median stay of 15 days (interquartile range: 13 to 23) for NRP compared with 18 days (interquartile range: 15 to 30) for the conventional static cold storage group, representing a statistically significant difference between the NRP, conventional static cold storage and NMP cohorts (p=0.05). Similarly, Puttappa et al. (2025) reported a hospital stay of 17 days(interquartile range: 13 to 24) for NRP and 16 days

(interquartile range: 13 to 24) for conventional static cold storage (p=0.890 between cohorts).

- **NRP versus NMP**
  Gaurav et al. (2022) reported a median stay of 15 days for NRP compared with 19 days (interquartile range: 13 to 29) for NMP (p=0.05 between cohorts). Mohkam et al. (2022) reported a median hospital stay of 16 days (interquartile range: 13 to 20) for the NRP group and 14 days (interquartile range: 8 to 17) for the NMP group, which was statistically significantly different favouring the NMP group (p=0.018). Puttappa et al. (2025) reported 17 days for NRP (interquartile range: 13 to 24) compared with 19 days (interquartile range: 12 to 28) for NMP (p=0.890 between cohorts).

Biliary complications

Overall biliary complications, including biliary strictures, were reported across 5 studies, including 1 systematic review.

- **NRP versus mixed non-NRP**
  Mastrovangelis et al. (2024) reported that NRP was associated with statistically significantly lower rates of other biliary complications compared with mixed non-NRP (relative risk 0.61, 95% CI 0.44 to 0.84, p=0.003).

- **NRP versus conventional static cold storage**
  NRP is associated with a lower incidence of general biliary complications when compared to conventional static cold storage. Hessheimer et al. (2022) found that overall biliary complications were statistically significantly lower in the NRP group (12.0%) compared with the conventional static cold storage group (29.0%) (odds ratio 0.320, 95% CI

0.211 to 0.485, p<0.001). Gaurav et al. (2022) similarly noted an overall biliary complication rate of 22.0% for NRP compared to 42.0% for conventional static cold storage, representing a statistically significant difference between NRP, conventional static cold storage and NMP (p=0.024). Watson et al. (2019) reported that the rate of anastomotic strictures was statistically significantly lower for NRP (7.0%) compared with conventional static cold storage (27.0%) (p=0.0041). However, the rate of biliary leaks was comparable between the 2 groups (7.0% compared with 10.0%), with no statistically significant difference (p=0.7731).

- **NRP versus NMP**
  When comparing NRP directly to NMP, biliary complications appear lower with NRP. Gaurav et al. (2022) reported an overall complication rate of 22.0% for NRP, 42.0% for conventional static cold storage and 37.0% for NMP (p=0.024 between cohorts). Mohkam et al. (2022) demonstrated that anastomotic strictures were statistically significantly lower in the NRP cohort (10.3%) compared with the NMP cohort (38.2%) (p<0.001).

Ischaemic cholangiopathy

The incidence of ischaemic cholangiopathy was reported in 2 systematic reviews and 2 observational cohort studies.

- **NRP versus mixed non-NRP**
  The incidence of ischaemic cholangiopathy was statistically significantly lower in the NRP group compared with mixed non-NRP. In the systematic review by Mastrovangelis et al. (2024), the incidence in the NRP group was 2.6% compared to 13.2% in the mixed non-NRP group, representing

a statistically significant risk reduction (relative risk 0.23, 95% CI 0.11 to 0.49, p=0.0002).

- **NRP versus conventional static cold storage**
  The incidence of ischaemic cholangiopathy was statistically significantly lower in the NRP group compared with conventional static cold storage. The Patrono et al. (2025) meta analysis found that NRP statistically significantly reduced the incidence of ischaemic cholangiopathy compared with conventional static cold storage (relative risk 0.10, 95% CI 0.05 to 0.21, p<0.0001). Heterogeneity between the included studies was low (I^2 =0%).

  Within the individual cohort studies, Watson et al. (2019) reported no cases of ischaemic cholangiopathy in the NRP group (0.0%) compared with an incidence of 27.0% in the conventional static cold storage group, representing a statistically significant reduction (p<0.0001). Additionally, Hessheimer et al. (2022) reported that rates of observed ischaemic type biliary lesions were statistically significantly lower in the NRP group (1.0%) compared with the conventional static cold storage group (9.0%) (odds ratio 0.111, 95% CI 0.040 to 0.309, p<0.001).

Hepatic artery thrombosis

Rates of hepatic artery thrombosis were detailed in 6 studies, which included 1 systematic review.

- **NRP versus mixed non-NRP**
  Mastrovangelis et al. (2024) reported that NRP was associated with statistically significantly lower rates of hepatic artery thrombosis compared with mixed non-NRP (relative risk 0.53, 95% CI 0.31 to 0.92, p=0.02).

- **NRP versus conventional static cold storage**
  Evidence is mixed when comparing NRP to conventional static cold storage. In individual studies, Hessheimer et al. (2022) found the rate of hepatic artery thrombosis was statistically significantly lower for NRP (4.0%) than for conventional static cold storage (7.0%) (odds ratio 0.452, 95% CI 0.219 to 0.932, p=0.032). Gaurav et al. (2022) reported a rate of 1.0% for NRP compared with 8.0% for conventional static cold storage, which was not statistically significant (p=0.18). Watson et al. (2019) reported a 28 day hepatic artery thrombosis rate of 2.0% for NRP compared with 3.0% for conventional static cold storage, showing no statistically significant difference (p>0.99).

- **NRP versus NMP**
  Gaurav et al. (2022) reported a 1.0% rate for NRP compared to 8.0% for NMP (p=0.18), while Mohkam et al. (2022) observed an identical rate of 2.9% in both the NRP and NMP groups, with no statistically significant difference (p>0.99).

Renal complications

Renal complications, primarily acute kidney injury and chronic kidney disease, were reported in 3 cohort studies.

- **NRP versus conventional static cold storage**
  Evidence is mixed when comparing NRP to conventional static cold storage. Gaurav et al. (2022) reported lower rates of acute kidney injury for NRP (39.0%) compared with conventional static cold storage (55.0%) but this was not statistically significant (p=0.08), and there were comparable rates of chronic kidney disease at 6 months (31.0% versus

33.0%; p=0.60). Puttappa et al. (2025) found that the incidence of stage 2 or higher acute kidney injury was 29.0% in the NRP group, which was statistically significantly lower than the 47.0% observed in the conventional static cold storage group (p=0.033). Watson et al. (2019) found that while there was less deterioration in renal function for NRP recipients compared to conventional static cold storage recipients, this difference was not statistically significant (p=0.6229).

- **NRP versus NMP**
  When compared to NMP, renal outcomes were comparable. Gaurav et al. (2022) reported acute kidney injury rates of 39.0% for NRP and 40.0% for NMP (p=0.08 between cohorts), with chronic kidney disease at 6 months occurring in 31.0% and 25.0%, respectively (p=0.060 between cohorts). Puttappa et al. (2025) similarly reported comparable rates of significant acute kidney injury (stage 2 or higher) between NRP (29.0%) and NMP (28.0%), with a statistically significant difference between NRP, NMP and conventional static cold storage (p=0.033).

Non-anastomotic stricture

The incidence of non-anastomotic stricture was reported in 3 studies, including 1 systematic review.

- **NRP versus conventional static cold storage**
  The systematic review by Liang et al. (2023) found a statistically significant difference in non-anastomotic strictures between NRP and conventional static cold storage groups (odds ratio 0.27; 95% CI 0.11 to 0.68; p<0.01). Gaurav et al. (2022) reported that the overall rate of non-anastomotic strictures was 6.0% in the NRP group, compared with 25.0% in the

conventional static cold storage group (p=0.009 between cohorts). When assessing for clinically significant non-anastomotic strictures, Gaurav et al. (2022) reported 0.0% in the NRP group, compared with 14.0% for conventional static cold storage (odds ratio 0.20, 95% CI 0.06 to 0.72, p=0.01).

- **NRP versus NMP**
  Gaurav et al. (2022) reported clinically significant non-anastomotic stricture rates of 0.0% for NRP compared with 11.0% for NMP and overall non-anastomotic stricture rates of 6.0% for NRP compared with 19.0% for NMP (p=0.009 between cohorts). Mohkam et al. (2022) similarly reported a non-anastomotic stricture rate of 2.9% in the NRP group compared to 8.8% in the NMP group, which was not statistically significant (p=0.330).

Procedure related and device adverse events

Procedure related and device adverse events were detailed in 2 cohort studies, focusing on technical failures that occurred during the surgical retrieval and removal of the donor liver.

- **NRP versus conventional static cold storage**
  Hessheimer et al. (2022) reported the reasons for discarding a cDCD liver before transplantation. Overall, technical problems led to the discard of 1.0% of livers in the NRP group, compared to 4.0% in the conventional static cold storage group (p=0.003). Specific technical failures relating to the NRP procedure itself were rare, leading to a discard in 0.1% of the NRP cases. Additionally, Watson et al. (2019) reported that 11.6% of livers in the NRP group sustained physical damage during the surgical retrieval

procedure, compared with 25.7% in the conventional static cold storage group, though this difference was not statistically significant (p=0.0689).

Anecdotal and theoretical adverse events

Expert advice was sought from consultants who have been nominated or ratified by their professional society or royal college. They were asked if they knew of any other adverse events for this procedure that they had heard about (anecdotal), which were not reported in the literature. They were also asked if they thought there were other adverse events that might possibly occur, even if they had never happened (theoretical).

Anecdotal and theoretical adverse events:

- Circuit thrombosis because of inadequate heparinisation
- Misplaced or failed cannulation
- Inadvertent brain perfusion
- Vascular donor damage affecting recipient outcomes
- Delayed determination of donor death
- Organ loss because of prolonged vascular complications
- Prolonged donor operation time
- Potential for donor to recipient infection

Seven professional expert questionnaires for this procedure were submitted. Three were from the selected experts and 4 from other clinicians not selected as experts. Find full details of what the professional experts said about the procedure in the specialist advice questionnaires for this procedure.

Summary of the evidence considered

NRP versus conventional static cold storage

Interventional procedures external assessment report: In-situ normothermic regional perfusion of the abdomen for livers donated after controlled circulatory death

Date: [April 2026]

Key efficacy points:

- NRP is associated with improved clinical efficacy compared to conventional static cold storage.
- NRP is associated with improved short and long term survival outcomes for the graft, with statistically significant reductions in graft loss compared to conventional static cold storage.
- Evidence regarding recipient mortality is mixed, with some studies showing statistically significant reductions compared to conventional static cold storage, and others showing comparable outcomes.
- NRP is associated with statistically significant reductions in the incidence of primary non-function and early allograft dysfunction, leading to a significantly lower requirement for retransplantation, compared to conventional static cold storage.
- Organ utilisation rates are higher with NRP compared to conventional static cold storage, with evidence demonstrating a statistically significant reduction in discarded livers.
- Evidence regarding recipient hospitalisation and length of stay is mixed, with results varying between the included studies reporting on NRP and conventional static cold storage.

Key safety points:

- NRP results in statistically significant risk reductions for ischaemic cholangiopathy, clinically significant non-anastomotic strictures, and

overall biliary complications compared with conventional static cold storage.

- The incidence of hepatic artery thrombosis is generally lower in people receiving NRP compared with conventional static cold storage, though the evidence is mixed and this difference does not consistently reach statistical significance.

- Postoperative renal complications, including the incidence and severity of acute kidney injury, are either numerically lower or statistically significantly reduced in cohorts utilising NRP compared with conventional static cold storage, depending on the study.

- Technical failures and procedure related adverse events during surgical retrieval, including physical damage to the organ, are either numerically lower or statistically significantly reduced with NRP compared to conventional static cold storage.

NRP versus NMP

Key efficacy points:

- Overall efficacy outcomes are broadly equivalent between in-situ NRP and ex-situ NMP.

- Both perfusion strategies (NRP and NMP) yield comparable graft survival and recipient survival rates up to 3 years, alongside very low incidences of primary non-function and early allograft dysfunction.

- While overall graft outcomes are comparable, limited evidence indicates that NRP may result in a statistically significantly lower requirement for retransplantation compared to NMP.
- Limited evidence from cohort studies suggests NMP may allow slightly higher organ utilisation rates compared to NRP, though these differences did not reach statistical significance.
- Evidence regarding hospital length of stay is mixed when comparing NRP and NMP directly.

Key safety points:

- The overall safety profiles of NRP and NMP are comparable, with no statistically significant differences observed in the incidence of several major postoperative complications (Clavien Dindo grade III or higher) between the 2 techniques.
- Evidence indicates no statistically significant differences between NRP and NMP regarding the incidence of hepatic artery thrombosis, or postoperative renal complications.
- NRP may provide superior preservation of the biliary system compared with NMP, with statistically significantly lower rates of clinically significant non-anastomotic strictures and overall biliary complications.

NRP versus mixed non-NRP

Key efficacy points:

- Compared to pooled mixed non-NRP cohorts, the NRP cohorts show statistically significantly lower rates of graft loss, recipient mortality, and primary non-function, though early allograft dysfunction rates were comparable.

Key safety points:

- The safety profile of livers recovered using NRP is superior to those recovered using mixed non-NRP modalities regarding the prevention of biliary complications and ischaemic cholangiopathy, with statistically significantly lower rates of hepatic artery thrombosis.

Limitations and considerations

- **Limited national data**: although some priority evidence is derived from the UK transplant registry (Watson et al. 2019), this data is limited to the early retrospective experiences of 2 transplant centres. There is a lack of comprehensive, prospective national registry data evaluating the procedure in the UK.
- **Absence of randomised controlled trials**: there is an absence of randomised controlled trials for this procedure; all prioritised evidence is from observational cohorts and systematic reviews. This is primarily due to the practical and ethical challenges of randomising donor interventions.
- **Study overlap and mixed comparators**: there is a large overlap of primary studies across the included systematic reviews. Consequently, the cumulative evidence base may appear larger than the true number of unique participants.
- **Comparator heterogeneity**: several reviews group different control groups together, comparing NRP against a mix of conventional static cold storage, NMP and hypothermic oxygenated machine perfusion. This

'mixed comparator' approach makes it difficult to isolate the specific treatment effect of NRP relative to conventional static cold storage, the current standard of care.

- **Lack of longer term data**: while 1 study (Puttappa et al. 2025) reported outcomes at 5 years, there is a limited amount of medium term outcome data for graft and recipient survival, and a lack of data at 10 years.
- **Variation in clinical protocols**: there is geographical variation in the clinical protocols used for NRP (e.g., differences in cannulation techniques or perfusion parameters). To ensure relevance to the UK NHS context, this assessment prioritised evidence from the UK and other countries with similar NRP protocols.

Ongoing trials

A search of clinical trial registries identified 8 relevant trial records. Three trials are complete, with 2 of the trials' results published (ISRCTN89667087 and NCT04945135). The EAG reviewed the associated publications for inclusion. Both were included at full text but were not prioritised. Another trial (NCT05361044) is reported as completed, but no associated results have been identified.

Of the 5 ongoing trials, 3 are recruiting, 1 is not yet recruiting, and the status of 1 is unknown, but some of the results from this trial have already been published. The ongoing trial registrations and that with an unknown status are summarised below:

- Study acronym: CONCLUDE. Title: Confirming Permanent Lack of Blood Flow to the Brain During NRP DCC Organ Transplant. ClinicalTrials.gov identifier: NCT05884736. Status: Recruiting. Country: UK. Trial Design: Prospective Observational cohort. Devices: Multimodal neuromonitoring will include:

Transcranial colour coded Doppler, Electroencephalography, and Somatosensory evoked potentials or brainstem auditory evoked potentials. Population: Standard criteria death determination by circulatory criteria donors undergoing NRP perfusion process to recondition organs prior to procurement (Adults 18 to 75 years of age). Date: 16/05/2023 (registration date) to 12/2025 (estimated completion date). Country: Canada. Associated publications: None.

- Title: Abdominal Regional Perfusion in Donation After Cardiac Death for Multi Organ Transplantation. ClinicalTrials.gov identifier: NCT03946852. Status: Not yet recruiting. Indication: liver transplant (end stage liver disease, cirrhosis, ischemia reperfusion injury). Estimated n=20. Trial design: interventional (single group). Devices: Abdominal Regional Perfusion. Date: 06/2019 (registration date) to 06/2026 (estimated completion). Country: Canada. Associated publications: None.

- Title: Direct Comparison of NRP With DHOPE and COR NMP to Maximize the Use of ECD After DCD Donation in the Netherlands. ClinicalTrials.gov identifier: NCT05327478. Status: Recruiting. Trial Design: Prospective Observational Case Control. Population: 150 cDCD Donors (Maastricht type III and IV), Age 50 to 75 years. Devices/Intervention: NRP, dual hypothermic oxygenated machine perfusion, COR NMP. Date: 24/02/2022 (registration date) to 01/05/2029 (estimated completion date). Country: The Netherlands. Associated publications: None.

- Study Acronym: iMaps. Title: Mechanistic Evaluation of Machine Perfusion Strategies in Donation After Circulatory Death Liver Transplantation. ClinicalTrials.gov identifier: NCT06371924. Status: Recruiting. Trial Design: Randomised interventional parallel assignment study. Devices: Machine Perfusion (NRP, NMP or hypothermic oxygenated machine perfusion).

Population: 36 Adult cDCD category III donors. Date: 13/02/2024 (registration date) to 31/05/2026 (estimated completion date). Country: UK. Associated publications: None.

- Study Acronym: DCDNet. Title: Optimization of an Evidence based Organizational Model of Liver and Pancreas Transplant Using Cardiac Death Donors: a Pilot, Prospective, Randomized, Multicenter Study for the Comparison of Hypothermic Versus Normothermic Ex vivo Preservation. ClinicalTrials.gov identifier: NCT04744389. Status: Unknown. Trial design: Randomised interventional parallel assignment study. Devices: NRP and ex vivo hypothermic oxygenated machine perfusion, and NRP and ex vivo NMP. Date: 18/01/2021 (registration date) to 31/03/2023 (estimated completion date). Population: 60 Adult cDCD (n=20) and uncontrolled donation after circulatory death (n=40) donors. Country: Italy. Three associated publications were identified during the literature search, Basta et al. (2023), Torri et al. (2024) and Lazzeri et al. (2025a). The study by Basta et al. (2023) was excluded at the title and abstract screening stage because it focused on biomarkers. An additional publication linked to this trial, Lazzeri et al. (2025b), was not identified during the database searches, but it was considered after being identified through the search for ongoing trials. Following a full text review, Torri et al. (2024), Lazzeri et al. (2025a) and Lazzeri et al. (2025b) were all included.

Existing assessments of this procedure

No existing health technology assessments or societal guidelines are included in the evidence for this report. Consensus statements and societal guidance documents were identified during the literature search, but were excluded at the

full text screening stage because of the large volume of more relevant primary comparative evidence.

Related NICE guidance

Interventional procedures

Ex-situ machine perfusion for extracorporeal preservation of lungs (ex vivo lung perfusion) for transplant (2021), NICE interventional procedure guidance 695 (IP695) (Recommendation: standard arrangements)

Ex-situ machine perfusion for extracorporeal preservation of livers for transplantation (2019), NICE interventional procedure guidance 636 (IPG636) (Recommendation: special arrangements)

Extracorporeal whole liver perfusion for acute liver failure (2021), NICE interventional procedure guidance 690 (IPG690) (Recommendation: research only)

Normothermic extracorporeal preservation of hearts for transplantation following donation after brainstem death (2016), NICE interventional procedure guidance 548 (IPG548) (Recommendation: standard arrangements)

Living donor liver transplantation (2015) NICE interventional procedure guidance 535 (IPG535) (Recommendation: standard arrangements)

Technology appraisals

Machine perfusion systems and cold static storage of kidneys from deceased donors (2009), NICE technology appraisal guidance 165 (TA165)

NICE guidelines

Alcohol use disorders: diagnosis and management of physical complications (2017), NICE clinical guideline 100 (CG100)

Organ donation for transplantation: improving donor identification and consent rates for decreased organ donation (2011; last updated 2016) NICE clinical guideline 135 (CG135)

Hepatitis B (chronic): diagnosis and management (2013; last updated 2017), NICE clinical guideline 165 (CG165)

NICE quality standards

Hepatitis B (2014), NICE quality standard 65 (QS65)
Liver disease (2017), NICE quality standard 152 (QS152)

Health technology evaluations

- Ex-situ machine perfusion devices for deceased donor liver transplants (In progress due to complete August 2026) NICE HealthTech guidance in development HTE10066
- Machine perfusion devices for lung transplants (in development)

National policy documents

NHS Blood and Transplant UK national protocol for normothermic regional perfusion (NRP) in controlled Donation after Circulatory determination of Death (2025)

NHS Blood and Transplant policy on liver transplantation: selection criteria and recipient registration (2024)

NHS Blood and Transplant policy on decreased donor liver distribution and allocation (2025)

NHS Blood and Transplant policy on the registration process for liver indications requiring additional waiting time (2025)

NHS Blood and Transplant policy on living donor liver transplant (2025)

Other national guidelines

Milson C, Considine A, Cramp M et al. (2020) Adult liver transplantation: a UK clinical guideline – part 1: pre operation. Frontline Gastroenterology 11(5): 375 384.

Milson C, Considine A, Cramp M et al. (2020) Adult liver transplantation: UK clinical guideline part 2: summary and post operation. Frontline Gastroenterology 11(5): 385 396.

British Transplantation Society's UK guidelines on transplantation from deceased donors after circulatory death (2023)

Professional societies

- British Association for the Study of the Liver
- British Liver Transplant Group
- British Transplantation Society

Evidence from people who have had the procedure and patient organisations

NICE received no submissions from patient organisations about in-situ NRP of the abdomen for livers donated after controlled circulatory death.

NICE received no questionnaires from people who have had the procedure (or their carers).

Company engagement

NICE asked companies who manufacture a device potentially relevant to this procedure for information on it. NICE received 1 completed submission. This was considered during the assessment, and any relevant points or studies have been taken into consideration when preparing this report.

References

Arnaoutakis GJ, George TJ, Robinson CW et al. (2011) Severe acute kidney injury according to the RIFLE (risk, injury, failure, loss, end stage) criteria affects mortality in lung transplantation. The Journal of Heart and Lung Transplantation 30(10): 1161–8

Carroll C., Cooper K., Harnan S., Wailoo A. Technical Support Document 27. Prioritising studies and outcomes for consideration in NICE HealthTech literature reviews (2025)

Eden J, Sousa Da Silva R, Cortes Cerisuelo M, et al. (2023) Utilization of livers donated after circulatory death for transplantation – An international comparison. Journal of Hepatology 78(5):1007–16.

Esser H, De Jong IE, Roos FM et al. (2025) Consensus classification of biliary complications after liver transplantation: guidelines from the BileducTx meeting. British Journal of Surgery 112(5):znae321

Foley DP, Fernandez LA, Leverson G et al. (2011) Biliary complications after liver transplantation from donation after cardiac death donors: an analysis of risk factors and long term outcomes from a single center. Annals of Surgery 253(4): 817–25

Gaurav R, Butler AJ, Kosmoliaptsis V et. al. (2022) Liver Transplantation Outcomes From Controlled Circulatory Death Donors: SCS vs in situ NRP vs ex situ NMP. Annals of Surgery 275(6): 1156–64.

Haddaway NR, Grainger MJ, Gray CT (2021) citationchaser: An R package and Shiny app for forward and backward citations chasing in academic searching.

Hessheimer AJ, de la Rosa G, Gastaca M et al. (2022) Abdominal normothermic regional perfusion in controlled donation after circulatory determination of death liver transplantation: outcomes and risk factors for graft loss. American Journal of Transplantation 22(4): 1169–81

Levey AS, Coresh J, Bolton K et al. (2002) K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. American Journal of Kidney Diseases 39(2 Suppl. 1): i–ii+S1–S266

Liang A, Cheng W, Cao P et al. (2023) Effects of machine perfusion strategies on different donor types in liver transplantation: a systematic review and meta analysis. International Journal of Surgery 109(11): 3617–30

Mastrovangelis C, Frost C, Hort A et al. (2024) Normothermic Regional Perfusion in Controlled Donation After Circulatory Death Liver Transplantation: A Systematic Review and Meta Analysis. Transplant International 37: 13263

Mohkam K, Nasralla D, Mergental H et al. (2022) In situ normothermic regional perfusion versus ex situ normothermic machine perfusion in liver transplantation from donation after circulatory death. Liver Transplantation 28(11): 1716–25

Neves DB, Rusi MB, Diaz LGG et al. (2016) Primary graft dysfunction of the liver: definitions, diagnostic criteria and risk factors. Einstein (Sao Paulo) 14: 567–72

NHS Blood and Transplant (2025) UK national protocol for normothermic regional perfusion (NRP) in controlled Donation after Circulatory determination of Death

Olthoff KM, Kulik L, Samstein B et al. (2010) Validation of a current definition of early allograft dysfunction in liver transplant recipients and analysis of risk factors. Liver Transplantation 16(8): 943–9

Oniscu GC, Randle LV, Muiesan P et al. (2014) In situ normothermic regional perfusion for controlled donation after circulatory death—the UK experience. American Journal of Transplantation 14(12): 2846–2854

Pareja E, Cortes M, Hervas D et al. (2015) A score model for the continuous grading of early allograft dysfunction severity. Liver Transplantation 21(1): 38–46

Patrono D, Del Prete L, Eden J et al. (2025) Machine perfusion of liver grafts: hypothermic versus normothermic versus normothermic regional perfusion. International Journal of Surgery 111(9): 5768–82

Puttappa A, Gaurav R, Kakhandki V et al. (2025) Normothermic regional and ex situ perfusion reduces postreperfusion syndrome in donation after circulatory

death liver transplantation: a retrospective comparative study. American Journal of Transplantation 25(6): 1296–305

Rodrigues T, Boike JR (2021) Biliary strictures: etiologies and medical management. Seminars in Interventional Radiology 38(3): 255–62

Tringali, A., Costa, D. and Ramai, D., 2025. Endoscopic management of biliary leaks: Where are we now? World Journal of Gastrointestinal Endoscopy, 17(7), p.107587.

Verdonk RC, Buis CI, Porte RJ et al. (2006) Anastomotic biliary strictures after liver transplantation: causes and consequences. Liver Transplantation 12(5): 726–35

Watson CJE, Hunt F, Messer S et al. (2019) In situ normothermic perfusion of livers in controlled circulatory death donation may prevent ischemic cholangiopathy and improve graft survival. American Journal of Transplantation 19(6): 1745–58

Appendix A: Methods and literature search strategy

Literature search methods

The EAG identified systematic reviews, primary studies, and clinical trial registrations relevant to in situ normothermic regional perfusion of the abdomen for livers donated after controlled circulatory death across a wide range of databases. The following databases of published evidence were searched from inception to January 2026: Medline ALL (via Ovid), Embase (via Ovid), Cochrane Library (CENTRAL and CDSR), CINAHL Ultimate (via EBSCO), and INAHTA. The medRxiv database of pre prints was searched for unpublished evidence. A search for clinical trials was performed across the ClinicalTrials.gov, ICTRP, and ISRCTN databases. Additionally, MHRA and FDA MAUDE were searched for reports of adverse events. The search strategy was developed in Medline using the Ovid interface by an information specialist and reviewed by another information specialist before it was finalised and translated into the other databases. The full search strategies are provided in the literature search strategy section of this appendix. No limits and restrictions were used in the database searches apart from removing animal studies on Medline.

As a supplementary search strategy to verify sensitivity of the database searches, back citation searching was performed on the included full text studies using the Shiny app *citationchaser* (Haddaway et al. 2021), which accesses bibliographic records through Lens.org. A total of 82 records that were published since 2023 were checked for relevance. Four records were found to be of relevance to the scope, but none were suitable for prioritisation. These are listed in table 5. The cut off date of 2023 was chosen based on the dates of the searches done for the relevant systematic reviews identified and prioritised for

this assessment, to identify any new evidence published since then that may not have been retrieved by the database searches.

Reference management

References were downloaded from the databases and deduplicated using the reference management software EndNote using a 2 stage process. First, automated deduplication based on author, title, and year was used to remove duplicate records on import. Then, manual deduplication was performed. During screening, the online screening tool Rayyan was used for reference management.

Literature selection methods

Literature selection was guided by the following eligibility criteria. Literature was included if it:

a) reported on people receiving a liver transplant from donors who have died from controlled circulatory death, or donor livers from donors who have died from controlled circulatory death;

b) reported on in situ NRP of the abdomen to retrieve the liver after the donor has died from controlled circulatory death;

c) used the following comparators: conventional static cold storage only, ex-situ NMP or hypothermic oxygenated machine perfusion only, ex-situ NMP or hypothermic oxygenated machine perfusion with conventional static cold storage;

d) had the following study designs: randomised controlled trials, non-randomised comparative studies, systematic reviews and meta analyses,

observational studies (retrospective and prospective), diagnostic accuracy studies, surveys, cross sectional studies, case series, or case reports;

e) were the following publication types: full text publications, conference abstracts and proceedings (provided they contain sufficient detail on methods and outcomes), letters and or correspondence that report novel research findings.

Literature was excluded if it:

a) reported on people receiving a liver transplant from donors who have died from non-circulatory death, on people receiving a liver transplant from donors who have died from uncontrolled circulatory death, or on organ transplantation for other organs, where no specific data for the liver is reported;

b) reported on thoracoabdominal NRP or ex-situ NMP/hypothermic oxygenated machine perfusion in the absence of an in situ NRP group;

c) had the following study designs: narrative review, animal study, editorial, commentary, cost effectiveness or economic study;

d) reported only on physiological outcomes.

The records were screened in Rayyan. Its AI capability to display studies in order of their likelihood of being included based on the reviewers' previous decision was not used and all decisions were made by the review team. At both the title and abstract and full text stages, all records were screened by 1 reviewer and a random 20.0% of excluded records were checked by a second reviewer, with any disagreements resolved through discussion.

In accordance with the NICE Interventional Procedures Programme Manual (PMG28) (NICE, 2025) and the principles of evidence selection outlined in TSD27 (Carroll et al, 2025), a targeted prioritisation strategy was developed and further refined using input from clinical experts. To form the main evidence summary, recent, larger scale comparative studies were prioritised (typically those with a sample size of 50 or more in the NRP group) that evaluated in situ NRP against the standard UK practice of conventional static cold storage, or NMP.

Priority was heavily weighted towards data from the UK and comparable European nations (specifically France, Spain, and the Netherlands) because of their structured national retrieval systems and similar cDCD protocols. Selected studies were required to report on key outcomes in the protocol, including graft survival, primary non-function, early allograft dysfunction, and key safety outcomes such as biliary complications (e.g., ischaemic cholangiopathy) and device related failures.

To prevent confounding of the primary efficacy data, we also applied a population filter to exclude studies exclusively evaluating extended criteria donors (such as those over 60 years of age). Studies were deprioritised if they utilised out of scope comparators (such as donation after brain death [DBD] or uncontrolled DCD) or originated from healthcare settings with NRP protocols which were not comparable to the UK (such as Italy's 20 minute no touch period) or practices involving thoracoabdominal NRP, such as the US. Furthermore, studies focusing solely on intra procedural technical variables (such as optimal perfusion duration or perfusate composition) rather than the efficacy of the intervention against standard care were deprioritised. Finally, in line with TSD27's guidance on study hierarchy and data synthesis, lower quality or non-empirical publications, including small case series (n<5), predictive machine learning papers, consensus

statements, studies on isolated single centre techniques, inaccessible conference abstracts, studies lacking liver specific data, and earlier publications of national registry data where a more recent, updated analysis of the same cohort was available, to avoid double counting people in the final synthesis, were deprioritised.

Potentially relevant studies not included in the main evidence summary are listed in the other relevant studies section, with a rationale for why each was not prioritised.

Literature search strategy

In the tables below, we provide a summary of the search results.

Database search audit

Database & interface	Search date	Number of records
Medline ALL (Ovid)	28/01/2026	220
Embase (Ovid)	28/01/2026	666
Cochrane Library CENTRAL Cochrane Library CDSR	27/01/2026	13 1
CINAHL Ultimate (EBSCO)	27/01/2026	17
INAHTA	27/01/2026	2
ClinicalTrials.gov	27/01/2026	16
ICTRP	27/01/2026	7
ISRCTN	27/01/2026	19
medRxiv	27/01/2026	19
Number of records after deduplication		**750**

Adverse event searches audit

Database	Search date	Number of records downloaded for review
MHRA	16/02/2026	6
MAUDE	16/02/2026	40

The search strategies as used in each database are presented below.

Ovid MEDLINE(R) ALL <1946 to January 27, 2026>

#	Query	Hits
1	Extracorporeal Membrane Oxygenation/	18187
2	((regional* or local* or abdom*) adj2 (perfus* or reperfus*)).tw.	6593
3	NRP.tw.	2299
4	abdominal RP.tw.	5
5	((extracorpor* or extra corpor*) adj1 (membran* oxygenat* or membran* reoxygenat* or membran* re oxygenat*)).tw.	21915
6	((normotherm* or normo therm*) adj2 (circulation or recirculation)).tw.	93
7	CardioHelp.tw.	33
8	GETINGE.tw.	68
9	Donor Assist.tw.	1
10	XVIVO.tw.	35
11	or/1 10	35824
12	Liver Transplantation/	69092
13	((liver* or hepat*) adj10 (donor* or donat* or recover* or retriev* or transplant* or procur* or graft* or allotransplant* or allograft*)).tw.	122732
14	or/12 13	131325
15	exp Heart Arrest/	60739
16	((circulatory or cardi* or heart) adj2 (arrest or death)).tw.	120213
17	(withdr* adj2 life support).tw.	727
18	non heart beating donor*.tw.	982
19	DCD.tw.	4515
20	cDCD.tw.	230
21	NHBD.tw.	340
22	or/15 21	145689
23	11 and 14 and 22	238
24	exp animals/ not humans.sh.	5418975
25	23 not 24	220

Embase <1974 to 2026 January 26>

#	Query	Hits
1	exp extracorporeal oxygenation/	59065
2	((regional* or local* or abdom*) adj2 (perfus* or reperfus*)).tw.	8890
3	NRP.tw.	3448
4	abdominal RP.tw.	9
5	((extracorpor* or extra corpor*) adj1 (membran* oxygenat* or membran* reoxygenat* or membran* re oxygenat*)).tw.	34116
6	((normotherm* or normo therm*) adj2 (circulation or recirculation)).tw.	137
7	CardioHelp.tw.	197
8	GETINGE.tw.	229
9	Donor Assist.tw.	0
10	XVIVO.tw.	162
11	or/1 10	73769
12	exp liver transplantation/	162634
13	((liver* or hepat*) adj10 (donor* or donat* or recover* or retriev* or transplant* or procur* or graft* or allotransplant* or allograft*)).tw.	205267
14	or/12 13	231582
15	exp heart arrest/	156863
16	non heart beating donor/	3165
17	((circulatory or cardi* or heart) adj2 (arrest or death)).tw.	202506
18	(withdr* adj2 life support).tw.	1218
19	non heart beating donor*.tw.	1375
20	DCD.tw.	9943
21	cDCD.tw.	401
22	NHBD.tw.	523
23	or/15 22	266033
24	11 and 14 and 23	666

Cochrane Library 27/01/2026 17:18:13

ID	Search	Hits
#1	MeSH descriptor: [Extracorporeal Membrane Oxygenation] explode all trees	396
#2	((regional* OR local* OR abdom*) NEAR/1 (perfus* OR reperfus*)):ti,ab,kw	471
#3	(NRP):ti,ab,kw	206
#4	(abdominal RP):ti,ab,kw	0
#5	((extracorpor* OR extra corpor*) NEXT ((membran* NEXT oxygenat*) OR (membran* NEXT reoxygenat*) OR (membran* NEXT re oxygenat*))):ti,ab,kw	1117
#6	((normotherm* OR normo therm*) NEAR/1 (circulation OR recirculation)):ti,ab,kw	1
#7	(CardioHelp):ti,ab,kw	6
#8	(GETINGE):ti,ab,kw	15
#9	(Donor NEXT Assist):ti,ab,kw	0
#10	(XVIVO):ti,ab,kw	73
#11	#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10	1869
#12	MeSH descriptor: [Liver Transplantation] explode all trees	1734
#13	((liver* OR hepat*) NEAR/9 (donor* OR donat* OR recover* OR retriev* OR transplant* OR procur* OR graft* OR allotransplant* OR allograft*)):ti,ab,kw	7770
#14	#12 OR #13	7770
#15	MeSH descriptor: [Heart Arrest] explode all trees	3202
#16	((circulatory OR cardi* OR heart) NEAR/1 (arrest OR death)):ti,ab,kw	17181
#17	(withdr* NEAR/1 "life support"):ti,ab,kw	16
#18	("non heart beating" NEXT donor*):ti,ab,kw	68
#19	(DCD):ti,ab,kw	468
#20	(cDCD):ti,ab,kw	11
#21	(NHBD):ti,ab,kw	10
#22	#15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21	17937
#23	#11 AND #14 AND #22	14
		13 CENTRAL, 1 CDSR

CINAHL Ultimate

#	**Query** (Limiters/Expanders: Expanders Apply equivalent subjects Search modes – Proximity. Last Run Via: Interface EBSCOhost Research Databases Search Screen Advanced Search Database CINAHL Ultimate)	**Results**
S23	S11 AND S14 AND S22	17
S22	S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21	50,699
S21	XB NHBD	27
S20	XB cDCD	21
S19	XB DCD	1,110
S18	XB "non heart beating donor*"	71
S17	XB (withdr* N1 "life support")	355
S16	XB ((circulatory OR cardi* OR heart) N1 (arrest OR death))	39,017
S15	(MH "Heart Arrest+")	24,296
S14	S12 OR S13	15,785
S13	XB ((liver* OR hepat*) N9 (donor* OR donat* OR recover* OR retriev* OR transplant* OR procur* OR graft* OR allotransplant* OR allograft*))	13,838
S12	(MH "Liver Transplantation")	8,335
S11	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10	11,127
S10	XB XVIVO	6
S9	XB "Donor Assist"	0
S8	XB GETINGE	50
S7	XB CardioHelp	18
S6	XB ((normotherm* OR normo therm*) N1 (circulation OR recirculation))	9
S5	XB ((extracorpor* OR extra corpor*) N0 ("membran* oxygenat*" OR "membran* reoxygenat*" OR "membran* re oxygenat*"))	7,094
S4	XB abdominal RP	3
S3	XB NRP	397
S2	XB ((regional* OR local* OR abdom*) N1 (perfus* OR reperfus*))	810
S1	(MH "Extracorporeal Membrane Oxygenation")	7,135

INAHTA January 27 2026 4:54 PM

Line	Query	Hits
23	#22 AND #14 AND #11	2
22	#21 OR #20 OR #19 OR #18 OR #17 OR #16 OR #15	303
21	NHBD	2
20	cDCD	2
19	DCD	4
18	non heart beating donor*	5
17	withdr* AND "life support"	0
16	(circulatory OR cardi* OR heart) AND (arrest OR death)	286
15	"Heart Arrest"[mhe]	72
14	#13 OR #12	132
13	(liver* OR hepat*) AND (donor* OR donat* OR recover* OR retriev* OR transplant* OR procur* OR graft* OR allotransplant* OR allograft*)	127
12	"Liver Transplantation"[mh]	48
11	#10 OR #9 OR #8 OR #7 OR #6 OR #5 OR #4 OR #3 OR #2 OR #1	47
10	XVIVO	0
9	"Donor Assist"	0
8	GETINGE	0
7	CardioHelp	1
6	(normotherm* OR normo therm*) AND (circulation OR recirculation)	0
5	(extracorpor* OR extra corpor*) AND membran* AND (oxygenat* OR reoxygenat* OR re oxygenat*)	35
4	abdominal RP	0
3	NRP	1
2	(regional* OR local* OR abdom*) AND (perfus* OR reperfus*)	9
1	"Extracorporeal Membrane Oxygenation"[mh]	33

ClinicalTrials.gov

Query	Hits	Cumulative hits
normothermic regional perfusion *in Intervention/treatment*	14	14
Liver Transplantation *in Other terms* AND Extracorporeal Membrane Oxygenation *in Intervention/treatment*	2	16
liver donation *in Other terms* AND Extracorporeal Membrane Oxygenation *in Intervention/treatment*	1	16
liver donor *in Other terms* AND Extracorporeal Membrane Oxygenation *in Intervention/treatment*	1	16
normothermic recirculation *in Intervention/treatment*	0	16
Liver Transplantation *in Other terms* AND NRP *in Intervention/treatment*	3	16
liver donation *in Other terms* AND NRP *in Intervention/treatment*	2	16
liver donor *in Other terms* AND NRP *in Intervention/treatment*	3	16

ICTRP

Query	Hits	Cumulative hits
normothermic regional perfusion *(simple search)*	7	7
normothermic regional perfusion *in Title* *Recruitment status is ALL*	7	7
normothermic regional perfusion *in Intervention* *Recruitment status is ALL*	0	7
liver *in Title* AND Extracorporeal Membrane Oxygenation *in Intervention* *Recruitment status is ALL*	0	7
liver *in Condition* AND Extracorporeal Membrane Oxygenation *in Intervention* *Recruitment status is ALL*	0	7
organ *in Title* AND Extracorporeal Membrane Oxygenation *in Intervention* *Recruitment status is ALL*	0	7
organ *in Condition* AND Extracorporeal Membrane Oxygenation *in Intervention* *Recruitment status is ALL*	0	7
donation *in Title* AND Extracorporeal Membrane Oxygenation *in Intervention* *Recruitment status is ALL*	0	7
donation *in Condition* AND Extracorporeal Membrane Oxygenation *in Intervention* *Recruitment status is ALL*	0	7
donor *in Title* AND Extracorporeal Membrane Oxygenation *in Intervention* *Recruitment status is ALL*	0	7
Donor *in Condition* AND Extracorporeal Membrane Oxygenation *in Intervention* *Recruitment status is ALL*	0	7
normothermic recirculation *in Intervention* *Recruitment status is ALL*	0	7

ISRCTN

Query	Hits	Cumulative hits
normothermic regional perfusion	6	6
Extracorporeal Membrane Oxygenation liver	12	18
normothermic recirculation	1	19

medRxiv

Query	Hits	Cumulative hits
normothermic regional perfusion *in Abstract or Title (words: all)*	2	2
Extracorporeal Membrane Oxygenation liver *in Abstract or Title (words: all)*	2	4
normothermic recirculation *in Abstract or Title (words: all)*	0	4
normothermic regional perfusion liver *in Full Text or Abstract or Title (words: all)*	16	19

MHRA

Query	Hits	Downloaded for review
"normothermic regional perfusion"	0	0
"Extracorporeal Membrane Oxygenation"	0	0
ECMO	0	0
"normothermic recirculation"	0	0
NRP	1^	1
"abdominal perfusion"	0	0
CardioHelp	3^	5
"Donor Assist"	0	0
Total		6

^Number of field safety notice roundups retrieved by the search. Each roundup contains multiple field safety notices.

MAUDE

Query (all years)	Hits	Downloaded for review
normothermic regional perfusion	8 (6 displayed)	6
Extracorporeal Membrane Oxygenation donor liver	3	3
ECMO	5 (3 duplicates)	2
normothermic recirculation donor liver	26	26
NRP donor liver	0	0
abdominal perfusion donor liver	3	3
CardioHelp	0	0
Donor Assist	0	0
Total		40

Appendix B: Other relevant studies

Other potentially relevant studies that were not included in the main evidence summary (**Tables 2 and 3**) are listed in tables 4, 5 and 6 below.

Table 4: Additional studies identified

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
Antoine C, Jasseron C, Dondero F et al. (2020) Liver Transplantation From Controlled Donors After Circulatory Death Using Normothermic Regional Perfusion: An Initial French Experience. Liver transplantation: official publication of the American Association for the Study of Liver Diseases and the International Liver Transplantation Society 26(11): 1516 1521	Study Design: Retrospective observational study (National program case series) Sample Size: cDCD livers: n=123 Follow up: 1 year Country: France	Graft Survival: 30 days: 93.1% 90 days: 93.1% 1 year: 89.7% Early allograft dysfunction: n=4 Primary non-function: n=3 Hepatic artery thrombosis: n=1 Recipient survival (1 year): 93.6% Transplant utilisation: 80.9% (123 out of 152)	Study lacks a standard care comparative arm (focuses only on adherence to national protocol versus deviations), limiting its ability to directly assess efficacy relative to standard NHS practice.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		First 4 years of a French cDCD program. Excellent liver transplant results were observed with NRP where protocol was followed. Use of NRP limits liver damage induced by warm ischemia.	
Barbier L, Guillem T, Savier E et al. (2022) Impact of the duration of normothermic regional perfusion on the results of liver transplant from controlled circulatory death donors: A retrospective, multicentric study. Clinical transplantation 36(2): e14536	Study Design: Retrospective, multicentre cohort. Sample Size: n=157 Follow up: Mean 2 years (plus or minus 1 years) Country: France (n=6 centres)	Did not identify any impact of in situ NRP duration on liver graft function nor on biliary complications. Early allograft dysfunction: n=30 (19.2%) Primary non-function: n=3 (1.9%) Biliary complications: n=26 (16.7%)	Study assesses internal protocol variations (evaluating different durations of NRP) rather than providing a comparison against a standard retrieval control arm.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
Bekki Y, Loszko A, Endo Y et al. (2026) Embracing Liver Transplantation From Donation After Circulatory Death in the United States in the Era of Perfusion Technology. Transplantation 110(2): e416 e424	Study Design: Retrospective observational study Sample Size: n=5535 DCD liver donors Follow up: 90 days Country: US	Utilisation rate: 21.5% (2022); 29.1% (2023); 42.5% (2024). Waitlist mortality (90 days): 5.3% (2022); 5.0% (2023); 4.6% (2024). Graft survival (90 days): 95.1% (2022); 95.7% (2023); 95.7% (2024). Recipient survival (90 days): 97.3% (2022); 97.7% (2023); 97.6% (2024).	Outcome data is not sufficiently granular (pools perfusion types and does not isolate controlled DCD) and lacks comprehensive reporting on the key safety outcomes defined in the scope. Follow up is also of short duration, and study is done in the US and less generalisable to UK NHS practice.
Blondeel J, van Leeuwen OB, Schurink IJ et al. (2025) Dynamic Preservation of Donation After Circulatory Death Liver Grafts From Donors Aged 60 y and Older. Transplantation 109(5): 844 852	Study Design: Retrospective, multicentre cohort. Sample Size (3 cohorts): Total: n=16 Static cold storage: n=56 aNRP: n=27 Dual hypothermic oxygenated machine perfusion controlled	Non-anastomotic strictures (1 year): Static cold storage: 21% aNRP: 7% Dual hypothermic oxygenated machine perfusion controlled oxygenated rewarming-NMP: 3% Early allograft dysfunction: Static cold storage: n=9 (16%)	Population included people who received a DCD liver graft from donors older than 60 years. Limited sample size in the intervention arm (aNRP n=27) relative to other identified comparative studies; larger cohorts were prioritised.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
	oxygenated rewarming NMP: n=33 Follow up: 1 year Country: Belgium	aNRP: n=5 (19%) Dual hypothermic oxygenated machine perfusion controlled oxygenated rewarming NMP: n=7 (21%) Graft survival (1 year): Static cold storage: n=52 (93%) aNRP: n=25 (93%) Dual hypothermic oxygenated machine perfusion controlled oxygenated rewarming NMP: n=31 (94%) Recipient survival (1 year): Static cold storage: n=52 (93%) aNRP: n=26 (96%) dual hypothermic oxygenated machine perfusion controlled oxygenated rewarming NMP: n=32 (97%) In situ aNRP resulted in a marked decrease in non-	

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		anastomotic strictures incidence, compared with Static cold storage.	
Bluhme E, Gabel M, Martinez de la Maza L et al. (2024) Normothermic regional perfusion in controlled DCD liver procurement: Outcomes of the Swedish national implementation protocol. Liver transplantation: official publication of the American Association for the Study of Liver Diseases and the International Liver Transplantation Society 30(11): 1132 1144	Study Design: Retrospective observational study. Sample Size: cDCD: n=18 DBD: n=28 Follow up: 1 year Country: Sweden	Evaluation of Swedish National Pilot of cDCD liver transplants with NRP. cDCD cohort outcomes: Biliary strictures (1 year): 5.6% Non-anastomotic strictures: 0.0% Recipient survival (1 year): 94.0% Graft survival (1 year): 94.0% Early allograft dysfunction: n=4 (22.0%) NRP shows comparable outcomes to a matched DBD cohort with 94.4% 1 year recipient and graft survival and no incidence of non-	Comparator group is outside the primary scope of the assessment (Donation after Brain Death [DBD]), and the intervention cohort is too small (n=18) to provide robust comparative data.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		anastomotic strictures within 1 year.	
Brubaker AL, Sellers MT, Abt PL et al. (2024) US Liver Transplant Outcomes After Normothermic Regional Perfusion versus Standard Super Rapid Recovery. JAMA surgery 159(6): 677 685	Study Design: Retrospective observational multicentre cohort. Sample Size: Total: 242 cDCD livers NRP: n=106 aNRP: n=27 Thoracoabdominal normothermic regional perfusion: n=79 Super rapid recovery n=136 Follow up: (median) NRP: 316 days Super rapid recovery: 438 days Country: US (n=17 centres)	Primary non-function: NRP: n=0 (0.0%) Super rapid recovery: n=2 (2.0%) Early allograft dysfunction: aNRP: 28.0% Thoracoabdominal normothermic regional perfusion: n=39.0% Super rapid recovery:56.0% Anastomotic stricture: aNRP: 3.7% Thoracoabdominal normothermic regional perfusion: 7.7% Recipient mortality: NRP: n=1 Super rapid recovery: n=3	Limited cohort size for the relevant intervention (aNRP n=27) and larger cohort studies prioritised. Outcome data lacks sufficient granularity, frequently pooling results with thoracoabdominal NRP (thoracoabdominal NRP), which is outside the scope of this assessment.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		Peak aspartate aminotransferase: aNRP: 767 (340 to 1680) Thoracoabdominal normothermic regional perfusion: 940 (429 to 2010) Peak alanine aminotransferase: aNRP: 562 (249 to 1101) Thoracoabdominal normothermic regional perfusion: 678 (324 to 1085) Comparable recipient and graft survival in liver transplant recipients of cDCD donors recovered by NRP versus super rapid recovery, with reduced rates of ischaemic cholangiopathy, biliary complications, and early allograft dysfunction in NRP recipients.	

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
Butler AJ, Randle LV, Watson CJ (2014) Normothermic regional perfusion for donation after circulatory death without prior heparinization. Transplantation 97(12): 1272 1278	Study Design: Prospective case series Sample Size: All organs: n=8 Liver transplant: n=3 Follow up: 6 months Country: UK	Relevant outcome data not reported.	Small case series (n=3 for liver); not prioritised in favour of larger observational cohorts that provide more comprehensive patient focused outcomes and longer follow up.
Camagni S, Amaduzzi A, Grazioli L et al. (2023) Extended criteria liver donation after circulatory death with prolonged warm ischemia: a pilot experience of normothermic regional perfusion and no subsequent ex situ machine perfusion. HPB: the official journal of the International Hepato Pancreato Biliary Association 25(12): 1494 1501	Study Design: Retrospective observational cohort. Sample Size: n=24 Follow up (median): 38 months Country: Italy	Pilot experience of cDCD liver transplant with aNRP alone. Primary non-function: n=0 (0.0%) Ischaemic cholangiopathy: n=0 (0.0%) Anastomotic stricture: n=6 (25.0%) Follow up at 1 year: n=21	Limited cohort size (n=24) relative to other identified comparative studies, and geographic differences in donor management protocols (Italy) reduce generalisability to UK NHS standard practice.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		Retransplantation rate: n=1 (4.8%) Graft loss: n=3 (14.3%) Mortality: n=2 (9.5%) Recipient survival at 36 months: 92.0%	
Campo Canaveral de la Cruz JL, Minambres E, Coll E et al. (2023) Outcomes of lung and liver transplantation after simultaneous recovery using abdominal normothermic regional perfusion in donors after the circulatory determination of death versus donors after brain death. American journal of transplantation: official journal of the American Society of Transplantation and the American Society of Transplant Surgeons 23(7): 996 1008	Study Design: Retrospective multicentre observational cohort. Sample Size: cDCD NRP donors: n=227 Follow up (median): 575 days Country: Spain	Liver utilisation: n=177 (78.0%) Liver graft complications (n=145): Primary non-function: n=6 (4.1%) Ischaemic cholangiopathy: n=1 (0.6%) Other biliary complications: n=12 (8.3%) Graft survival in cDCD donors (3 years): 80.8% Incidence of early complications did not show any	Comparator group is outside the primary scope of the assessment (Donation after Brain Death [DBD]), and concurrent multi organ recovery confounds the ability to reliably isolate liver specific procedural safety and efficacy outcomes.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		statistically significant difference between recipients of cDCD versus DBD organs for primary non-function or ischaemic cholangiopathy.	
Cannon RM, Nassel AF, Walker JT et al. (2022) Lost potential and missed opportunities for DCD liver transplantation in the United States. American journal of surgery 224(3): 990 998	Study Design: Retrospective database analysis Sample Size: n=265 NRP livers Follow up: 2 years Country: US	Recipient survival (Matched actual donor cohort): 6 months: 93.6% 1 year: 91.7% 2 years 88.9% Recipient survival (Unmatched donor cohort): 6 months: 94.1% 1 year: 91.0% 2 years: 86.6% Graft survival (Matched actual donor cohort): 6 months: 91.0% 1 year: 85.9% 2 years: 80.4%	Does not report comprehensively on the key efficacy or safety outcomes. Larger available datasets with superior granularity were prioritised.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		Graft survival (Unmatched donor cohort): 6m: 91.0% 1 year: 87.1% 2 years: 82.0%	
Caralt M, Bello I, Sandiumenge A et al. (2019) "Non Touch" Vena Cava Technique as an Improvement in Combined Lung and Liver Procurement in Controlled Donation After Circulatory Death. Transplantation proceedings 51(1): 9 11	Study Design: Case study Sample Size: n=3 Follow up: minimum 1 year Country: Spain	Aspartate aminotransferase, alanine aminotransferase levels post op (units per litre peak): Case 1: 304, 237 Case 2: 1902,1532 Case 3: 524, 590 All livers exhibited excellent immediate function	Small case series (n=3); not prioritised in favour of larger observational cohorts.
Carter T, Bodzin AS, Hirose H et al. (2014) Outcome of organs procured from donors on extracorporeal membrane oxygenation support: an analysis of kidney and liver allograft data. Clinical transplantation 28(7): 816 820	Study Design: Retrospective observational cohort. Sample Size: n=24 liver donations Follow up : Up to 12 months Country:	15 out of 24 livers transplanted (63%) Liver allograft survival at 12m: 93% The cohort of 15 transplanted livers is comprised of cDCD allografts: n=1	Study done in the US and published over 10 years ago with a limited relevant cohort (n=1 cDCD); procedural methodologies and outcomes may no longer accurately reflect current clinical practice, and larger recent datasets were prioritised.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
	US	DBD allografts: n=14 Mean total bilirubin: At discharge: 2.8 plus or minus 3.1 milligrams per decilitre At 6 months: 0.7 plus or minus 0.4 At 12 months: 0.6 plus or minus 0.4 Mean alanine aminotransferase level: At discharge: 65 plus or minus 45 units per litre At 6 months:48 plus or minus 41 At 12 months: 37 plus or minus 35 Primary non-function: n=0	
Circelli A, Antonini MV, Gamberini E et al. (2024) EISOR Delivery: Regional experience with sharing equipe, equipment & expertise to increase CDCD donor pool in time of pandemic.	Study Design: Retrospective observational study Sample Size:	Liver transplantation: n=25 (86.2%) Recipient survival (1 year): n=14 (82.4%)	Evaluates a mobile NRP team with a delivery model rather than standard in house NRP retrieval; this divergence from UK NHS practice limits

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
Perfusion (United Kingdom) 39(1): 85 95	n=29 Follow up : Up to 1 year Country: Italy		the generalisability of procedural and utilisation outcomes. The cohort is also limited in size (n=29).
Circelli A, Brogi E, Gamberini E et al. (2021) Trauma and donation after circulatory death: a case series from a major trauma center. Journal of International Medical Research 49(3)	Study Design: Retrospective case series Sample Size: n=5 Follow up: 1 to 4 years Country: Italy	No extractable outcomes other than survival.	Small case series (n=5); not prioritised in favour of larger cohorts. Geographic differences in donor management (Italy) reduce generalisability to the UK NHS context.
Croome KP, Brown TE, Mabrey RL et al. (2023) Development of a portable abdominal normothermic regional perfusion (NRP) program in the United States. Liver transplantation: official publication of the American Association for the Study of Liver Diseases and the International Liver Transplantation Society 29(12): 1282 1291	Study Design: Prospective protocol for NRP Sample Size: n=11 liver donors Follow up: Median 142 days Country: US	Primary non-function: n=0 Early allograft dysfunction: n=1 Ischaemic cholangiopathy: n=0 Follow up (3m): Bilirubin: 0.6 milligrams per decilitre	Small pilot cohort (n=11) done in the US assessing a mobile NRP unit; not prioritised in favour of larger available datasets.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		Alanine aminotransferase: 81 units per litre n=2 liver transplant recipients had grade 1 acute kidney injury that resolved before discharge.	
Croome KP, Subramanian V, Mathur AK et al. (2025) Outcomes of DCD Liver Transplant Using Sequential Normothermic Regional Perfusion and Normothermic Machine Perfusion or NRP Alone Versus Static Cold Storage. Transplantation 109(7): 1184 1190	Study Design: Retrospective cohort study Sample Size: n=83 DCD liver transplants (n=62 NRP alone and n=21 NRP and NMP) Follow up: (median) 27.8 months Country: US	Graft survival (at 3, 12 and 24 months): NRP: 98.3%, 96.5% and 96.5% NRP NMP: 100.0%, 100.0% and time not reached Static cold storage: 91.6%, 87.5% and 83.7% Recipient survival (at 3,12 and 24 months): NRP: 100.0%, 98.2% and 98.2% NRP and NMP: 100.0%, 100.0% and time not reached Static cold storage: 97.3%, 94.0% and 90.3% Primary non-function:	Geographic differences in US clinical practice and donor management reduce generalisability to the UK NHS context.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		NRP: n=0 (0.0%) NRP and NMP: n=0 (0.0%) Static cold storage: n=6 (2.0%) Hepatic artery thrombosis: NRP: n=1 (1.6%) NRP and NMP: n=0 (0.0%) Static cold storage: n=3 (1.0%) Early allograft dysfunction: NRP: n=7 (11.3%) NRP and NMP: n=9 (42.9%) Static cold storage: n=187 (64.5) Acute kidney injury (type 2 or 3): NRP: n=3 NRP and NMP: n=1 Static cold storage: n=29 Ischaemic cholangiopathy:	

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		NRP: n=0 (0.0%) NRP and NMP: n=0 (0.0%) Static cold storage: n=50 (16.8%) Lower rates of Ischaemic cholangiopathy and improved graft survival with NRP alone or NRP and NMP compared with Static cold storage when using liver grafts from DCD donors	
De Beule J, Vandendriessche K, Pengel LHM et al. (2021) A systematic review and meta analyses of regional perfusion in donation after circulatory death solid organ transplantation. Transplant international: official journal of the European Society for Organ Transplantation 34(11): 2046 2060	Study Design: Systematic review and meta analyses Sample Size: n=88 studies included (n=43 cDCD, n=39 uDCD and n=6 did not specify if uncontrolled or controlled DCD) n=8 studies in NRP in cDCD Follow up: 2 years	Graft function: Variable primary non-function (0 to 9%) and Early allograft dysfunction (0 to 36%) rates were reported. Meta analysis showed non-significant reduction in primary non-function after NRP compared to in situ cold preservation in cDCD (risk ratio 0.67, 95% CI 0.24 to 1.87)	Systematic review; superseded by more recent, comprehensive reviews included in the main evidence summary that capture a larger volume of relevant primary studies.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
	Country: Italy n=1,Russia n=1,Spain n=4,USA n=1	NRP lowered risk of early allograft dysfunction by 56% compared to ISP in DCD (risk ratio 0.44, 95% CI 0.26 to 0.76) No evidence that NRP influenced risk of Hepatic artery thrombosis Biliary complications: Consistently low ischaemic cholangiopathy rates (0 to 2%) were reported Meta analysis showed that NRP lowered the risk of any type of biliary strictures by 79% compared to in situ cold preservation cDCD When analysing ischaemic cholangiopathy and anastomotic strictures separately, NRP lowered risks by 75% and 65% respectively	

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		Anastomotic biliary strictures: 15 fewer (95% CI 10 to 18 fewer) cases per 100 NRP cases compared to in situ cold preservation cDCD liver transplants. Reported 1 year recipient survival rates with NRP: 93% to 94%. Meta analysis found no significant difference in mortality risk between NRP or in situ cold preservation	
De Carlis L, Lauterio A, De Carlis R et al. (2016) Donation After Cardiac Death Liver Transplantation After More Than 20 Minutes of Circulatory Arrest and Normothermic Regional Perfusion. Transplantation 100(4): e21 22	Study Design: Letter Sample Size: n=1 Follow up: 3 months	Reports on first successful DCD liver transplantation in Italy Graft rejection or other complications observed after 3	Single case report published as a letter; not prioritised in favour of larger observational cohorts. Geographic differences (Italy) also reduce generalisability.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
	Country: Italy	months: n=0 Biliary issues after 3 months: n=0 Ischaemic cholangiopathy: n=0	
De Carlis R, Di Sandro S, Lauterio A et al. (2018) Liver Grafts from Donors After Circulatory Death on Regional Perfusion with Extended Warm Ischemia Compared with Donors After Brain Death. Liver transplantation: official publication of the American Association for the Study of Liver Diseases and the International Liver Transplantation Society 24(11): 1523 1535	Study Design: Retrospective comparison study Sample Size: DCD: n=20 Extracorporeal membrane oxygenation group: n=17 DBD: n=52 Follow up (median): DCD (,14m) Extracorporeal membrane oxygenation (20m), DBD (18m) Country: Italy	Compared liver transplant from donors maintained on NRP after DCD and suffered extended warm ischemia (DCD group, n=20) versus donors maintained on Extracorporeal membrane oxygenation and succumbed to DBD (Extracorporeal membrane oxygenation group, n=17) versus standard donors after brain death (DBD group, n=52) 1 year recipient survival for the DCD group (95%) was not significantly different from that of the Extracorporeal membrane oxygenation group (87%) or the DBD group (94%)	Comparators are outside the primary scope of the assessment (Donation after Brain Death [DBD] and extended criteria donors), limiting the utility of the data for addressing the primary decision problem.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		Graft survival: Slightly inferior in the DCD group (85%) because of a high rate of primary non-function (10%) and transplantation (15%) not significantly different from the Extracorporeal membrane oxygenation group (87%) or the DBD group (91%) Ischaemic cholangiopathy was more frequent in the DCD group (10%) DCD recipients were more likely to develop posttransplant renal dysfunction with the need for renal replacement therapy	
De Carlis R, Lauterio A, Centonze L et al. (2022) Current practice of normothermic regional perfusion and machine perfusion in donation after circulatory death liver transplants in	Study Design: National survey Sample Size: n=119 DCD livers transplanted	Utilisation rate: n=172 out of 199 Acceptance rate during NRP: 90.1%	Study design (national survey) and geographic differences in clinical protocols (Italy) limit generalisability to the UK NHS context. Patient focused

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
Italy. Updates in surgery 74(2): 501 510	Follow up: Not reported Country: Italy	Subsequent machine perfusion: 95.9% Overall utilisation rate from initial donors offer to transplant: 69.2% NRP with subsequent machine perfusion is the most used protocol in Italy for DCD livers	outcomes and follow up durations are not reported.
De Carlis R, Schlegel A, Frassoni S et al. (2021) How to Preserve Liver Grafts From Circulatory Death with Long Warm Ischemia? A Retrospective Italian Cohort Study with Normothermic Regional Perfusion and Hypothermic Oxygenated Perfusion. Transplantation 105(11): 2385 2396	Study Design: Retrospective cohort study Sample Size: n=78 DCD livers treated with NRP n=64 transplanted (n=45 from cDCD) Follow up: Minimum of 1 year, median follow up of 17 months Country: Italy and UK	Matched and compared n=37 cDCD preserved with NRP and dual hypothermic oxygenated machine perfusion, with static preserved cDCD transplants from an established European program Dual hypothermic oxygenated machine perfusion was used in 84% of cases Primary non-function: 5%	Intervention involves sequential ex-situ machine perfusion (dual hypothermic oxygenated machine perfusion [D hypothermic oxygenated machine perfusion]), confounding the specific safety and efficacy effects of in situ NRP. Additionally, geographic differences (Italy) reduce applicability to UK practice.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		Moderate and severe Acute kidney injury: NRP and dual hypothermic oxygenated perfusion group: stage 2: 8% stage 3: 3% Matched comparator group: 27% for stage 2 and 3 Ischaemic cholangiopathy (2 years proportion free): NRP and dual hypothermic oxygenated perfusion: 97% Comparator: 92% Utilisation rate: cDCD: 87% uDCD: 73% Retransplantation: NRP and dual hypothermic oxygenated perfusion: n=37	

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		NRP: n=1 Primary non-function NRP and dual hypothermic oxygenated perfusion: n=1 (3%) Comparator group: n=1(3%) Death with graft failure NRP and dual hypothermic oxygenated perfusion: n=0 NRP: n=1 (sepsis after retransplantation) Technical failure or complications during NRP: none	
De Stefano N, Panconesi R, Labellarte G et al. (2026) Advanced Perfusion Techniques Level Liver Transplantation Outcomes With Different Donor Types: A Propensity Score matched Analysis. Transplantation (forthcoming)	Study Design: Single centre retrospective study Sample Size: n=61 Follow up: (median)	Compared outcomes of NRP liver transplant with cDCD donors, with those of liver transplant with DBD donors preserved by Static cold storage and extended criteria donor DBD donors treated with end Ischaemic dual	Intervention involves sequential ex-situ machine perfusion (dual hypothermic oxygenated machine perfusion or NMP), confounding the specific effects of in situ NRP. Also, the comparators are outside

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
	DCD: 22 months (13 to 52 months) DBD Static cold storage: 62 months (39 to 90 months) Extended criteria donor dual hypothermic oxygenated machine perfusion: 32 months (19 to 55 months) Country: Italy	hypothermic oxygenated machine perfusion Controlled DCD (NRP and ex-situ machine perfusion): n=61 (dual hypothermic oxygenated machine perfusion: n=50, NMP: n=11) Outcomes compared with 2 matched groups of recipients of DBD static cold storage (n=122) and dual hypothermic oxygenated machine perfusion treated extended criteria donor DBD (n=122) Early allograft dysfunction: DCD n=17 (27.9%) DBD static cold storage n=43 (35.2%) Extended criteria donor dual hypothermic oxygenated machine perfusion n=45 (36.9%)	the primary scope (DBD), and geographic differences (Italy) reduce generalisability.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		Primary non-function: DCD n=1 (1.6%) DBD static cold storage n=0 (0.0%) Extended criteria donor dual hypothermic oxygenated machine perfusion n=0 (0.0%) New onset renal replacement therapy needed: DCD n=2 (3.3%) DBD static cold storage n=1 (0.8%) Extended criteria donor dual hypothermic oxygenated machine perfusion n=10 (8.2%) Incidence of ischaemic cholangiopathy: DCD n=2 (3.3%) DBD static cold storage n=6 (4.9%)	

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		ECD dual hypothermic oxygenated machine perfusion n=4 (3.3%)	
Dondossola D, Ravaioli M, Lonati C et al. (2021) The Role of Ex-Situ Hypothermic Oxygenated Machine Perfusion and Cold Preservation Time in Extended Criteria Donation After Circulatory Death and Donation After Brain Death. Liver transplantation: official publication of the American Association for the Study of Liver Diseases and the International Liver Transplantation Society 27(8): 1130 1143	Study Design: Retrospective case series study Sample Size: n=50 liver grafts n=21 from DCD n=8 from ECD DBD Follow up: Follow up (mean): 17 months (10 to 26 months) Country: Italy	All DCD donors were subjected to NRP before organ procurement Livers underwent end ischaemic hypothermic oxygenated machine perfusion or dual hypothermic oxygenated machine perfusion (n=21 from over extended warm ischemia time DCD grafts and n=29 from extended criteria DBD donors) Early allograft dysfunction: n=10 (20%) Biliary complications: n=3 Ischemia type biliary lesions: n=1 Primary non-function: n=1 (2%) Stage 2 or 3 Acute kidney injury: n=11 (21%)	Intervention involves sequential ex-situ machine perfusion (hypothermic oxygenated machine perfusion and or Dual hypothermic oxygenated machine perfusion), confounding the specific safety and efficacy effects of in situ NRP. Additionally, population is extended criteria donors, and geographic differences in clinical protocols (Italy) reduce generalisability to the UK NHS context.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		Graft loss: 2 (4%) n=1 because of primary non-function Recipient mortality: n=1 No differences were shown in terms of early post liver transplant results between liver transplant done with DCD and DBD.	
Feo M, Minambres E, Suberviola B et al. (2022) Controlled Donation After Circulatory Death Program: Analysis and Results at a Tertiary Care Hospital. Transplantation proceedings 54(1): 70 72	Study Design: Retrospective cohort study Sample Size: n=247 donors, n=97 cDCD Follow up: Minimum 1 year Country: Spain	Survival (1 year): DCD = 93.3% DBD = 93.7% Liver donation: DCD: n=29 (30.5%) DBD n=71 (46.7%)	Does not report comprehensively on the key efficacy or safety outcomes defined in the scope.
Fernandez de la Varga M, Del Pozo Del Valle P, Bejar Serrano S et al. (2022) Good post transplant outcomes using liver donors after circulatory death when applying strict selection	Study Design: Propensity score matched cohort study Sample Size:	Compared recipients undergoing liver transplant (liver transplant) with donation after circulatory death (DCD) compared with a 1:1 matched	Comparator group is outside the primary scope of the assessment (DBD), and the relevant intervention cohort is limited in size (n=22).

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
criteria: A propensity score matched cohort study. Annals of hepatology 27(5): 100724	n=51 DCD liver transplant (n=22 NRP) Follow up (minimum): 6 months Follow up (mean): 27.4 months plus or minus 3.6 months in DBD group and 23.1 months plus or minus 2.6 months in DCD group Country: Spain	control group of liver transplant with donation after brain death (DBD). n=51 recipients with DCD liver transplant (n=29 super rapid recovery, n=22 NRP) were matched with n=51 DBD liver transplant recipients. Key Outcomes (DCD compared with DBD) Biliary complications: 10% (n=5, all with the super rapid recovery technique) compared with n=1, 2%. Primary graft non-function: 4%, n=2 (n=1 super rapid recovery and n=1 NRP) compared with 0% (n=0). Postoperative bleeding: n=7, 14% compared with n=1, 2%.	

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		Reinterventions: n=8, 15.7% compared with n=2, 3.9%. Peak aspartate aminotransferase and alanine aminotransferase: Higher in the DCD group on the first postoperative day. The incidence of rejection, vascular complications, renal injury, hospital stay, and readmissions were similar in both groups. Cumulative 1, 2, 3 and 4 year graft and recipient survival were also similar.	
Galeone A, Casartelli Liviero M, Borin A et al. (2025) Early and Mid Term Results of Solid Organ Transplantation After Circulatory Death: A 4 Year Single Centre Experience. Medicina (Kaunas, Lithuania) 61(12)	Study Design: Single centre retrospective review Sample Size: n=123 organs, n=46 livers considered for transplantation	n=46 livers were considered suitable for transplantation, n=31 underwent liver transplantation	Geographic differences in donor management protocols (Italy) reduce generalisability to UK NHS standard practice. Furthermore, the intervention is confounded by the

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
	Follow up: The follow up time was calculated either to death or to the last verified contact Country: Italy	n=17 (41%) Subsequent dual hypothermic oxygenated machine perfusion n=21 (51%) Ex-situ machine perfusion, n=4 (10%) NMP The 30 day graft and recipient survival was 95% and 98% respectively Primary non-function was observed in n=2 liver recipients, n=1 died and n=1 needed transplantation Mean survival time was 3.9 plus or minus 0.1 year. Ischaemic cholangiopathy: n=0 Anastomotic biliary stricture: n=7 (17%)	sequential use of ex-situ machine perfusion.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		Non-anastomotic strictures: n=2 (5%)	
Ghinolfi D, Dondossola D, Rreka E et al. (2021) Sequential Use of Normothermic Regional and Ex-Situ Machine Perfusion in Donation After Circulatory Death Liver Transplant. Liver transplantation: official publication of the American Association for the Study of Liver Diseases and the International Liver Transplantation Society 27(3): 385 402	Study Design: Retrospective review Sample Size: n=34 DCD donors Follow up (median): 15.1 months (9.5 to 22.3 months) Country: Italy	All grafts underwent NRP and then either NRP and ex-situ machine perfusion (n=18), NRP and NMP (n=7) or NRP and hypothermic oxygenated machine perfusion (n=11). n=3 (8.8%) grafts were discarded before NRP, one of which because of technical failure of the NRP. n=20 grafts (58.8%, 12 uDCD, 8 cDCD) were considered eligible for liver transplant. n=18 (52.9%, 11 uDCD, 7 cDCD) were eventually transplanted. Reperfusion syndrome occurred in n=8 (44.0%) recipients.	Intervention involves sequential ex-situ machine perfusion, confounding the evaluation of in situ NRP alone. Additionally, the relevant cohort size is very small (n=8), and geographic differences (Italy) limit generalisability.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		Early allograft dysfunction: n=5 (28.0%), acute kidney injury: n=5 (28.0%). After a median follow up of 15.1 months: n=1 Ischaemic type biliary lesion n=1 recipient death	
Ghinolfi D, Patrono D, De Carlis R et al. (2024) Liver transplantation with uncontrolled versus controlled DCD donors using normothermic regional perfusion and ex situ machine perfusion. Liver transplantation: official publication of the American Association for the Study of Liver Diseases and the International Liver Transplantation Society 30(1): 46 60	Study Design: Multicentre, retrospective study Sample Size: n=153 DCD donors Follow up (median): 35 and 27 months in uDCD and cDCD groups, respectively Country: Italy	Used sequential NRP and end Ischaemic machine perfusion in uDCD n=40 uDCD and n=59 cDCD out of 153 DCD donor livers were transplanted, with a utilisation rate of 52% and 78% respectively DCD recipients had a trend towards more severe acute kidney injury	Intervention involves the sequential use of ex-situ machine perfusion, confounding the specific safety and efficacy effects of in situ NRP. Geographic differences in clinical protocols (Italy) also reduce UK generalisability.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		1 year graft survival was lower in uDCD (75% versus 90%, p=0.007) but became comparable when non-liver related graft losses were treated as censors (77% versus 90%, p=0.100). Incidence of ischaemic cholangiopathy was 10% in uDCD versus 3% in cDCD, p=0.356.	
Hagness M, Foss S, Sorensen DW et al. (2019) Liver Transplant After Normothermic Regional Perfusion From Controlled Donors After Circulatory Death: The Norwegian Experience. Transplantation proceedings 51(2): 475 478	Study Design: Cohort study Sample Size: n=8 Follow up: 1 year (n=7 recipients) and 6 months (n=1 recipient) Country: Norway	Delayed graft function or graft loss: 0% n=7 recipients reached 1 year of follow up, and n=1 recipient reached 6 months n=2 recurrence of primary disease n=8 (100%) had normalised liver function at last follow up.	Small case series (n=8); not prioritised in favour of larger observational cohorts.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		n=2 recipients underwent procedure for biliary complications Concluded results after liver transplant using cDCD with NRP are good. The rate of complications is within the same range as those with DBD.	
Herrero Torres MA, Domniguez Bastante M, Molina Raya A et al. (2020) Eight Years of Extracorporeal Membrane Oxygenation in Liver Transplantation: Our Experience. Transplantation proceedings 52(2): 572 574	Study Design: Single centre, observational cohort study Sample Size: n=36 organs from DCD (n=33 liver transplant with NRP, n=3 liver transplant with super rapid recovery) Follow up: Not reported, but maximum recipient survival was reported at 66 months plus or minus 9 months	uDCD recipients suffered vascular complications including 2 recipients requiring retransplantation cDCD recipients had fewer vascular complications Graft survival was 66 plus or minus 9 months and recipient survival was 67 plus or minus 9 months In cDCD, aspartate aminotransferase peak in 7	Does not report comprehensively on the key efficacy or safety outcomes defined in the scope.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
	Country: Spain	days was 1784 plus or minus 2806 international units per decilitre. Alanine aminotransferase peak in 7 days was 1013 plus or minus 999 international Units per decilitre Graft survival was 41 plus or minus 7 months and recipient survival was 41 plus or minus 7 months	
Hessheimer AJ, Coll E, Torres F et al. (2019) Normothermic regional perfusion versus super rapid recovery in controlled donation after circulatory death liver transplantation. Journal of hepatology 70(4): 658 665	Study Design: Propensity matched nationwide observational cohort study Sample Size: n=95 cDCD liver transplants with NRP n=117 with super rapid recovery Follow up (median): 20 monthsCountry: Spain	IPTW adjusted risks were significantly improved among NRP livers for: Overall biliary complications (OR 0.14, 95% CI 0.06 to 0.35, p<0.001) Ischaemic type biliary lesions (OR 0.11, 95% CI 0.02 to 0.57, p=0.008)	Interim analysis: superseded by the publication of the full, finalised study results in Hessheimer et al. (2022), which were prioritised for the main evidence summary.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		Graft loss (hazard ratio 0.39, 95% CI 0.20 to 0.78, p=0.008). There was significantly less graft loss (hazard ratio 0.39, 95% CI 0.20 to 0.78, p=0.008), and fewer retransplantations among recipients of NRP livers during follow up (OR 0.24, 95% CI 0.07 to 0.78, p=0.018). 1 year and 3 year survival rates were both 93% for NRP recipients versus 88% and 84% for super rapid recovery recipients, respectively. Both were 88% for NRP grafts versus 83% and 76%, respectively, for super rapid recovery graft. Results suggest NRP helps reduce rates of post transplant biliary complications and graft	

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		loss and allows for the successful transplantation of livers from older cDCD donors	
Hunt F, Johnston CJC, Coutts L et al. (2022) From Haphazard to a Sustainable Normothermic Regional Perfusion Service: A Blueprint for the Introduction of Novel Perfusion Technologies. Transplant international: official journal of the European Society for Organ Transplantation 35: 10493	Study Design: Observational cohort and service implementation study Sample Size: n=61 DCD (NRP) liver transplants Follow up: Up to 8 years Country: UK	n=61 DCD NRP (100.0%) of liver transplants undertaken exhibited no primary non-function or ischaemic cholangiopathy 37.5% of liver transplant in the UK in 2021 was with ex-situ normothermic liver perfusion and NRP n=5 livers were declined by all UK centres based on donor history prior to retrieval were rescued and transplanted following assessment during NRP leading to a change in acceptance policy to only declining livers after functional assessment during NRP.	The study is a descriptive service evaluation focusing on the logistical implementation, training, and funding of an NRP program. It lacks a standard care comparative arm to directly assess clinical efficacy and safety.
Lazzeri C, Ghinolfi D, Bonizzoli M et al. (2025) Management of Normothermic Regional Perfusion	Study Design:	NRP in cDCD versus uDCD was analysed	Geographic differences in clinical protocols and donor management strategies (Italy)

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
Performance in Uncontrolled Versus Controlled Donation After Circulatory Death: A Multi Center Investigation. Journal of Clinical Medicine 14(19): 7053	Retrospective analysis of a prospective multi centre protocol Sample size: n=99 DCD donors n=45 cDCD donors Follow up: 30 days Country: Italy	In the cDCD donor cohort: n=39 liver transplants were done with a utilisation rate of 87.0% n=8 (20.0%) participants had early allograft dysfunction observed n=4 recipients died with n=1 graft liver dysfunction At 30 day follow up, liver graft function was present in 38 out of 39 (97.4%) of participants In the uDCD donor cohort: n=16 livers were transplanted, with a utilisation rate of 36.0% (16 out of 44). Early allograft dysfunction was observed in 7 recipients (n=7 out of 16, 43.0%).	differ significantly from UK NHS standard practice, reducing generalisability. The study also evaluates uncontrolled DCD alongside controlled DCD, which is outside of the scope of this assessment.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		n=5 recipients died because of septic shock. Among the dead recipients, graft liver dysfunction was present in n=4. At the 30 day follow up, liver graft function was present in all but 4 recipients (75%). Concluded that NRP performance and management are different in uDCD versus cDCD and there is likely space for optimisation of management.	
le Dinh H, de Roover A, Kaba A et al. (2012) Donation after cardio circulatory death liver transplantation. World Journal of Gastroenterology 18(33): 4491 4506	Study design: Literature review Sample size: Not applicable Follow up: Up to 10 years Country: Belgium	Reviews mono and multi centric DCD liver transplant and experimental strategies on animal models. Compared to DBD, DCD livers have a higher risk of early graft dysfunction, more frequent vascular and ischemia type	Published over 10 years ago; procedural methodologies and outcomes may no longer accurately reflect current clinical practice, and larger recent comparative datasets were prioritised. Also reports on experimental strategies on animal models

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		biliary lesions, and higher rates of re listing and retransplantation.	
Maroni L, Musa N, Ravaioli M et al. (2021) Normothermic with or without hypothermic oxygenated perfusion for DCD before liver transplantation: European multicentric experience. Clinical transplantation 35(11): e14448	Study design: Retrospective analysis study Sample size: Group A (treated with hypothermic oxygenated machine perfusion) n=19 Group B (preservation using cold storage) n=17 Follow up (median): 24 months Country: France and Italy	3 centres used DCD grafts treated with NRP and then successively with either hypothermic oxygenated machine perfusion or cold storage The 2 groups had similar rates of Early allograft dysfunction (21.1% versus 25.0%), primary non-function (5.3% versus 6.3%), ischaemic cholangiopathy (0.0% versus 12.5%, p=0.112), and non-ischaemic cholangiopathy biliary complications (0.0% versus 6.3%, p=0.457), retransplantation (10.5% versus 12.5%) Biliary complication and organ dysfunction rates of cDCD	Intervention involves sequential ex-situ machine perfusion (hypothermic oxygenated machine perfusion), confounding the specific safety and efficacy effects of in situ NRP alone. Also, geographic differences in clinical protocols and donor management strategies (Italy) differ significantly from UK NHS standard practice, reducing generalisability.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		treated with NRP comparable to DBD. Concluded that hypothermic oxygenated machine perfusion preservation rather than NRP seems to be the reason, though not conclusive, for the protective effects observed on livers retrieved from NRP DCD donors and on the positive effect of the outcome of liver transplant.	
Maspero M, Ali K, Cazzaniga B et al. (2023) Acute rejection after liver transplantation with machine perfusion versus static cold storage: A systematic review and meta analysis. Hepatology (Baltimore, Md.) 78(3): 835 846	Study design: Systematic review and meta analysis Sample size: n=8 studies included in total Only in n=1 study livers underwent NRP (n=23 NRP, n=22 super rapid recovery) Follow up :	Early allograft dysfunction occurred in 68.1% in super rapid recovery versus 30.4% in NRP Retransplantation: 0.0% with NRP versus 9.1% in super rapid recovery Biliary complications occurred in 22.7% in super rapid recovery versus 4.3% in NRP	Systematic review and meta analysis; superseded by more recent, comprehensive reviews and larger primary data cohorts included in the main evidence summary.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
	12 months in n=4 studies, 6 months in n=1 study, and between 8.8 months and 15 months in the rest of the studies. Country: Belgium (n=1), Czech Republic (n=1), Germany (n=1), Italy (n=2), Netherlands (n=1), Spain (n=1), Switzerland (n=2), UK (n=2)	Acute and chronic rejection occurred in n=4 (18.1%) and n=2 (4.0%) of super rapid recovery and of n=3 (13.0%) and 0 of the NRP group respectively Among super rapid recovery group, at follow up 85.0% of recipients were alive (n=4 recipients died) versus 95.0% (n=1 recipient) in NRP group	
Melandro F, Basta G, Torri F et al. (2022) Normothermic regional perfusion in liver transplantation from donation after cardiocirculatory death: Technical, biochemical, and regulatory aspects and review of literature. Artificial organs 46(9): 1727 1740	Study design: Systematic review Sample size: n=15 total studies n=11 cDCD NRP n=3 uDCD n=1 uDCD and cDCD Follow up : Studies reported a range of follow up durations from 6 67 months	NRP versus Super rapid recovery: Reduced ischaemic cholangiopathy Improved Early allograft dysfunction and lower model for early allograft function score Improved graft and recipient loss rates reduced need for retransplantation. NRP DCD versus DBD:	Systematic review superseded by more recent, comprehensive systematic reviews and primary data cohorts included in the main evidence summary.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
	Country: France (n=1), Italy (n=4), Spain (n=7), UK (n=1), Norway (n=1), US (n=1)	No statistical difference observed in Early allograft dysfunction, graft survival or biliary complications NRP and machine perfusion: Showed low acute kidney injury rates and improved Recipient survival	
Minambres E, Estebanez B, Ballesteros MA et al. (2023) Normothermic Regional Perfusion in Pediatric Controlled Donation After Circulatory Death Can Lead to Optimal Organ Utilization and Posttransplant Outcomes. Transplantation 107(3): 703 708	Study design: Multicentre, retrospective, observational cohort study Sample size: n=13 paediatric cDCD donors n=11 livers transplanted Follow up: Not specified Country: Spain	1 year, non-censored for death liver graft survival: 90.9%. Utilisation rate was 85% for livers (n=11). Both paediatric and adult recipients had a 0% rate of primary non-function and ischaemic cholangiopathy. n=1 paediatric recipient had graft loss (20%) and therefore n=1 recipient.	Study evaluates a small paediatric cohort (n=11 livers) and compares their outcomes to adult populations, limiting generalisability to the primary adult decision problem. Also, the intervention is procedurally confounded and outside the established scope, as it includes the use of thoracoabdominal NRP in a subset of donors, as well as the simultaneous rapid recovery of thoracic organs.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		Results reveal that NRP may lead to an increased utilisation of cDCD paediatric organs and offer optimal recipients' outcomes.	
Minambres E, Ruiz P, Ballesteros MA et al. (2020) Combined lung and liver procurement in controlled donation after circulatory death using normothermic abdominal perfusion. Initial experience in two Spanish centers. American journal of transplantation: official journal of the American Society of Transplantation and the American Society of Transplant Surgeons 20(1): 231 240	Study design: Retrospective cohort study Sample size: n=19 cDCD recipient n=16 liver transplants done n=34 DBD used as controls (n=29 liver transplants) Follow up (median): cDCD: 6 months (interquartile range 3 to 18 months) DBD: 16 months Country: Spain	n=2 cDCD liver recipients developed primary non-function (12.5%). No cases of Ischaemic cholangiopathy were observed among cDCD recipients. The 1 and 2 year liver recipients' survival was 87.5% and 87.5% for the cDCD group, and 96% and 84.5% for the DBD group, respectively	Study describes a combined lung and liver procurement technique in cDCD donors that deviates from the standard abdominal NRP protocol.
Minambres E, Suberviola B, Dominguez Gil B et al. (2017)	Study Design:	1 year liver survival rate was 90.1%	Limited cohort size for the relevant intervention (n=11

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
Improving the Outcomes of Organs Obtained From Controlled Donation After Circulatory Death Donors Using Abdominal Normothermic Regional Perfusion. American journal of transplantation: official journal of the American Society of Transplantation and the American Society of Transplant Surgeons 17(8): 2165 2172	Single centre retrospective review Sample size: n=27 cDCD donors undergoing aNRP n=11 livers transplanted Follow up: Minimum 3 months, median was 17 months (interquartile range 7-22 months) Country: Spain	n=0 cases of ischaemic cholangiopathy n=12 liver grafts procured and n=11 transplanted (91.6%) The values of alanine aminotransferase in liver cDCD donors were 46 (IQR: 19 to 63) international units per litre before withdrawal of life-sustaining therapy and 33 (IQR: 24 to 44) international units per litre after 60 min of abdominal NRP For aspartate aminotransferase, values were 33 (IQR: 23 to 42) and 34 (IQR: 28 to 61) international units per litre, respectively. n=1 case of primary non-function in cDCD group resulting in recipient mortality	livers transplanted); larger available datasets were prioritised.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		n=10 had no evidence of biliary lesions There was no difference in liver graft survival from DCD donors (90.9% at 6, 12, and 18 months) compared with DBD donors (100.0%, 91.6%, and 91.6%, respectively. p=0.571).	
Mourad MM, Reay M, Muiesan P et al. (2014) Patient with liver dysfunction while maintained on veno venous extracorporeal membrane oxygenation should not be overlooked as a potential donor. Transplant international: official journal of the European Society for Organ Transplantation 27(6): e50 53	Study design: Case report Sample size: n=1 Follow up: 1 year Country: UK	Aspartate transaminase and alanine aminotransferase peaked at 549 and 884 units per litre respectively, following transplantation. Recipient was diagnosed with acute cellular rejection on day 5 and successfully treated. All graft functions were normalised at 14 days following transplantation.	Single case report; not prioritised in favour of larger observational cohorts.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		Recipient completed 1 year with stable graft function. No evidence of postperfusion syndrome observed.	
Muller X, Mohkam K, Mueller M et al. (2020) Hypothermic Oxygenated Perfusion Versus Normothermic Regional Perfusion in Liver Transplantation From Controlled Donation After Circulatory Death: First International Comparative Study. Annals of surgery 272(5): 751 758	Study design: Retrospective comparative cohort study Sample size: n=93 liver graft transplanted after NRP n=132 liver grafts transplanted after hypothermic oxygenated machine perfusion n=32 propensity score matched recipients (NRP and hypothermic oxygenated machine perfusion) Follow up: NRP: 20 months	1 year tumour death censored graft and Recipient survival was 93% versus 86% and 95% versus 93% after NRP and hypothermic oxygenated machine perfusion respectively. No differences in non-anastomotic strictures, primary non-function: n=3 (2%) versus n=32 (34%) in NRP and hypothermic oxygenated perfusion machine respectively) and hepatic artery thrombosis (n=0 in NRP versus n=2 in hypothermic oxygenated machine perfusion) were observed in the total cohort. The same was observed in	Study includes a hypothermic oxygenated machine perfusion cohort which introduces technical and physiological variables, specifically end ischaemic cold oxygenated perfusion, which fall outside the scope of this assessment.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
	Hypothermic oxygenated machine perfusion: 28 months Country: France and Switzerland	n=32 versus n=32 propensity score matched recipients. Biliary complications were reported in n=23 (17.4%) of NRP versus n=32 (34.4) of hypothermic oxygenated machine perfusion cohorts. Because of more stringent donor selection criteria in the NRP cohort, the liver graft utilisation rate was significantly lower compared to the hypothermic oxygenated machine perfusion cohort (63.0% versus 81.0%). No significant differences were observed for non-anastomotic strictures (4.5% versus 8.6%), primary non-function (2.3% versus 4.3) and hepatic artery thrombosis (3.0% versus 2.2%) between NRP and hypothermic	

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		oxygenated machine perfusion, respectively. A higher proportion of post liver transplant renal replacement therapy was observed in the hypothermic oxygenated machine perfusion cohort. Overall NRP and hypothermic oxygenated machine perfusion achieved similar post transplant recipient and graft survival and were similar results to standard DBD liver transplant	
Muller X, Rossignol G, Damotte S et al. (2021) Graft utilisation after normothermic regional perfusion in controlled donation after circulatory death a single center perspective from France. Transplant international: official journal of the European Society for Organ Transplantation 34(9): 1656 1666	Study design: Retrospective single centre cohort study Sample size: n=125 cDCD donors n=58 successful liver grafts Follow up : 1 year	Utilisation rates for liver grafts were 59% (n=58 out of a potential 99). 20% of liver donors were extended criteria donors. Cannulation was attempted in n=118 donors and successful NRP followed by transplantation of at least 1	Focuses on graft utilisation rates and specific reasons for organ discard. It centres on the decision making process for liver acceptance rather than providing the comparative clinical outcome data required for the adult decision problem.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
	Country: France	abdominal organ was done in n=109 donors (87%). In n=10 liver grafts there was technical failure of NRP 14 adverse events (11%) were reported during NRP most being cannulation failures (n=7, 54%). 1 year recipient and graft survival was 93%. Overall, showed NRP in cDCD as a promising procurement strategy.	
Munoz DC, Perez BS, Martinez MP et al. (2020) Does Normothermic Regional Perfusion Improve the Results of Donation After Circulatory Death Liver Transplantation? Transplantation proceedings 52(5): 1477 1480	Study design: Prospective cohort study (NRP versus super rapid recovery) Sample size: n=45 cDCD transplants (n=23 with NRP)	Compares super rapid recovery versus NRP NRP: n=23 Super rapid recovery: n=22	Limited cohort size for NRP (n=23).

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
	Follow up (median): Super rapid recovery: 1052 days NRP: 440 days Country: Spain	n=5 livers discarded because of technical problems or liver appearance. Reperfusion occurred in 27.3% of super rapid recovery and 6.3% of NRP group Early allograft dysfunction occurred in 68.1% in super rapid recovery versus 30.4% in NRP. Retransplantation rate was 0.0% with NRP versus 9.1% in super rapid recovery. Biliary complications occurred in 22.7% of participants in super rapid recovery versus 4.3% in NRP. Study supports use of NRP in reducing biliary complications and in helping to improve DCD liver graft survival.	

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		Acute and chronic rejection occurred in n=4 (18.1%) and n=2 (4.0%) of super rapid recovery and of n=3 (13.0%) and 0 of the NRP group respectively. Among super rapid recovery group, at follow up 85.0% of recipients were alive (n=4 recipients died) versus 95.0% (n=1 recipient) in NRP group.	
Na B G, Hwang S, Hong S K et al. (2020) Liver transplantation from a non heart beating donor. Case Report Korean journal of transplantation 34(4): 302 307	Study design: Case Report Sample size: n=1 Follow up : Not specified Country: Korea	Peak aspartate transaminase level of 1,835 international units per litre and alanine transaminase level of 656 international units per litre during the first posttransplant week.	Single case report based in Also, geographic differences in clinical protocols and donor demographics and management (Korea) reduce generalisability to UK NHS standard practice
Olivieri T, Magistri P, Guidetti C et al. (2019) University of Modena Experience With Liver Grafts From	Study design: Retrospective case series Sample size:	In n=5 cases biliary drainage was placed during surgery.	Small case series (n=10) relative to other identified comparative studies. Also,

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
Donation After Circulatory Death: What Really Matters in Organ Selection? Transplantation proceedings 51(9): 2967 2970	n=10 Follow up: Not stated Country: Italy	Primary graft nonfunction did not occur in this cohort. n=1 case of biliary anastomosis stricture n=0 donors needed transplantation n=0 recipient mortality Mean hospital day post transplant = 12.7 days	geographic differences in clinical protocols and donor management (Italy) reduce generalisability to UK NHS standard practice.
Oniscu GC, Mehew J, Butler AJ et al. (2023) Improved Organ Utilisation and Better Transplant Outcomes With In-Situ Normothermic Regional Perfusion in Controlled Donation After Circulatory Death. Transplantation 107(2): 438 448	Study design: Retrospective analysis Sample size: n=94 cDCD NRP grafts n=1376 non-NRP group Follow up : 1 year Country: UK	A mean of 3.3 (n=83, 63%) organs were transplanted when NRP was used compared with 2.6 organs per donor when NRP was not used (n=1412, 34%). When adjusting for organ specific donor risk profiles, the use of NRP increased the odds of all abdominal organs being transplanted by 3 fold for liver. NRP group, 7% experienced transplant failure (recipient	Study focuses on broader organ utilisation and high level graft survival, lacking comprehensive reporting on the key granular safety and efficacy outcomes.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		death or graft loss) within 12 months versus 13% in non-NRP group. 12 month liver transplant survival was superior for recipients of a cDCD NRP graft with a 51% lower risk adjusted hazard of transplant failure (hazard ratio = 0.494).	
Oniscu GC, Randle LV, Muiesan P et al. (2014) In situ normothermic regional perfusion for controlled donation after circulatory death the United Kingdom experience. American journal of transplantation: official journal of the American Society of Transplantation and the American Society of Transplant Surgeons 14(12): 2846 2854	Study design: Case series Sample size: NRP retrievals at 3 UK centres: n=21 Received a liver transplant: n=11 Follow up: Minimum 3 months (mean 10 months, range 3 months to 36 months) Country: UK	The first week median peak alanine aminotransferase was 389 international units per litre (range 58 to 3043). n=4 recipients had early allograft dysfunction but only grade 1. The number of livers recovered and transplanted was higher than the current national DCD liver utilisation rates (52% versus 27%)	Limited cohort (n=11 liver transplants).

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		No clinical or radiological evidence of ischaemic type biliary lesions by the time of reporting. n=1 recipient had an anastomotic stricture, n=1 recipient had primary non-function and died	
Oniscu GC, Siddique A, Dark J (2014) Dual temperature multi organ recovery from a Maastricht category III donor after circulatory death. American Journal of Transplantation 14(9): 2181 2186	Study design: Case report Sample size: n=1 Follow up: 6 months Country: UK	The peak alanine aminotransferase in the liver recipient in the first week posttransplant was 48 international units per litre with no evidence of non-anastomotic biliary strictures at 6 months.	Single case report describing a novel multi organ technical procurement protocol.
Patrono D, Zanierato M, Vergano M et al. (2022) Normothermic Regional Perfusion and Hypothermic Oxygenated Machine Perfusion for Livers Donated After Controlled Circulatory Death With Prolonged Warm Ischemia Time: A Matched	Study design: Prospective single centre study Sample size: Matched cohort:	DCD utilisation rate was 59.5% Early outcomes of DCD grafts recipients were comparable to those of matched DBD liver transplants.	Intervention involves sequential hypothermic oxygenated machine perfusion, confounding the specific safety and efficacy effects of in situ NRP alone. The comparator is outside the

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
Comparison With Livers From Brain Dead Donors. Transplant international: official journal of the European Society for Organ Transplantation 35: 10390	Controlled DCD liver transplants done using NRP and dual hypothermic oxygenated machine perfusion n=20 DBD n=40 Whole cohort: DBD: n=555 DCD: n=20 Follow up: 1 year Country: Italy	In the matched cohort, the incidence of anastomotic biliary complications was 15% in the DCD group compared with 22% in the DBD group (p=0.73). The incidence of ischaemic cholangiopathy was 5% in the DCD group versus 2% in the DBD group (p=1.00). 1 year recipient and graft survival was 100% versus 95% (p=0.18) and 90% versus 95% (p=0.82). In the DCD and DBD cohorts, Early allograft dysfunction and grade 2 or 3 acute kidney injury rates were 5% versus 15% and 15% versus 22%, respectively, with no recipient requiring renal replacement therapy after liver transplant. n=5 (25%) and n=8 (20%) recipients of a DCD or DBD	primary scope (DBD), and geographic differences (Italy) reduce generalisability.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		liver, respectively, developed grade 3 or more complications and median comprehensive complication index were 16.5 (0.0, 33.9) versus 21.8 (8.7, 35.4). In conclusion, the association of NRP and dual hypothermic oxygenated machine perfusion in DCD liver transplant with prolonged warm ischemia time allows achieving comparable outcomes to DBD liver transplant.	
Perez Redondo M, Alcantara Carmona S, Fernandez Simon I et al. (2020) Implementation of a mobile team to provide normothermic regional perfusion in controlled donation after circulatory death: Pilot study and first results. Clinical transplantation 34(8): e13899	Study design: Pilot study, case series Sample size: Livers recovered and transplanted: n=12 Follow up: Not reported Country: Spain	None of the livers were discarded because of an elevation in transaminases during NRP. n=21 livers discarded (utilisation rate of 61.9%) n=4 had unsuccessful NRP.	Evaluates a mobile NRP with ECMO team delivery model; procedural safety, ischaemic times, and organ utilisation rates are confounded by practical differences that are not generalisable to the standard UK NHS.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		Supports use of a mobile NRP team.	
Perez Villares JM, Lara Rosales R, Fernandez Carmona A et al. (2018) Mobile ECMO team for controlled donation after circulatory death. American Journal of Transplantation 18(5): 1293 1294	Study design: Case series Sample size: n=2 liver transplants Follow up: Not reported Country: Spain	cDCD donations achieved by mobile Extracorporeal membrane oxygenation team allowed for 2 liver transplants not possible otherwise n=1 liver graft recipient died because of intraoperative complication during surgery.	Evaluates a mobile NRP with ECMO team delivery model; procedural safety, ischaemic times, and organ utilisation rates are confounded by practical differences that are not generalisable to the standard UK NHS. Also, a small cohort of NRP (n=2).
Ramirez Del Val A, Guarrera J, Porte RJ et al. (2022) Does machine perfusion improve immediate and short term outcomes by enhancing graft function and recipient recovery after liver transplantation? A systematic review of the literature, meta analysis and expert panel recommendations. Clinical transplantation 36(10): e14638	Study design: Systematic review, meta analysis and expert panel recommendations Sample size: Total articles included: n=38 Studies in meta analysis: n=28 NRP studies: n=13 Follow up: Not stated Country:	NRP reduces early allograft dysfunction and primary non-function when compared to both DBD and super rapid recovery DCD preserved in static cold storage The direction and strength of recommendations was rated as strong for the use of NRP regarding early allograft dysfunction and primary non-function	Systematic review and meta analysis superseded by more recent, comprehensive reviews and larger primary data cohorts included in the main evidence summary.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
	Not reported	However, NRP fails to reverse risk of primary non-function and need for renal replacement therapy compared to DBD grafts (but findings extrapolated from handful of low vol retrospective studies) 13 studies included reporting on NRP	
Richards JA, Gaurav R, Upponi SS et al. (2023) Outcomes of livers from donation after circulatory death donors with extended agonal phase and the adjunct of normothermic regional perfusion. The British journal of surgery 110(9): 1112 1115	Study design: Retrospective analysis of prospectively collected data Sample size: n=181 NRP retrievals done Follow up: 12 months Country: UK	Out of n=181 NRP retrievals n=130 (71.8%) were transplanted, n=101 of which were in Cambridge without additional ex-situ perfusion 12 month overall recipient survival was 93.9%, death censored graft survival was 98.0% Assessed impact of prolonged agonal time or asystolic time on outcomes and early allograft dysfunction	Small cohort size (n=14) focused on a highly specific donor sub population (extended agonal phase).

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
Rodriguez RP, Perez BS, Daga JAP et al. (2022) Outcome of Liver Transplants Using Donors After Cardiac Death With Normothermic Regional Perfusion. Transplantation proceedings 54(1): 37 40	Study design: Observation cohort study Sample size: n=117 liver transplants n=39 NRP and n=78 DBD Follow up : NRP: mean 22.66 months DBD: mean 22.59 months Country: Spain	In DBD recipients n=3 (4%) of recipients developed primary non-function versus n=0 in DCD group Acute kidney injury was more frequent in DBD although no significant difference was found n=8 needed retransplantation all in the DBD group. Biliary complications were reported in 12% in NRP and 5% DBD. n=1 Ischaemic cholangiopathy affected recipient in the DBD group Graft survival showed better outcomes in the NRP group but not a significant difference Concluded that the use of NRP can convert suboptimal liver	Comparator group is outside the primary scope of the assessment (DBD).

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		grafts such as in DCD into organs comparable to DBDs	
Rodriguez Sanjuan JC, Ruiz N, Minambres E et al. (2019) Liver Transplant From Controlled Cardiac Death Donors Using Normothermic Regional Perfusion: Comparison With Liver Transplants From Brain Dead Donors. Transplantation proceedings 51(1): 12 19	Study design: Retrospective study Sample size: Liver transplants from controlled DCDs using NRP and extracorporeal membrane oxygenation: n=11 DBD donors: n=51 Follow up : Up to 34.2 months Country: Spain	Ischaemic damage minimal in cDCD group, slight alanine aminotransferase and Aspartate aminotransferase rises in donor serum after 1 hour on NRP and after 24 hours after transplantation in both groups No ischaemic cholangiopathy or acute kidney injury in either group No significant difference for vascular or biliary complication n=1 (9.1%) cDCD recipient experienced primary non-function resulting in death n=5 (9.8%) donors in the DBD group needed retransplantation versus 0 in cDCD group	Comparator group is outside the scope of the assessment (DBD), and the NRP cohort is very limited in size (n=11).

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		Estimated mean survival in cDCD was 24.6 months and 32.3 months in DBD but no statistically significant difference was observed. Overall, NRP and extracorporeal membrane oxygenation in cDCD was associated with minimal risk of primary non-function, ischaemic cholangiopathy, complications and acute renal failure and was not any higher than in DBD transplants.	
Ruiz P, Gastaca M, Bustamante FJ et al. (2019) Favorable Outcomes After Liver Transplantation With Normothermic Regional Perfusion From Donors After Circulatory Death: A Single center Experience. Transplantation 103(5): 938 943	Study design: Descriptive analysis of data from a prospective database Sample size: n=57 cDCD donors Follow up: Minimum 9 months Country: Spain	n=46 out of 57 livers were transplanted (80% recovery rate) n=11 grafts discarded (n=1 graft discarded because of technical failure of the pump, n=2 exceeded alanine aminotransferase limit during NRP, n=1 kidney tumour, n=1 bilateral hepatolithiasis n=6	Study lacks a standard care comparative arm and is based on a limited single centre cohort (n=46 livers transplanted) with a short follow up (9 months).

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		suboptimal macroscopic aspect) n=7 (15%) presented with postreperfusion syndrome n=11 (23%) showed early allograft dysfunction n=0 (0%) cases of Ischaemic cholangiopathy diagnosed and n=0 graft loss over median follow up of 19 months n=1 cases of biliary complications or ischaemic cholangiopathy (2%) cDCD liver grafts with NRP appear far superior to those obtained by rapid recovery technique	
Ruiz P, Valdivieso A, Palomares I et al. (2021) Similar Results in Liver Transplantation From Controlled Donation After Circulatory Death	Study design:	cDCD donors (n=133):	Comparator group is outside the primary scope of the assessment (DBD).

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
Donors With Normothermic Regional Perfusion and Donation After Brain Death Donors: A Case Matched Single Center Study. Liver transplantation: official publication of the American Association for the Study of Liver Diseases and the International Liver Transplantation Society 27(12): 1747 1757	Single centre retrospective case matched study (1:2) Sample size: n=493 livers evaluated n=100 NRP cDCD liver transplant n=200 DBD liver transplants Follow up: Minimum: 6 months Median: 36 months Country: Spain	cDCD liver transplant (% of total liver transplant) n=100 (28.0%) cDCD discarded n=23 (17.0%) Alanine aminotransferase peak: (p=0.53) cDCD: 836 units per litre DBD: 909 units per litre Early allograft dysfunction: (p=0.83) DBD :19.2% cDCD 21.0% 1 and 3 year overall graft survival: cDCD: 99.0%, 93.0% DBD: 92.0%, 97.0% Primary non-function:	

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		n=0 cases of primary non-function observed in cDCD grafts Retransplantation (p=0.29): cDCD: 1.0% DBD: 3.5% n=1 liver was discarded because of technical failure of NRP (4% of all discarded, 0.75% of all cDCD livers) Acute kidney injury: (p=0.11) cDCD: 19.8% DBD: 29.3% Biliary complications: (p=0.90) cDCD: 5.2% DBD: 6.3% Hepatic artery thrombosis: (p=1.00) cDCD: 1.0%	

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		DBD: 1.5% Ischemia type biliary lesions: n=0 cases were observed among the cDCD grafts	
Savier E, Lim C, Rayar M et al. (2020) Favorable Outcomes of Liver Transplantation from Controlled Circulatory Death Donors Using Normothermic Regional Perfusion Compared to Brain Death Donors. Transplantation 104(9): 1943 1951	Study design: Multicentre retrospective matched control study Sample size: n=50 cDCD n=100 DBD Follow up (minimum): 2 years Country: France	Intervention: cDCD liver transplant with NRP Comparator: DBD liver transplant n=284 cDCD liver were proposed to 6 centres and n=159 were accepted Early allograft dysfunction: cDCD 18% DBD 32% 90 d graft loss: cDCD: 2% DBD: 5% Arterial complications:	Comparator group is outside the primary scope of the assessment (DBD).

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		cDCD: 4% DBD: 12% 2 year graft survival: cDCD: 88% DBD:85% 2 years participant survival: cDCD: 90% DBD: 88% Acute kidney injury: (p=0.49) Similar rates achieved cDCD: n=13(26%) DBD: n=33 (33%) Biliary complications: (p=0.94) cDCD: n=8(16%) DBD: n=17 (17%) Technical failure	

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		n=19 (8%) of donors were unable to be used because of technical failure to perform NRP (n=7 percutaneous cannulation failure, n=1 circuit malfunction or defect, n=1 clots in circuit, n=4 dysfunction, n=5 balloon related complications, n=1 aortic dissection)	
Schurink IJ, de Goeij FHC, Habets LJM et al. (2022) Salvage of Declined Extended criteria DCD Livers Using In-Situ Normothermic Regional Perfusion. Annals of surgery 276(4): e223 e230	Study design: Prospective single centre study Sample size: n=45 donor livers offered to be rescued n=28 aNRP initiated donors, n=25 livers evaluated Follow up: 12 months Country: Netherlands	Comparator cohort was standard DCD and DBD livers transplanted in centre n=3 technical failures meant aNRP was prematurely terminated (n=1 insufficient blood flow, n=2 haemostasis not achieved sufficiently n=5 (20%) of liver grafts declined because of rising alanine aminotransferase levels	Small cohort size for NRP and focuses on a highly specific donor population (declined extended criteria livers).
Schurink IJ, de Goeij FHC, van der Heijden FJ et al. (2024) Liver function maximum capacity test during	Study design:	n=12 livers were accepted for transplantation	Small cohort study (n=18) focusing on evaluating a

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
normothermic regional perfusion predicts graft function after transplantation. The EPMA journal 15(3): 545 558	Prospective observational study Sample size: n=18 extended DCD liver donors Follow up : 18 months Country: Netherlands	n=1 LiMAx test failed, n=4 did not pass acceptance criteria and were declined (n=3 alanine aminotransferase levels outside protocol and n=1 insufficient biliary quality) In transplanted group, aspartate aminotransferase and alanine aminotransferase levels were significantly lower versus non-transplanted group n=1 (8%) suffered post reperfusion syndrome n=1 (8%) portal vein thrombosis Median alanine aminotransferase and aspartate aminotransferase 24 hour post transplantation 350	novel diagnostic viability tool (LiMAx test) during NRP.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		(224 to 481) units per litre and 462 (276 to 560) units per litre n=2 Early allograft dysfunction n=0 Primary non-function Graft survival at 6 and 12 months = 92% Used liver function maximum capacity to assess liver function during aNRP All livers also underwent dual hypothermic oxygenated machine perfusion	
Schurink IJ, van de Leemkolk FEM, Fondevila C et al. (2022) Donor eligibility criteria and liver graft acceptance criteria during normothermic regional perfusion: A systematic review. Liver transplantation: official publication of the American Association for the Study	Study design: Systematic review Sample size: n=1711 or 1247 total cDCD	n=14 articles included Organ utilisation rate = 64% for cDCD versus 16% for uDCD Primary non-function:	Systematic review focused primarily on donor eligibility and graft acceptance criteria; superseded by more comprehensive recent reviews.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
of Liver Diseases and the International Liver Transplantation Society 28(10): 1563 1575	n=14 total studies included n=8 cDCD NRP studies Follow up : 1 year Country: Italy n=4, Spain n=4, France n=3, UK n=2, USA n=1	3% (2 to 4%) of DCD versus 13% (6 to 25%) of uDCD 1 year graft and recipient survival rates in cDCD were 91% (89% to 93%) and 93% (91% to 94%) respectively versus 75% (66 to 82%) and 82% (75 to 88%) in uDCD 17% of grafts were declined because of technical or logistical failure. Technical failure reasons included donor vasculature being incompatible with NRP circuit establishment, cannulation problems and ability to reach adequate blood flow	
Shapey IM, Muiesan P (2013) Regional perfusion by extracorporeal membrane oxygenation of abdominal organs from donors after circulatory death: a systematic review. Liver transplantation: official publication of the American Association for the Study	Study design: Systematic review Sample size: n=11 studies (included n=4 liver, n=7 kidneys)	Only n=1 study reported on controlled NRP DCD Study had successful transplantation of n=12 livers	Systematic review published over 10 years ago; superseded by more recent, comprehensive systematic reviews and larger primary data cohorts.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
of Liver Diseases and the International Liver Transplantation Society 19(12): 1292 1303	n=12 livers transplanted from regional perfusion supported cDCD sources Follow up: 1 year Country: Spain n=6, USA n=3, Taiwan n=1, Japan n=1, Russia n=1	(follow up data available for n=11) 91% (n=10) reported for 1 year recipient and graft survival comparable with DBD and better than with standard DCD and Recipient survival was similar to DBD recipients but significantly better than for DCD. Ischaemic cholangiopathy and primary non-function occurred in 9% and 0% of cases respectively.	
Steinberg I, Patrono D, De Cesaris E et al. (2023) Viability assessment of livers donated after circulatory determination of death during normothermic regional perfusion. Artificial organs 47(10): 1592 1603	Study design: Observational prospective cohort study Sample size: n=27 donors Follow up (minimum): 6 months Country: Italy	n=20 (74%) of donor livers were accepted All grafts exhibited primary function n=5 (25%) recipients presented with early allograft dysfunction n=3 (15%) presented with stage 2 to 3 acute kidney injury	Study primarily focuses on in situ viability assessment and metabolic markers rather than comparative clinical outcomes. Also, geographic differences in donor management protocols (Italy) reduce generalisability to the UK NHS context.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
		n=2 (10%) presented with biliary complications n=4 (20%) needed reoperation n=7 (35%) Clavien Dindo score equal or more than 3	
Torri F, Balzano E, Melandro F et al. (2024) Sequential Normothermic Regional Perfusion and End Ischaemic Ex-Situ Machine Perfusion Allow the Safe Use of Very Old DCD Donors in Liver Transplantation. Transplantation 108(6): 1394 1402	Study design: Interim sub analysis of a DCDNet study (NCT04744389), a prospective, randomised trial Sample size: n=17 cDCD donors older than 70 years Follow up: Median 8 months Country: Italy	NRP followed by end Ischaemic machine perfusion or dual hypothermic oxygenated machine perfusion In 35% (n=6) cases the graft was not suitable for liver transplantation versus 65% (n=11) were transplanted Post liver transplant results were optimal with no major complications after 7 months. post reperfusion syndrome, acute kidney injury and early allograft dysfunction were kept low.	Intervention involves sequential ex-situ machine perfusion, confounding the specific safety and efficacy effects of in situ NRP alone. Additionally, it focuses on a highly specific donor sub population (septuagenarian and octogenarian donors), and geographic differences (Italy) reduce generalisability.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
Viguera L, Blasi A, Reverter E et al. (2021) Liver transplant with controlled donors after circulatory death with normothermic regional perfusion and brain dead donors: A Multicentre cohort study of transfusion, one year graft survival and mortality. International journal of surgery (London, England) 96: 106169	Study design: Retrospective non-inferiority multicentre study Sample size: n=591 liver transplants n=144 cDCD with NRP Follow up: 1 year Country: Spain	Non-inferiority of cDCD with NRP grafts to DBD was shown in terms of post reperfusion syndrome as well as post operative 1 year recipient and graft survival (92% and 90% versus 91% and 89% respectively)	Comparator group is outside the primary scope of the assessment (DBD).
Wall A, Du J, Snoddy M et al. (2025) The Landscape of In Situ and Ex-Situ Machine Perfusion Utilisation for Liver Grafts From Noncardiac Donation After Circulatory Death Donors in the Early era of Machine Perfusion in the United States. Transplantation direct 11(11): e1858	Study design: Retrospective cohort study, national, multicentre registry based analysis Sample size: n=284 NRP donors Follow up : 1 year Country: US	55% utilisation of NRP livers (156 out of 284 donors) versus 2497 utilisation from n=9132 super rapid recovery donors (27%) utilisation No statistically significant difference in recipient or graft survival at 1 year between NRP and super rapid recovery (96% versus 95% and 96% versus 92% respectively)	Geographic differences in clinical protocols and donor management (US) reduce generalisability to UK NHS standard practice. The study also focuses on high level organ utilisation trends rather than the key comparative safety and efficacy outcomes relevant to this assessment.

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
Wang L, Thompson E, Bates L et al. (2020) Flavin Mononucleotide as a Biomarker of Organ Quality A Pilot Study. Transplantation direct 6(9): e600	Study design: Novel retrospective study Sample size: n=23 abdominal NRP in DCD donors n=15 deemed suitable Follow up: 3 months Country: UK	Flavin mononucleotide levels at 30 minutes were significantly lower in livers accepted for transplant versus those declined.	Focuses on evaluating a novel biomarker for organ viability assessment rather than providing comparative clinical efficacy and safety data against standard care.

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Table 5: Additional studies identified from back citation searches

Study	Number of people and follow up	Direction of conclusions	Rationale for not including
Eden J, Sousa Da Silva R, Cortes Cerisuelo M, et al. Utilization of livers donated after circulatory death for transplantation. An international comparison. J Hepatol. 2023;78(5):1007 1016. doi:10.1016/j.jhep.2023.01.025	Study Design: Retrospective cohort Sample size: n=181 in UK NRP cohort, n=418 France NRP, n=124 Italy NRP and hypothermic oxygenated machine perfusion, n=803 Spain NRP	UK 1 year graft survival: 96.1% France 1 year graft survival: 92.5%	Focuses on comparison of utilisation rates and graft survival between different European countries.

	Follow up: UK and France:1 year, Italy: 5 years, Spain:10 years Country: UK, France, Italy, Spain with extractable NRP data	Italy 1 year graft survival: 91.9% 5 year graft survival (overall, *tumour death censored): 81.8% Graft loss due to primary graft non-function: 3 out of 124 (2.4%) Graft loss due to cholangiopathy: 1 out of124 (0.8%) Spain 1 year graft survival: 86.0% 5 year graft survival (overall, *tumour death censored): 76.0%, 80.0% 10 year graft survival (overall, *tumour death censored): 72.0%, 75.0%	
Fallani G, Stocco A, Siniscalchi A, et al. Beyond the Concepts of Elder and Marginal in DCD Liver Transplantation: A Prospective	Study Design: Prospective observational cohort	Post operative infectious complications: n=7 (26.9%)	Study done in Italy.

Observational Matched Cohort Study in the Italian Clinical Setting. Transpl Int. 2023;36:11697. Published 2023 Sep 7. doi:10.3389/ti.2023.11697	Sample size: n=26 in the DCD arm Follow up: Median=19 months (interquartile range: 14 24 months) Country: Italy	Severe acute kidney injury: n=1 (4.0%) Respiratory failure: n=0 Post operative haemorrhage: n=0 Hepatic artery thrombosis: n=0 12 months biliary complications: n=3 (11.5%) 30 days acute cellular rejection: n=0 90 days mortality: n=0 Early allograft dysfunction: n=3 (11.5%) Primary graft non-function: n=1 (4.0%) Re transplantation: n=1 (4.0%)	DCD population size of n=26. DCD population stratified by age >75 or <75 years. Comparator is DBD population.

		Major complications: n= 4 (15.4%) Hospital stay in days (median, interquartile range) n=15, 13–23	
Ivanics T, Claasen MPAW, Patel MS, et al. Outcomes after liver transplantation using deceased after circulatory death donors: A comparison of outcomes in the UK and the US. Liver Int. 2023;43(5):1107 1119. doi:10.1111/liv.15537			No data specifically on NRP as the use of machine preservation and NRP is not recorded in either of the database cohorts were extracted.
Sellers M, Grandas J, Warhoover MT, Poland JD, Clapper DC. Normothermic regional perfusion performed by a United States organ procurement organization for nonthoracic organ donors. Am J Transplant. 2025;25(8):1677 1684. doi:10.1016/j.ajt.2025.04.005	Study Design: Prospective cohort Sample size: n=90 NRP Follow up: NR Country: USA	Liver utilisation: n=62 (69%) Primary non-function: n=2	Study done in the US. Compares to direct procurement and DBD which is out of scope. Only really reports demographics of NRP cohort, liver utilisation and primary non-function.

Terminology note: the standard of care procedure has not been standardised to 'conventional static cold storage' in this table. Instead, terminology used in this table directly reflects the terminology used by the study authors.

Table 6: Additional studies identified abstracts

Study	Reason study was not included in main evidence summary
Alomar O, Vachharajani N, Chapman W, et al (2025) Revolutionizing DCD Liver Transplantation : Expanding Donor Criteria with Normothermic Machine and Regional Perfusion. American Journal of Transplantation 25(1): S45 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Badenes R, Alvarez C, Hornero F, et al (2020) ECMO mobile team for donor cardiac death . a pilot ECMO TT study. Critical Care 24: [page number unknown] [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Badenes R, Segura JM, Carbonell J, et al (2019) Mobile ECMO team and donor cardiac death . A pilot ECMO TT study. Intensive Care Medicine Experimental 7: [page number unknown] [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Baskin R and Kautzman L (2023) Liver DCD Using Normothermic Regional Perfusion : A Single Center Review. American Journal of Transplantation 23(6): S726 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Botha JF, Paci P, Contreras A, et al (2025) One Hundred Abdominal Normothermic Regional Perfusion (NRP) DCD Liver Transplants: Zero Ischemic Cholangiopathy. American Journal of Transplantation 25(8): S209 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Camagni S, Amaduzzi A, Grazioli L, et al (2023) LIVER DONATION after CIRCULATORY DEATH with VERY PROLONGED WARM ISCHEMIA: A PILOT EXPERIENCE of ABDOMINAL NORMOTHERMIC REGIONAL PERFUSION ALONE. International Journal of Artificial Organs 46(7): 430 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Camagni S, Amaduzzi A, Grazioli L, et al (2021) Selective use of ex situ machine perfusion after normothermic regional perfusion in liver transplantation from donation after circulatory death. Transplant International 34: 54 55 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Caralt M, Bello I, Sandiumenge A, et al (2017) "non touch" vena cava technique as an	Deprioritised: Abstract only (Sufficient full text available).

Study	Reason study was not included in main evidence summary
improvement in combined lung and abdominal organs procurement in donation after circulatory death (DCD) Maastricht III. Transplant International 30: 227 [Abstract]	
Catalano G, Vacca PG, Pezzati D, et al (2024) Sequential normothermic regional and end ischemic ex situ machine perfusion allows the safe use of very old DCD donors in liver transplantation (DCDNet trial). Transplantation 108(9): 125 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Cederquist K, Vyas F, Ong OY, et al (2025) Lactate Trends in NRP and TNRP: A Single Center Analysis. American Journal of Transplantation 25(8): S975 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Collins GL, Lotts MP, Roberts RJ, et al (2025) Iterative Development of an OPO Based Abdominal Normothermic Regional Perfusion Program. American Journal of Transplantation 25(8): S1002 S1003 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Dallai C, Baroni S, Marudi A, et al (2020) Apheresis or not apheresis in controlled liver donation after circulatory death: A single centre experience in Italy. Critical Care 24: [page number unknown] [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
De Almeida ESM, Atutxa L, Sebastian R, et al (2018) Controlled donation after circulatory death (cDCD) in Donostia University Hospital, 2015 2018. Intensive Care Medicine Experimental 6: [page number unknown] [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
De Carlis R, Lauterio A, Centonze L, et al (2022) How to combine normothermic regional perfusion and machine perfusion in donation after circulatory death liver transplantation? Answers from an Italian national survey. Transplantation 106(8): 118 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
De Carlis R, Schlegel A, Frassoni S, et al (2021) Liver grafts from controlled and uncontrolled donation after circulatory death in Italy: Preservation protocol and results. Transplant International 34: 311 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).

Study	Reason study was not included in main evidence summary
De Goeij, F. H. C., Schurink, I. J., Habets, L. J. M., Van De Leemkolk, F. E. M., Van Dun, C. A. A., Oniscu, G. C., . . . De Jonge, J. (2022). Salvage of declined extended criteria DCD livers using abdominal normothermic regional perfusion (ANRP). Transplantation, 106(8), 121. [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Duarte S, Bhutani S, Ngo T, et al (2025) Comparative Analysis of Liver Transplants from Donation After Circulatory Death Using Abdominal Normothermic Regional Perfusion versus Rapid Recovery: A Single Center Experience. American Journal of Transplantation 25(1): S18 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Endo Y, Nair A, Tomiyama K, et al (2025) The Impact of Normothermic Regional Perfusion on the Utilization and Post Transplant Outcomes for Liver Transplant. American Journal of Transplantation 25(8): S748 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Esser H, Sherif A, Hunt F, et al (2018) Recipients of DCD liver grafts treated with nrp display lower postoperative morbidity and mortality compared to standard DCD liver graft recipients in the first year post transplant. Transplant International 31: 10 11 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Estefania K, Serradilla J, Ramirez C, et al (2025) Pediatric transplantation from donors after circulatory determination of death using normothermic regional perfusion. Pediatric Transplantation 29: [page number unknown] [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Fauche C, Gay S, Muller M, et al (2016) Uncontrolled donation after circulatory determination of death: 42 months of experience in a general hospital. Annals of Intensive Care 6: [page number unknown] [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Fauche C, Muller M, Gay S, et al (2016) Encouraging results of the French controlled donation after circulatory death Maastricht category III program. Annals of Intensive Care 6: [page number unknown] [Abstract]	Deprioritised: Abstract only (Sufficient full text available).

Study	Reason study was not included in main evidence summary
Figini MA, Bottazzi A, Dondossola D, et al (2021) First Italian experience of mobile ecmo teams for controlled donation after circulatory death. Transplant International 34: 342 343 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Figini MA, Paredes Zapata D, Juan EO, et al (2019) Mobile ecmo teams organization for controlled donation after circulatory death. Transplant International 32: 430 431 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Foss S, Nordheim E, Hagness M, et al (2019) Similar 1 year organ function from controlled donation after circulatory death using normo thermic regional perfusion and donation after brain death. Transplantation 103(11): S51 S52 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Foss S, Sorensen DW, Syversen T, et al (2017) The first protocol in scandinavia for controlled donation after circulatory death using normo thermic regional perfusion. Transplant International 30: 16 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Gauntt K, Carrico B and Klassen D (2021) DCD heart donation: Impact on organ yield. American Journal of Transplantation 21: 342 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Gaurav R, Butler A, Martin J, et al (2023) Early liver transplant failure after normothermic perfusion: not everything ends well. Transplantation 107(9): 186 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Gaurav R, Butler A, Swift L, et al (2021) Ex-situ normothermic machine perfusion as salvage for liver grafts following unsuccessful in-situ normothermic regional perfusion. Transplantation 105(8): 124 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Gaurav R, Webb G, Butler A, et al (2023) Outcomes of liver retransplantation from donation after circulatory death livers using normothermic regional perfusion. Transplantation 107(9): 178 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Georges P, Muller X, Wautier A, et al (2023) Hypothermic Oxygenated Perfusion after Normothermic Regional Perfusion to Extend Selection Criteria in cDCD Liver Transplantation	Deprioritised: Abstract only (Sufficient full text available).

Study	Reason study was not included in main evidence summary
A French Multicenter Study. HPB 25: S205 S206 [Abstract]	
Ghinolfi D, Patrono D, De Carlis R, et al (2023) Multicenter comparison of liver transplantation with uncontrolled versus controlled donors after circulatory death with prolonged warm ischemia using normothermic regional perfusion and ex-situ machine perfusion. Transplantation 107(9): 183 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Ghinolfi D, Pezzati D, Rreka E, et al (2019) Sequential use of locoregional abdominal perfusion and end ischemic normothermic machine perfusion in DCD liver transplantation using graft with prolonged wit. Transplant International 32: 39 40 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Grinberg S, Marklin G, Waters D, et al (2025) Increased Yield and Observed to Expected Organ Utilization with DCD NRP Recovery and Liver NMP: A Single OPO Study. American Journal of Transplantation 25(8): S750 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Gupta S, Hakeem A, Nawaz A, et al (2025) Histidine tryptophan ketoglutarate (HTK) is associated with higher post reperfusion syndrome in deceased donor liver transplantation : Time for a global rethink? British Journal of Surgery 112: vi6 vi7 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Ha A, Chen D, Goncalves C, et al (2025) Should early allograft dysfunction early allograft dysfunction Be Redefined in the Modern Era of DCD Liver Transplantation ? American Journal of Transplantation 25(1): S112 S113 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Ha A, Goncalves C, Reynolds D, et al (2025) Increasing Access to DCD Liver Transplant via Perfusion Technology: Time is On Our Side. American Journal of Transplantation 25(1): S51 S52 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Haddad W, Alhayani I, Zakour G, et al (2025) Advanced Perfusion Techniques Reduce AKI Risk in DCD Liver Transplantation. American Journal of Transplantation 25(8): S475 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).

Study	Reason study was not included in main evidence summary
Hagness M, Foss S, Sorensen DW, et al (2019) Liver transplantation in Norway with normothermic regional perfusion cDCD grafts. Transplant International 32: 39 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Hessheimer A, Coll E, Ruiz P, et al (2018) Superior outcomes using normothermic regional perfusion in cDCD liver transplantation. HPB 20: S173 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Hessheimer A, Coll E, Valdivieso A, et al (2018) Superior outcomes using normothermic regional perfusion in cDCD liver transplantation. American Journal of Transplantation 18: 400 401 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Hessheimer A, Coll E, Valdivieso A, et al (2018) Superior outcomes using normothermic regional perfusion in CDCD liver transplantation. Transplantation 102(7): S380 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Hunt F, Herries W, Sutherland A, et al (2017) Normothermic regional perfusion increases liver utilisation and improves the outcomes after liver transplantation from controlled dcd donors. Transplant International 30: 41 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Huurman V, Detillon D, Detillon L, et al (2019) Implementation of normothermic regional perfusion in extended criteria donors in The Netherlands. Transplant International 32: 304 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Jacques A, Monday K, Bayer J, et al (2025) Utilizing ECMO cannula exchange to facilitate abdominal DCD NRP organ procurement technical considerations for successful liver transplantation. American Journal of Transplantation 25(1): S85 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Jacques A, Walker O, Monday K, et al (2025) Utilization of Liver Grafts from Donation After Circulatory Death Donors on Extracorporeal Membrane Oxygenation Support Using Normothermic Regional Perfusion. American Journal of Transplantation 25(8): S739 S740 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).

Study	Reason study was not included in main evidence summary
Jacques A, Walker O, Monday K, et al (2025) Utilization of Liver Grafts From Donation After Circulatory Death Donors on Extracorporeal Membrane Oxygenation Support Using Normothermic Regional Perfusion. Transplantation Direct 11(11): e1870 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Johnston C, Stutchfield B, Sherif AE, et al (2021) Introducing normothermic machine perfusion (OrganOx) into clinical practice the Edinburgh experience. Transplant International 34: 315 316 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Krist DT, Nakayama T, Melcher M, et al (2025) Can Current Preservation Techniques Expand Utilization of Liver Grafts Donated After Circulatory Death for Re Transplant? American Journal of Transplantation 25(8): S497 S498 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Kueht M, Wall A, Gupta A, et al (2023) Development and Implementation of an Abdominal Normothermic Regional Perfusion Donation After Circulatory Death Protocol. American Journal of Transplantation 23(6): S748 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Lesurtel M, Muller X, Mohkam K, et al (2021) Hypothermic Oxygenated Perfusion versus Normothermic Regional Perfusion in Liver Transplantation from Non heart Beating Donors first International Comparative Study. HPB 23: S2 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Liu Y (2013) Development and prospect of donation after cardiac death in China. American Journal of Transplantation 13: 400 401 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Machado L, Chen A, Murickan T, et al (2025) Liver Transplantation Using Normothermic Regional Perfusion A Single Center Experience. American Journal of Transplantation 25(1): S119 S120 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Magistri P, Catellani B, Olivieri T, et al (2022) Sequential hypothermic and normothermic machine perfusion for recovery of a cardiac death	Deprioritised: Abstract only (Sufficient full text available).

Study	Reason study was not included in main evidence summary
deceased donor (DCD) liver graft. Transplantation 106(8): 123 [Abstract]	
Magistri P, Olivieri T, Guidetti C, et al (2019) Does the policy on cardiac death declaration affect the outcomes of DCD liver grafts? Transplant International 32: 164 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Magistri P, Olivieri T, Guidetti C, et al (2021) Successful use of injured DCD liver grafts. Transplantation 105(8): 119 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Maksimuk T, Goncalves C, Bakhtiyar SS, et al (2025) DCD Liver Transplantation Contemporary US Experience with NRP and NMP. American Journal of Transplantation 25(1): S57 S58 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Martinelli C, Ghinolfi D, Pezzati D, et al (2024) Sequential normothermic regional and end ischemic ex situ machine perfusion allows the safe use of very old DCD donors in liver transplantation (DCDNet trial). Journal of Hepatology 80: S370 S371 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Martin Lefevre L, Videcoq M, Venhard JC, et al (2018) Extracorporeal regional perfusion from donors after controlled circulatory death: Clinical and biologic retrospective analysis in 3 centers in France. Transplant International 31: 12 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Masiero L, Procaccio F, Vespasiano F, et al (2021) Donation after circulatory death (DCD) strategy in Italy: The barrier of a prolonged no touch period can be overcome. Transplant International 34: 154 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Miguel CS, Fundora Y, Triguero J, et al (2015) Report of experience and results in liver transplantation using controlled and uncontrolled non heart beating donors in an Andalusian tertiary referral center. Transplantation 99(7): 207 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Minambres E, Arlaban M, Lavid N, et al (2017) Improving the outcomes of organs obtained from controlled donation after circulatory death donors using abdominal normothermic regional	Deprioritised: Abstract only (Sufficient full text available).

Study	Reason study was not included in main evidence summary
perfusion. Transplant International 30: 16 [Abstract]	
Minambres E, Lavid N, Arlaban M, et al (2017) Excellent results from controlled donation after circulatory death donors using abdominal normothermic regional perfusion. Transplantation 101(8): S37 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Minambres, E., Ruiz, P., Ballesteros, M. A., Sanchez, L., Atutxa, L., Fernandez Santiago, R., Gastaca, M. (2019). Combined lungs and liver procurement in controlled donation after circulatory death using normothermic abdominal perfusion. initial experience in two Spanish centers. Transplant International, 32, 407–408.	Deprioritised: Abstract only (Sufficient full text available).
Mohkam K, Nasralla D, Mergental H, et al (2021) Normothermic regional perfusion or normothermic machine perfusion in liver transplantation from donation after circulatory death. Transplant International 34: 51 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Mohkam K, Nasralla D, Mergental H, et al (2021) Normothermic Regional Perfusion or Normothermic Machine Perfusion in Liver Transplantation from Donation after Circulatory Death: A First Comparative Study. HPB 23: S669 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Moreno Gonzalez G, Juan EO, Busquets J, et al (2021) Comparison of ante mortem versus post mortem cannulation in liver donation after circulatory determination of death. Transplant International 34: 305 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Mowlem E, Randle L, Fear C, et al (2017) Normothermic regional perfusion of donors following circulatory death improves outcomes in liver transplantation. American Journal of Transplantation 17: 257 258 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Oniscu G, Butler A, Hunt F, et al (2019) Normothermic regional perfusion (NRP) increases abdominal organ utilisation from CDCD donors. Transplant International 32: 125 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).

Study	Reason study was not included in main evidence summary
Oniscu G, Hunt F, Herries W, et al (2017) Improved outcomes after liver transplantation from controlled dcd donors with normothermic regional perfusion. American Journal of Transplantation 17: 305 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Oniscu G, Randle L, Muiesan P, et al (2013) In situ normothermic regional perfusion (NRP) a revolution in category 3 dcd organ retrieval? The UK experience. Transplant International 26: 172 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Oniscu GC, Butler A, Hunt F, et al (2018) Better graft survival with no ischemic cholangiopathy in DCD liver transplantation in the UK using normothermic regional perfusion (NRP). Transplantation 102(7): S413 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Paci P, Cook B, Ryan R, et al (2025) Pushing the limits in DCD with NRP – a single center experience of 67 cases of liver transplantation. American Journal of Transplantation 25(1): S125 S126 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Paci P, Cook B, Ryan R, et al (2024) Extended Criteria donors in donation after circulatory death: can abdominal normothermic regional perfusion safely expand the deceased donor pool? Hepatology 80: S1044 S1045 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Patrono D, Zanierato M, Magaton C, et al (2022) Outcome of livers from donation after circulatory death with prolonged warm ischemia time treated with normothermic regional perfusion and hypothermic oxygenated machine perfusion. Transplantation 106(8): 34 35 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Pearson R, Geddes C, Clancy M, et al (2019) Normothermic regional perfusion of kidneys: A single non retrieval centre experience. American Journal of Transplantation 19: 356 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Pelletier SJ, Hundley JC, Englesbe MJ, et al (2009) Liver transplantation and ECMO assisted donation after cardiac death. American Journal of Transplantation 9: 263 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).

Study	Reason study was not included in main evidence summary
Perez A, Sanchez JJ, Bajo RR, et al (2024) Organ donation after euthanasia in Spain: A summary of the first results. Transplantation 108(9): 123 124 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Perez Calle M, Bellon Ramos AM, Galiano Gordillo JA, et al (2023) Controlled donation after the determination of circulatory death with normothermic regional perfusion in a third level hospital: a six year review. Intensive Care Medicine Experimental 11: [page number unknown] [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Perez Redondo M, Alcantara Carmona S, Fernandez Simon I, et al (2018) ECMO mobile teams for normothermic regional perfusion to support cardiac death donors in hospitals of the Autonomous Community of Madrid, Spain. A 1 year experience. Intensive Care Medicine Experimental 6: [page number unknown] [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Perim V, Faleiro M, Ogawa T, et al (2025) Deciphering DCD Liver Preservation: A Network Meta Analysis of NRP , NMP (Back to Base & On Site), and static cold storage Unveiling the Superior Methodology. American Journal of Transplantation 25(8): S754 S755 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Puttappa A, Gaurav R, Kakhandki V, et al (2022) Perioperative outcomes after controlled donation after circulatory death: A comparative study of cold storage, normothermic regional perfusion and normothermic machine perfusion. Transplantation 106(8): 8 9 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Quandahl R, Merani S, Kassel C, et al (2023) Intra operative outcomes In donation after circulatory death liver transplantation using normothermic machine perfusion, or normothermic regional perfusion versus super rapid recovery with static cold storage. Hepatology 78: S278 S279 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Ramos AMB, Calle MP, Garcia EBI, et al (2024) Succes rate of liver retrieval in normothermic regional perfusion during controlled donation after	Deprioritised: Abstract only (Sufficient full text available).

Study	Reason study was not included in main evidence summary
circulatory death. Journal of Critical Care 81: 154672 [Abstract]	
Richards J, Gaurav R, Kosmoliaptsis V, et al (2019) Recipients of DCD livers from donors undergoing in situ normothermic regional perfusion have less Acute Kidney Injury than recipients of standard DCD livers or DCD livers undergoing ex-situ normothermic perfusion. Transplant International 32: 40 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Rinaldi S, Baroni S, Ghedini S, et al (2019) Apheresis in organ donation after cardiac death (DCD): A single centre experience. Blood Purification 47: 20 21 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Ruiz P, Palomares I, Gastaca M, et al (2019) Donation after cardiac death liver transplantation without Ischemic cholangiopathy: Facing the challenge. Transplantation 103(8): 427 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Ruiz Ordorica P, Palomares I, Gastaca M, et al (2021) 100 consecutive cDCD liver transplantations preserved with normothermic regional perfusion: A unicentric experience. Transplantation 105(8): 153 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Ruiz Ordorica P, Palomares I, Gastaca M, et al (2021) Analysis of the liver recovery rate in DCD donors preserved with Normothermic Regional Perfusion: Comparison with the "gold standard" DBD. Transplantation 105(8): 165 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Savier E, Rayar M, Boudjema K, et al (2018) Normothermic regional circulation for type 3 donation after circulation death (DCD). Results in liver transplantation of a French multicentric series. Transplant International 31: 8 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Savier E, Rousseau G, Perdigao F, et al (2017) Liver transplantation from type 3 donor after circulatory death and regional normothermic circulation. first results of a French center. Transplant International 30: 13 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Sherif AE, Johnston C, Coutts L, et al (2022) Defining the boundaries of viability assessment	Deprioritised: Abstract only (Sufficient full text available).

Study	Reason study was not included in main evidence summary
criteria during NRP. Transplantation 106(8): 119 [Abstract]	
Sherif AE, Johnston C, Coutts L, et al (2022) Utilising NRP to 'rescue' extended criteria DCD livers that have been declined by all UK transplant centres. Transplantation 106(8): 118 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Sherif AE, Sutherland A, Currie I, et al (2021) Re writing the definition of high risk and futile DCD liver transplantation with NRP. Transplant International 34: 158 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Strom C, Curran C, Oldham M, et al (2025) Implementation of an OPO Driven NRP Program: Impact on Abdominal Organ Utilization. American Journal of Transplantation 25(8): S95 S96 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Suarez YF, Meneu Moreno P, Garcia R, et al (2024) Barcelona Clinic Liver Perfusion Protocol for Uncontrolled Donation after Cardiac Death (uDCD): A Preliminary Report Series. Journal of the American College of Surgeons 239(5): S487 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Sutherland AI, Randle L, Muiesan P, et al (2014) Liver transplantation with allografts recovered from donors after circulatory death using in situ normothermic regional perfusion (NRP). Liver Transplantation 20: S104 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Torri F, Melandro F, Balzano E, et al (2023) Pilot, open, randomized, multicenter trial for the comparison of hypothermic versus normothermic ex situ liver preservation in DCD liver transplantation with extended ischemia time (DCDNet trial). Transplantation 107(9): 21 22 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Trujillo Garcia E, Valverde Montoro A, Molina Diaz H, et al (2018) Features and monitoring of liver transplants from donation after cardiac death in a Spanish hospital. Intensive Care Medicine Experimental 6: [page number unknown] [Abstract]	Deprioritised: Abstract only (Sufficient full text available).

Study	Reason study was not included in main evidence summary
Trujillo Garcia E, Bravo EB, Montoro AV, et al (2019) A description of donation after cardiac death in a Spanish hospital. Critical Care Medicine 47(1): [page number unknown] [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Walker O, Snoddy M, Saracino G, et al (2025) NRP DCD Liver Grafts Yield Equal Outcomes of DBD Liver Grafts: A Single US Center Experience. American Journal of Transplantation 25(8): S185 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Wall A, Abt P, Brubaker A, et al (2025) Utilization of DCD NRP liver grafts: A multicenter study of opportunities for improvement in organ acceptance. American Journal of Transplantation 25(1): S86 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Wall A, Du J, Snoddy M, et al (2025) The Current Landscape of In-Situ and Ex Situ Machine Perfusion Utilization for Liver Grafts from Non Cardiac Donation After Circulatory Death Donors. American Journal of Transplantation 25(8): S971 S972 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Wall A, Snoddy M, Du J, et al (2025) Normothermic regional perfusion increases graft utilization from non cardiac donation after circulatory death donors: A review of US data. American Journal of Transplantation 25(1): S20 S21 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Ward CJ, Bellingham J, Vo A, et al (2025) A Collaborative " Donor to Base" Abdominal Normothermic Regional Perfusion Program Leads to Superior Organ Utilization and Recipient Allograft Outcomes. American Journal of Transplantation 25(8): S237 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Watson C, Hunt F, Butler A, et al (2018) Normothermic regional perfusion (NRP) for DCD liver transplantation in the UK: Better graft survival with no cholangiopathy. Transplantation 102(5): 47 48 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Watson C, Mowlem E, Crick K, et al (2017) Normothermic regional perfusion of donors following circulatory death is associated with	Deprioritised: Abstract only (Sufficient full text available).

Study	Reason study was not included in main evidence summary
improved outcomes and no cholangiopathy. Transplant International 30: 15 [Abstract]	
Wells R, Fischbach C, Schwartz G, et al (2025) Splitting the Sandbox: The Use of Abdominal Normothermic Regional Perfusion with Super Rapid Recovery Lung Procurement. American Journal of Transplantation 25(8): S209 S210 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Yu J, Nakayama T, SasAcute Kidney Injury K, et al (2025) Liver Transplantation Outcomes from Donation After Circulatory Death Recovered by Thoracoabdominal versus Abdominal Normothermic Regional Perfusion. American Journal of Transplantation 25(8): S751 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Yu J, Nakayama T, Sasaki K, et al (2025) A UNOS Database Outcomes Analysis of DCD Liver Transplantation Using Normothermic Regional Perfusion versus Normothermic Machine Perfusion. American Journal of Transplantation 25(8): S751 S752 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).
Yu J, Nakayama T, Sasaki K, et al (2025) A UNOS Database Outcomes Analysis of DCD Liver Transplantation Using Sequential Normothermic Regional Perfusion and Normothermic Machine Perfusion versus NRP Alone. American Journal of Transplantation 25(8): S183 S184 [Abstract]	Deprioritised: Abstract only (Sufficient full text available).

IP Survey IP1890

This report was generated on 23/04/26. Overall 4 respondents completed this questionnaire. The report has been filtered to show the responses for 'All Respondents'. A total of 4 cases fall into this category.

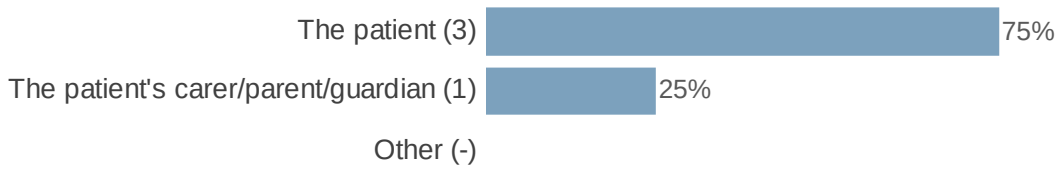
The following charts are restricted to the top 12 codes. Lists are restricted to the most recent 100 rows.

I have read the information above which explains the purpose of the project and how any information I provide will be used

I consent (agree) to NICE using the information I have given in the ways described above

How did you hear about this survey?

Are you (the person completing the questionniare)



Your age

69
57
57
42

In years

1
1.5
2

In months

17
7
10

in weeks

3

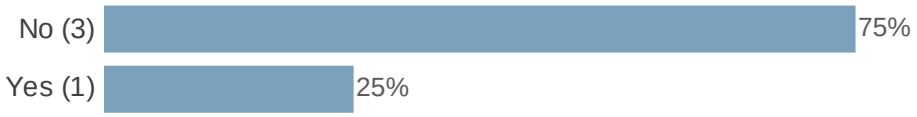
To which gender identity do you most identify?

What other treatment options did you consider, and why did you choose this one?

No other option viable so transplant or no future.
None - it was a life-saving procedure recommended by our Liver Consultant
no other treatment options available
I didn't get a direct choice of how my liver transplant would go ahead and what the parameters would be. However I did get told about all the different ways in which a liver could make its way to be a potential match for me and choose to widen my chances as much as possible by agreeing to all of the options. The use of NPR seemed like a sensible option to give me and the liver a better chance of getting along.

Did the procedure work?

Did you have any side-effects following your procedure?



If **yes**, please provide further details along with information about whether symptoms later reoccurred.

From the liver transplant itself, yes. Severe rejection which was not resolved by steroids. Loss of movement in my right arm which returned over a few weeks. Neither of these were related to NPR.

How long did it take you to recover from the procedure?

3 months initially eg able to drive. 12-17 months to fully recover ie back to where I was 5 years ago.

Six months

i took 5 months off work. After 1 month i was able to go for walks outside the house (short walks around the park).

Full recovery from the liver transplant is hard to judge. I was able to go back to a WFH-type job after 3 months. I didn't feel physically back to stable for 6 - 9 months. Mentally, I am still working on it.

How did the procedure positively affect your condition and/or your quality of life? Please consider things such as:

- Your physical symptoms
- Your ability to perform daily activities
- Your quality of life, lifestyle and/or social life
- Your state of mind, emotional health and/or wellbeing
- The effect on family, friends and others

I got a second chance of life. If I did not have a transplant I only had 6months to 1 year to live. Mentally I could not speak to be understood, brain function severely affected for mobility etc. I could not do simple tasks eg cooking, clean8ng house. Huge impact on my family who had to look after me: they were all fantastic and much of my recovery is down to their care and support. Now fully recovered mentally and physically. Planning and living the rest of my new life.

There was a complete reversal of all symptoms from prior to the liver transplant, loss of jaundice, complete reduction of fluid in limbs, raised energy levels. I was able to return to work and carry out my duties with energy and enjoyment Life became more enjoyable and I was able to plan a future with my partner and family. I feel more energised, positive and content. The worry of my health has been greatly reduced following a successful transplant. Family life has become productive again, caring for elderly parent is possible again. My partner and I are able to enjoy life again, to take holidays and enjoy our pets and home life fully!

All of the above: energy (no more fatigue), improved concentration, a positive outlook on life, a future

The use of NPR potentially enabled a liver which wouldn't have been viable to be used. In short, it gave me a chance to live again.

How did the procedure negatively affect your condition and/or your quality of life? Please consider things such as:

- Your physical symptoms
- Your ability to perform daily activities
- Your quality of life, lifestyle and/or social life
- Your state of mind, emotional health and/or wellbeing
- The effect on family, friends and others

The procedure was all positive for me and my family. Nothing negative
To be honest the procedure brought nothing but positive effects... yes there was a journey through the transplant procedure that was stressful - however - there was good support for both the patient and family right from the beginning of the process. The whole process was one of positivity.
none.

Did you require anymore treatment, including procedures or surgery after this procedure?

Would you recommend this procedure to another patient with your condition?

If **yes**, what might you tell them?

Just do it, it is better than winning the largest lottery in the world.
We have advised others who have been offered the opportunity of transplant to fully engage with the programme and the assessment process. That there is full support for all including family members. To have confidence in the skills of the medical team and nursing staff who will care for you. The benefits of the transplant are fully worth the journey. Life is transformed because of the transplant. Also, to engage with the voluntary support groups that work alongside the medical team, they are so helpful in giving good information that you will need.
That the quality of life improves; focus on the future; that the patient care is excellent
Take any and all options given to you

If the procedure had an impact on any other areas of your life that are not covered by the questions above please tell us about them here.

No, all positive.
We engaged with the voluntary support group connected to the hospital we attended. We have had such support and positive information from those who have experienced the transplant process. Through the group we have become involved in public information programmes sharing our story of transplant. It has been great to make new friends and feel part of a larger community of transplant families.
none

NICE National Institute for Health and Care Excellence

Professional Expert Questionnaires

- Barney Stephenson
- Benoy Babu
- Christopher Watson
- Elijah Ablorsu
- Ian Currie
- Matthew Armstrong

View results

Respondent

3 Anonymous

00:17
Time to complete

This questionnaire is only to be completed and submitted by Health and care practitioners

This questionnaire should be completed by those whose role is, or is directly related to, one of the specialisms below. For each assessment, we engage with professionals with expertise relevant to the topic under evaluation. By completing this questionnaire, you acknowledge and consent to being considered for the role of professional expert on this assessment.
Please indicate which option best describes your area of expertise. If there is no option which you feel relates to your role, please select 'Other' and let us know your role and why you think we should include your knowledge and expertise on the assessment.
For expressions of interest and/or to share your lived experience please email pip@nice.org.uk

Note:
Please ensure all necessary edits or amendments are completed on your questionnaire before the portal close date. A final submission pull will be conducted after closure, and the portal will then be locked. Any changes made after the closing date will not be included in the final submission.
https://techcommunity.microsoft.com/blog/microsoftformsblog/you-can-now-save-and-edit-your-survey-responses/3865033

1. Which option below best relates to your own role? You will be asked to supply your job title and organisation in the next section.
If your role is not listed but you feel it ought to be included, please select 'Other' and let us know your role and why you think we should include your knowledge and expertise on the assessment.

- (●) Consultant liver transplant surgeon
- ( ) Consultant Hepatologist
- ( ) Nurse specialising in transplantation or donation
- ( ) Perfusionist or specialist in organ procurement
- ( ) Transplant co-ordinator
- ( ) Interventional radiologist
- ( ) Consultant in anaesthesia
- ( ) Intensive care consultant
- ( ) Other

2. Topic Title

NICE HealthTech Programme – Request for professional experts for IPG10405 (IP1890) – In-situ normothermic regional perfusion of the abdomen for donor livers following circulatory death

3. Name: *

Barney Stephenson

4. Job title *

Locum Consultant Surgeon in Abdominal Transplantation, Organ Retrieval and Machine Perfusion

5. Organisation

6. Email Address

[redacted]

7. Professional organisation or society membership/affiliation

8. Nominated/ratified by (if applicable)

9. Registration number (e.g. GMC, NMC, HCPC) *

6104175

Consent to publish response

How NICE will use this information: The information that you provide on this form may be used to develop guidance on this topic.

Your advice and views represent your individual opinion and not that of your employer, professional society or a consensus view. Where relevant your name, job title, organisation and your responses, along with your declared interests may be published online on the NICE website as part of public consultation on the draft guidance, except in circumstances but not limited to, where comments are considered voluminous, or publication would be unlawful or inappropriate.

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- [ ] No, I do not give my consent for the information in this questionnaire to be used and it may not be published on the NICE website as outlined above.
- [ ] Other

11. If you do not consent to us publishing your response, please explain why below:

Experience

Please answer the following questions as fully as possible to provide further information about the procedure/technologies and/or your experience

12. Please describe your level of experience with the procedure/technologies, for example:

    - Are you familiar with the procedure/technologies?
    - Have you used it or are you currently using it? If so, please indicate your experience with this.
    - Do you know how widely this procedure/technology is used in the NHS? Is this procedure/technology performed/used by clinicians in specialities other than your own?

NHSBT registered NORS surgeon
Attended NRP Masterclass
Perform abdominal NRP and, with approval from NRP Steering Committee, abdominal NRP with concurrent cardiothoracic retrieval
Appointed as substantive Consultant and lead for NRP in Birmingham, commencing in early 2026

13. Please indicate your research experience relating to this procedure or technology (please choose one or more if relevant): (Please highlight your choice(s))

- [x] I have done bibliographic research on this procedure or technology
- [ ] I have done research on this procedure or technology in laboratory settings (e.g. device-related research).
- [ ] I have done clinical research on this procedure or technology involving patients or healthy volunteers.
- [ ] I have published this research.
- [ ] I have had no involvement in research on this procedure or technology.
- [ ] Other

Interventional procedure related questions ONLY

Please skip 12 - 16 - if a DG/EVA/MTAC/LSA topic (information can be found on your email invite)

14. Does the title adequately reflect the procedure?

Yes

15. Is the proposed indication appropriate? If not, please explain.

Yes

16. Does this have a multi-indication?

Yes, for abominal, concurrent cardiothoracic and paediatric DCD organ retrievals.

Current management

17. Please describe the current standard of care that is used in the NHS

Standard is super rapid retrieval and static cold storage. NHSBT has recently commissioned this service. However, NRP is not currently provided uniformly by retrieval teams.

18. Does this procedure/technology have the potential to replace current standard care or would it be used as an addition to existing standard care? Where would the technologies/procedure fit in the care pathway?

This technology would become the standard of care.

19.
- What are the main aims of these procedures or technologies?
- How innovative are they?
- Can you name any technologies which are available in the UK and have this function/mode of action?
- Are there any competing or alternative procedures available to the NHS which have a similar function/mode of action to this?
- If so, how do these differ from the technology/procedure indicated here?

To provide warm oxygenated perfusion of organs following certification of death which aims to:
1. Replenish organ ATP
2. Reduce transplant cholangiopathy
3. Provide additional benefits to other organs including heart, lung, pancreas and kidneys

This highly innovative technology is available in the UK, although in heterogenously distributed.

There is no competing in situ perfusion technology. However, there are competing ex situ technologies (hypo- and normothermic) but that only provide perfusion to single organs once retrieval has been completed.

20. Approximately how many people each year would be eligible for an intervention with this procedure/technology, (give either as an estimated number, or a proportion of the target population)?

Every DCD donor in the UK.

Potential patient benefits and impact on the health system

21. What do you consider to be the potential benefits to patients from using this procedure/technology?

Reduced primary non function and delayed graft function of transplanted organs
Reduced complications of organ transplantation including post liver transplant cholangiopathy
Reduced post transplant costs

22.
- Are there any groups of patients who would particularly benefit from this procedure/technology?
- Are there any groups in which the technology would be less effective or would be less likely to benefit?
- Are there any potential equality issues that should be considered for this condition and procedure/technology?

All abdominal and potentially cardiothoracic organ donors.
This technology is not applicable for donation following brain stem death
Currently, paediatric donors do not receive NRP and thus pose a potential equity issue. However, this technology has the potential to be used in these donors.

23.
- What do you consider to be the potential benefits to the system from using this procedure/technology?
- Could it lead, for example, to a reduced number of appointments, improved care pathway, more efficient NHS staff time use?

Reduced primary non function and delayed graft function of transplanted organs
Reduced complications of organ transplantation including post liver transplant cholangiopathy
Reduced post transplant costs Including interventional procedures and appointments

24. What clinical facilities (or changes to existing facilities) are needed to do this procedure/implement this technology safely?

Appropriate storage for additional equipment required, although most centres could accommodate this currently.

25. Is any specific training needed in order to use the procedure/technology with respect to efficacy or safety?

All retrieval surgeons need to attend the NRP Masterclass and maintain competence.

Safety and efficacy of the procedure/technologies

26. What are the potential harms of the procedure/technology?

- Please list any adverse events and potential risks (even if uncommon) and, if possible, estimate their incidence:
- Adverse events reported in the literature (if possible, please cite literature)
- Anecdotal adverse events (known from experience)
- Theoretical adverse events

Very safe procedure.
An extension of the use to include Thoraco-Abdominal NRP poses potential risks of perfusion that are being addressed by the NRP Steering Committee.

27. Please list the key efficacy and safety outcomes for this procedure/technology? Please suggest the most appropriate method of measurement for these outcomes and the timescales over which these should be measured (where appropriate) and if there are any challenges in collecting key outcomes.

Reduced primary non function and delayed graft function of transplanted organs
Reduced complications of organ transplantation including post liver transplant cholangiopathy
Reduced post transplant costs
5 year post transplant creatinine/GFR
PROMS and PREMS for transplant recipients
Data routinely collected.

28. Please list any uncertainties or concerns about the efficacy and safety of this procedure/technology?

Currently unclear most appropriate combination perfusion strategies for which NRP is key

29. Is there controversy, or important uncertainty, about any aspect of the procedure/technology?

Not for current use.

30. If it is safe and efficacious, in your opinion, will this procedure be carried out in (please choose one):

- [x] Most or all district general hospitals
- [x] A minority of hospitals, but at least 10 in the UK
- [x] Fewer than 10 specialist centres in the UK
- [ ] Cannot predict at present

31. Are you aware of any additional issues which would prevent (or have prevented) this procedure/technology being adopted in your organisation or across the wider NHS? This could include costs, resource, staffing for example.

No.

32. Please list any abstract, real-world evidence, conference proceedings or any major trials or registries that you are aware of for this topic.
Please note that NICE will do a comprehensive literature search; we are only asking you for any very recent abstracts or conference proceedings which might not be found using standard literature searches. You do not need to supply a comprehensive reference list but it will help us if you list any that you think are particularly important. If you would like to share any studies which are confidential due to their publication status, please contact us via email.

NCBI search for "Watson Currie normothermic regional perfusion"

33. Is there any research that you feel would be needed to address uncertainties in the evidence base?

A UK based RCT would be useful as well as an adaptive platform trial for combination perfusion strategies.

34. Please suggest potential audit criteria for this procedure/technology. If known, please describe:

- Beneficial outcome measures - These should include short- and long-term clinical outcomes, quality-of-life measures and patient-related outcomes. Please suggest the most appropriate method of measurement for each and the timescales over which these should be measured.
- Adverse outcome measures - These should include early and late complications. Please state the post procedure timescales over which these should be measured.

Reduced primary non function and delayed graft function of transplanted organs
Reduced complications of organ transplantation including post liver transplant cholangiopathy
Reduced post transplant costs
5 year post transplant creatinine/GFR
PROMS and PREMS for transplant recipients
Data routinely collected.

Further Comments

35. Please add any further comments on your particular experiences or knowledge of the procedure/technology.

Contact confirmation

Please indicate if you would like to opt in to NICE contacting you regarding other technologies/treatments in the future for your advice, or if you would only like to be contacted regarding this specific technology:

36. Please select what NICE may contact you about: *

- (●) NICE can use my details to contact me for advice on this and future assessments.
- ( ) NICE can use my details to contact me for advice on this topic only, but not for others.

37. Date *

28/11/2025

View results

Respondent

2 Anonymous

70:13
Time to complete

This questionnaire is only to be completed and submitted by Health and care practitioners

This questionnaire should be completed by those whose role is, or is directly related to, one of the specialisms below. For each assessment, we engage with professionals with expertise relevant to the topic under evaluation. By completing this questionnaire, you acknowledge and consent to being considered for the role of professional expert on this assessment.
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Note:
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https://techcommunity.microsoft.com/blog/microsoftformsblog/you-can-now-save-and-edit-your-survey-responses/3865033

1. Which option below best relates to your own role? You will be asked to supply your job title and organisation in the next section.
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- (●) Consultant liver transplant surgeon
- ( ) Consultant Hepatologist
- ( ) Nurse specialising in transplantation or donation
- ( ) Perfusionist or specialist in organ procurement
- ( ) Transplant co-ordinator
- ( ) Interventional radiologist
- ( ) Consultant in anaesthesia
- ( ) Intensive care consultant
- ( ) Other

2. Topic Title

IPG10405 (IP1890) – In-situ normothermic regional perfusion of the abdomen for donor livers following circulatory death (provisional title), interventional procedures assessment

3. Name: *

Benoy I Babu

4. Job title *

Consultant Transplant Surgeon

5. Organisation

Leeds Teaching Hospital NHS Trust

6. Email Address

[redacted]

7. Professional organisation or society membership/affiliation

British Association for Study of the Liver

8. Nominated/ratified by (if applicable)

British Association for Study of the Liver

9. Registration number (e.g. GMC, NMC, HCPC) *

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Consent to publish response

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11. If you do not consent to us publishing your response, please explain why below:

Experience

Please answer the following questions as fully as possible to provide further information about the procedure/technologies and/or your experience

12. Please describe your level of experience with the procedure/technologies, for example:

    - Are you familiar with the procedure/technologies?
    - Have you used it or are you currently using it? If so, please indicate your experience with this.
    - Do you know how widely this procedure/technology is used in the NHS? Is this procedure/technology performed/used by clinicians in specialities other than your own?

I am familiar with the Normothermic Regional Perfusion technology and have been using it regularly when I was working at the Edinburgh Transplant Centre. I have now moved to Leeds Liver Unit which is in the process of setting up the program. Most of the UK Liver Transplant Centres have already set up or are in the process of setting up the program.

13. Please indicate your research experience relating to this procedure or technology (please choose one or more if relevant): (Please highlight your choice(s))

- [x] I have done bibliographic research on this procedure or technology
- [ ] I have done research on this procedure or technology in laboratory settings (e.g. device-related research).
- [ ] I have done clinical research on this procedure or technology involving patients or healthy volunteers.
- [x] I have published this research.
- [ ] I have had no involvement in research on this procedure or technology.
- [ ] Other

Interventional procedure related questions ONLY

Please skip 12 - 16 - if a DG/EVA/MTAC/LSA topic (information can be found on your email invite)

14. Does the title adequately reflect the procedure?

yes

15. Is the proposed indication appropriate? If not, please explain.

yes

16. Does this have a multi-indication?

yes it does. There are more advantages to the use of this technology. They are
1) the advantage to other organs like Kidneys, Pancreas,
2) the ability to viability test the liver

Current management

17. Please describe the current standard of care that is used in the NHS

The standard of care at the moment is static cold storage

18. Does this procedure/technology have the potential to replace current standard care or would it be used as an addition to existing standard care? Where would the technologies/procedure fit in the care pathway?

There is a very high chance that all donation after circulatory Death donors would undergo NRP as is standard practice in some of the other European countries.

19.
- What are the main aims of these procedures or technologies?
- How innovative are they?
- Can you name any technologies which are available in the UK and have this function/mode of action?
- Are there any competing or alternative procedures available to the NHS which have a similar function/mode of action to this?
- If so, how do these differ from the technology/procedure indicated here?

What are the main aims of these procedures or technologies?
- viability testing of donor livers after donation after circulatory death (DCD).
- Improve outcomes of DCD organs (liver, kidney & pancreas)

How innovative are they?
-This is a technology that is being used in a few European countries as standard of care for DCD organs.
- Its slowly being implemented in the liver transplant units in the UK

Can you name any technologies which are available in the UK and have this function/mode of action?
- There is no direct comparison of a technology that is being used in the UK that has similar indications.
There are ex-situ machine perfusion technologies that would help assess viability of DCD organs but does not reduce the potential damage that the cold ischaemia time has on the organ.

Are there any competing or alternative procedures available to the NHS which have a similar function/mode of action to this?
As above.
If so, how do these differ from the technology/procedure indicated here?

20. Approximately how many people each year would be eligible for an intervention with this procedure/technology, (give either as an estimated number, or a proportion of the target population)?

The number of Brain dead donors (DBD) are reducing year by year. The use of DCD organs are on the rise. I cannot give a number but I feel more patients would benefit in the short & long term.

Potential patient benefits and impact on the health system

21. What do you consider to be the potential benefits to patients from using this procedure/technology?

- reduces ishaemic cholangiopathy.
- viability testing of marginal DCD organs.
- Reduces ischaemia repercussion injury.
- its cheaper compared to other ex-situ viability testing machine perfusion systems present.
- It helps multiple organs at the same time where as present ex-situ machine perfusion technologies are organ specific which increases costs per organ.
-Extended criteria donor organs can be tested prior to being used, thus increasing the organ donation pool.

22.
- Are there any groups of patients who would particularly benefit from this procedure/technology?
- Are there any groups in which the technology would be less effective or would be less likely to benefit?
- Are there any potential equality issues that should be considered for this condition and procedure/technology?

Are there any groups of patients who would particularly benefit from this procedure/technology?
- yes, donor organs after DCD procurement

Are there any groups in which the technology would be less effective or would be less likely to benefit?
No,

Are there any potential equality issues that should be considered for this condition and procedure/technology?
- Yes the non- utilisation of this program nationally will disadvantage patients on the waiting list

23.
- What do you consider to be the potential benefits to the system from using this procedure/technology?
- Could it lead, for example, to a reduced number of appointments, improved care pathway, more efficient NHS staff time use?

please refer to response in Q21

24. What clinical facilities (or changes to existing facilities) are needed to do this procedure/implement this technology safely?

The machine perfusion system with the point of care testing availability.
The perfusion team to help run the system.

25. Is any specific training needed in order to use the procedure/technology with respect to efficacy or safety?

Yes the organ retrieval teams need to be trained and confident in using this procedure and being able to interpret the results.

Safety and efficacy of the procedure/technologies

26. What are the potential harms of the procedure/technology?

- Please list any adverse events and potential risks (even if uncommon) and, if possible, estimate their incidence:
- Adverse events reported in the literature (if possible, please cite literature)
- Anecdotal adverse events (known from experience)
- Theoretical adverse events

This is not a perfect machine but is better than any similar machines in the market at present.

27. Please list the key efficacy and safety outcomes for this procedure/technology? Please suggest the most appropriate method of measurement for these outcomes and the timescales over which these should be measured (where appropriate) and if there are any challenges in collecting key outcomes.

28. Please list any uncertainties or concerns about the efficacy and safety of this procedure/technology?

29. Is there controversy, or important uncertainty, about any aspect of the procedure/technology?

30. If it is safe and efficacious, in your opinion, will this procedure be carried out in (please choose one):

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- [ ] A minority of hospitals, but at least 10 in the UK
- [ ] Fewer than 10 specialist centres in the UK
- [x] Cannot predict at present

31. Are you aware of any additional issues which would prevent (or have prevented) this procedure/technology being adopted in your organisation or across the wider NHS? This could include costs, resource, staffing for example.

the initial funding and running costs

32. Please list any abstract, real-world evidence, conference proceedings or any major trials or registries that you are aware of for this topic.
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33. Is there any research that you feel would be needed to address uncertainties in the evidence base?

assessing biliary issues which is the Achilles heal of liver transplantation

34. Please suggest potential audit criteria for this procedure/technology. If known, please describe:

- Beneficial outcome measures - These should include short- and long-term clinical outcomes, quality-of-life measures and patient-related outcomes. Please suggest the most appropriate method of measurement for each and the timescales over which these should be measured.
- Adverse outcome measures - These should include early and late complications. Please state the post procedure timescales over which these should be measured.

Further Comments

35. Please add any further comments on your particular experiences or knowledge of the procedure/technology.

Contact confirmation

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37. Date *

21/11/2025

View results

Respondent

4 Anonymous

114:43
Time to complete

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- ( ) Consultant Hepatologist
- ( ) Nurse specialising in transplantation or donation
- ( ) Perfusionist or specialist in organ procurement
- ( ) Transplant co-ordinator
- ( ) Interventional radiologist
- ( ) Consultant in anaesthesia
- ( ) Intensive care consultant
- ( ) Other

2. Topic Title

In-situ normothermic regional perfusion of the abdomen for donor livers following circulatory death (provisional title), interventional procedures assessment

3. Name: *

Christopher Watson

4. Job title *

Honorary Consultant

5. Organisation

Cambridge University Hospitals NHS Foundation Trust

6. Email Address

[redacted]

7. Professional organisation or society membership/affiliation

British Transplantaiton Society

8. Nominated/ratified by (if applicable)

9. Registration number (e.g. GMC, NMC, HCPC) *

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Consent to publish response

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    - Are you familiar with the procedure/technologies?
    - Have you used it or are you currently using it? If so, please indicate your experience with this.
    - Do you know how widely this procedure/technology is used in the NHS? Is this procedure/technology performed/used by clinicians in specialities other than your own?

I introduced NRP to the UK in 2010. I co-wrote the National Protocol for undertaking NRP for NHSBT https://nhsbtdbe.blob.core.windows.net/umbraco-assets-corp/36508/uk-protocol-for-normothermic-regional-perfusion-version-114-final.pdf
I wrote the section of the British Transplantation Society's Guidelines for DCD donation about NRP, and have contributed to European and US guidance on the same
As well as performing many cases both as surgeon and perfusionist, I have also helped train new individuals and centres starting NRP, and provide remote mentoring via WhatsApp 24/7 for the same
The technology is currently used by 8 of the 10 national retrieval teams, although only 5 are independent while the other 3 are in the process of being fully trained. It is not used outside of organ donation

13. Please indicate your research experience relating to this procedure or technology (please choose one or more if relevant): (Please highlight your choice(s))

- [x] I have done bibliographic research on this procedure or technology
- [x] I have done research on this procedure or technology in laboratory settings (e.g. device-related research).
- [x] I have done clinical research on this procedure or technology involving patients or healthy volunteers.
- [x] I have published this research.
- [ ] I have had no involvement in research on this procedure or technology.
- [ ] Other

Interventional procedure related questions ONLY

Please skip 12 - 16 - if a DG/EVA/MTAC/LSA topic (information can be found on your email invite)

14. Does the title adequately reflect the procedure?

No. NRP also has benefits for donor kidneys. I suggest: In-situ normothermic regional perfusion of the abdomen for the recovery of abdominal organs for transplantation from donation after circulatory death donors, interventional procedures assessment

15. Is the proposed indication appropriate? If not, please explain.

NRP is appropriate. There are no randomised trials of NRP - its benefits are dramatic

16. Does this have a multi-indication?

The technique is very similar to ECMO in a living person. As such it would have the same indications as ECMO, and may also be extended to use in emergency departments for the resuscitation of patients suffering cardio-circulatory arrest

Current management

17. Please describe the current standard of care that is used in the NHS

In 2010 the standard of care was to in situ cold perfusion of organs with cold organ preservation solutions such as University of Wisconsin solution. NRP took off initially in Cambridge, then in 2014 Edinburgh began to use it. Pooled results from Cambridge and Edinburgh showed dramatic benefits for the liver, at the same time as Spanish data showed the same after which a bid was put together for funding to undertaken NRP nationally. The Welsh, Northern Irish and Scottish Health boards agreed to this some years ago, but the DHSC only agreed this year. Funding is channelled though NHSBT who commission organ retrieval in the UK.
NRP treats the liver, pancreas and kidneys.
For the liver, normothemric machine perfusion ex situ became available initially in trials starting in 2013, and commercial devices were available to purchase from 2014. Subsequently hypothermic oxygenated perfusion has also become available, although it offers less ability to determine viability than normothermic perfusion. Nevertheless, no ex site perfusion has been as successful in increasing utilisation and preventing ischaemia related complications, particularly in the liver, as NRP. I say that from our own experience in Cambridge where we have experience of over 350 NRP cases and 550 NMP cases

18. Does this procedure/technology have the potential to replace current standard care or would it be used as an addition to existing standard care? Where would the technologies/procedure fit in the care pathway?

It is already replacing the traditional standard of care, with an active programme to do so led by NHSBT

19.

- What are the main aims of these procedures or technologies?
- How innovative are they?
- Can you name any technologies which are available in the UK and have this function/mode of action?
- Are there any competing or alternative procedures available to the NHS which have a similar function/mode of action to this?
- If so, how do these differ from the technology/procedure indicated here?

The technique is not new- in the UK it dates back to 2010 and in Europe and the US cases were undertaken several years before that, but without there being programmes of activity like there are now.
The technique is very similar to extracorporeal membrane oxygenation (ECMO), although this is a technique for the living and involves perfusion of the entire body' NRP is designed for the dead and to perfuse the abdomen (or chest and abdomen) excluding the head and upper limbs

20. Approximately how many people each year would be eligible for an intervention with this procedure/technology, (give either as an estimated number, or a proportion of the target population)?

In 2024/25 there were 727 circulatory death donors, and the numbers of such donors is increasing annually

Potential patient benefits and impact on the health system

21. What do you consider to be the potential benefits to patients from using this procedure/technology?

NRP is associated with increased organ utilisation - more transplantable organs from each circulatory death donor. This is in large part because viability can be assessed during NRP
Liver graft survival is better, and cholangiopathy rather are much lower. Early allograft function is also better. These three elements are superior to any other preservation technique.
For the kidney, delayed graft function is less common, graft survival is better and renal function at one year is better - better one-year renal function usually results in superior long term dialysis free survival. Data for the pancreas transplants show NRP is not harmed by NRP, but there are insufficient data to say their outcomes are superior.

22.

- Are there any groups of patients who would particularly benefit from this procedure/technology?
- Are there any groups in which the technology would be less effective or would be less likely to benefit?
- Are there any potential equality issues that should be considered for this condition and procedure/technology?

Benefits: any recipient of an organ from a donation after circulatory death donor would likely do better if the organ was recovered using NRP than without it.
There are no groups that we have identified poorer outcomes
There are not equality issues.

23.
- What do you consider to be the potential benefits to the system from using this procedure/technology?
- Could it lead, for example, to a reduced number of appointments, improved care pathway, more efficient NHS staff time use?

Transplants are associated with fewer complications, which means fewer appointments, in patient stays, investigations etc. It was the savings in these, especially in patient days, that persuaded our trust to support us doing this clinically after our initial trial had been completed.

24. What clinical facilities (or changes to existing facilities) are needed to do this procedure/implement this technology safely?

The equipment is required and a perfusion practitioner is needed to run the equipment. Also required are point of care tests for assessing biochemistry (e.g. blood gases) during perfusion.

25. Is any specific training needed in order to use the procedure/technology with respect to efficacy or safety?

Yes. It is a novel technique and specialist training is required for surgeons and perfusion practitioners. An excellent course is run in Edinburgh regularly for this purpose

Safety and efficacy of the procedure/technologies

26. What are the potential harms of the procedure/technology?

- Please list any adverse events and potential risks (even if uncommon) and, if possible, estimate their incidence:
- Adverse events reported in the literature (if possible, please cite literature)
- Anecdotal adverse events (known from experience)
- Theoretical adverse events

If the circuit is not heparinised it will thrombose, with the likely loss of all organs.
Bleeding is the most common complication, since the circulation is fully heparinised, so third party blood transfusions are often necessary. It is particularly common if thoracic organs are being retrieved a the same time, where vessels are cut in the chest and bleed
Misplaced cannulas occur occasionally meaning delays in starting NRP; this is often rescuable by replacing the cannulas into a different vessel

27. Please list the key efficacy and safety outcomes for this procedure/technology? Please suggest the most appropriate method of measurement for these outcomes and the timescales over which these should be measured (where appropriate) and if there are any challenges in collecting key outcomes.

These relate to the outcomes of the retrieved organs.
1. Utilisation - the proportion of organs transplanted per donor
2. The early function of the organ
3. The incidence of primary non function, where it never works at all
The Graft and patient survival at 12 months (longer would be preferable, and is what matters most to patients, but tradition uses the 12 month time point)
4. Organ function at 12 months
5. Incidence of organ specific complications - the most common is cholangiopathy affecting donated livers, which is markedly less using NRP than any other retrieval method or post-recovery technique such as hypothermic or normothermic perfusion

28. Please list any uncertainties or concerns about the efficacy and safety of this procedure/technology?

There are no universally agreed criteria for confirming organ viability. For the liver this is in part because a marginal organ will work well in a fit recipient who can withstand early poor function, but not in a sick recipient.
In the UK we perfuse for 2 hours. It is not known what the ideal duration is, but 2 hours is a commonly accepted duration outside the US; in the US, where NRP was started primarily to facilitate heart duration, they use shorter times
Risk of infection during NRP is a possibility, but in reality serious infection of teh donated organs seems very uncommon, and similar in incidence to any retrieval technique (speaking from local experience)

29. Is there controversy, or important uncertainty, about any aspect of the procedure/technology?

Yes. When used to perfuse the thoracic organs as well as the abdominal organs there are concerns about collateral perfusion of the brain. This has been the stimulus for recent research in Spain, the results of which to date show that there is no cerebral perfusio; there is ongoing research in Canada and the UK. Implementation internationally has depended on the definitions of death in the various jurisdictions. In the UK we must not restore perfusion of the brain after death; in the US and Australia their definitions have revolved around cessation of the circulation, which is where difficulties in acceptance have arisen

30. If it is safe and efficacious, in your opinion, will this procedure be carried out in (please choose one):

- [x] Most or all district general hospitals
- [ ] A minority of hospitals, but at least 10 in the UK
- [ ] Fewer than 10 specialist centres in the UK
- [ ] Cannot predict at present

31. Are you aware of any additional issues which would prevent (or have prevented) this procedure/technology being adopted in your organisation or across the wider NHS? This could include costs, resource, staffing for example.

In answer to question 30, it will be used in any donor hospital, but only by one of the 10 national abdominal organ retrieval teams
The limitations for adoption relate to employment of and training or perfusion practitioners, and training of surgeons. Cost wise, it is relatively cheap (and much cheaper than ex situ perfusion) and treats all organs, rather than just one; It reduces complications and the investigation and hospital stay associated with that

32. Please list any abstract, real-world evidence, conference proceedings or any major trials or registries that you are aware of for this topic.
Please note that NICE will do a comprehensive literature search; we are only asking you for any very recent abstracts or conference proceedings which might not be found using standard literature searches. You do not need to supply a comprehensive reference list but it will help us if you list any that you think are particularly important. If you would like to share any studies which are confidential due to their publication status, please contact us via email.

NHSBT keep a registry of all NRP cases in the, which contains the outcomes of kidneys, livers, and pancreases in NRP cases. This is obtainable through Rachel Hogg at NHSBT Rachel.Hogg@nhsbt.nhs.uk, or I could send you the latest report

33. Is there any research that you feel would be needed to address uncertainties in the evidence base?

An RCT would be desirable to support its use, but is unlikely since once you have used it and seen the outcomes it seems unethical not to use it

34. Please suggest potential audit criteria for this procedure/technology. If known, please describe:

- Beneficial outcome measures - These should include short- and long-term clinical outcomes, quality-of-life measures and patient-related outcomes. Please suggest the most appropriate method of measurement for each and the timescales over which these should be measured.
- Adverse outcome measures - These should include early and late complications. Please state the post procedure timescales over which these should be measured.

Outcome measures are the same as those listed in answer to question 27. They should be addressed through data collection for the UK Transplant Registry by NHSBT

Further Comments

35. Please add any further comments on your particular experiences or knowledge of the procedure/technology.

While a NICE appraisal of this technology would be useful in establishing its use and embedding it in standard practice if, as I suspect, it would support that, I think the time for this review was probably 5 years ago when NRP was struggling to take off and not now that the DHSC has agreed to fund it

Contact confirmation

Please indicate if you would like to opt in to NICE contacting you regarding other technologies/treatments in the future for your advice, or if you would only like to be contacted regarding this specific technology:

36. Please select what NICE may contact you about: *

- (●) NICE can use my details to contact me for advice on this and future assessments.
- ( ) NICE can use my details to contact me for advice on this topic only, but not for others.

37. Date *

30/11/2025

NICE National Institute for Health and Care Excellence

Professional Expert Questionnaire

Topic number and title: IPG10405 (IP1890) - In-situ normothermic regional perfusion of the abdomen for donor livers following circulatory death

This questionnaire is only to be completed and submitted by health and care practitioners.

This questionnaire should be completed by those whose role is, or is directly related to, one of the specialisms below. For each assessment, we engage with professionals with expertise relevant to the topic under evaluation. By completing this questionnaire, you acknowledge and consent to being considered for the role of professional expert on this assessment.

Your information:

Please indicate which option best describes your area of expertise by selecting an option below.

If your role is not listed but you feel it ought to be included, please select 'Other' and let us know your role and why you think we should include your knowledge and expertise on the assessment.

☐ Consultant liver transplant surgeon

☐ Consultant Hepatologist

☐ Nurse specialising in transplantation or donation

☐ Perfusionist or specialist in organ procurement

☐ Transplant co-ordinator

☐ Interventional radiologist

☐ Consultant in anaesthesia

☐ Intensive care consultant

☒ Other - please share additional information: Click here to enter text. **Consultant Transplant Surgeon in Pancreas and kidney, Organ retrieval surgeon (with NRP expertise)**

Please enter your details within the brackets provided below (the brackets expand to fit the length of the text).

Name:	Click here to enter text. **Mr Elijah Ablorsu**
Job title:	Click here to enter text. **Consultant Transplant and Retrieval Surgeon**
Organisation:	Click here to enter text. **University Hospital of Wales, Cardiff**

Email address:	Click here to enter text. [redacted]
Professional organisation or society membership/affiliation:	Click here to enter text. **General Medical Council**
Nominated/ratified by (if applicable):	Click here to enter text. **N/A**
Registration number (e.g. GMC, NMC, HCPC)	Click here to enter text. **6097510**

Consent to publish information

How NICE will use this information:

The information that you provide on this form may be used to develop guidance on this topic.

Your advice and views represent your individual opinion and not that of your employer, professional society or a consensus view. Your name, job title, organisation and your responses, along with your declared interests may be published online on the NICE website as part of public consultation on the draft guidance, except in circumstances but not limited to, where comments are considered voluminous, or publication would be unlawful or inappropriate.

Please note: if consent is not given, you will not be eligible for the role of professional expert on this assessment.

For more information about how we process your data please see our privacy notice.

☒ Yes, I give my consent for the information in this questionnaire to be used and may be published on the NICE website as outlined above.

☐ No, I do not give my consent for the information in this questionnaire to be used and it may not be published on the NICE website as outlined above.

If consent is NOT given, please state reasons below:

Click here to enter text.

Contact confirmation

Please select what NICE may contact you about:

☒ NICE can use my details to contact me for advice on this and future assessments.

☐ NICE can use my details to contact me for advice on this topic only, but not for others.

Please answer the following questions as fully as possible to provide further information about the technologies and/or your experience

1	Please describe your level of experience with the procedure/technology, for example: • Are you familiar with the procedure/ technology? • Have you used it or are you currently using it? If so, please indicate your experience.	I have extensive experience with abdominal normothermic regional perfusion (NRP) in controlled donation after circulatory death (DCD) donors. I am fully familiar with the scientific principles, technical execution, governance requirements, and clinical applications of the procedure. I am currently and actively involved in delivering abdominal NRP as part of routine clinical practice within the NHS, both as an organ retrieval surgeon and as a clinical lead responsible for service development, clinical governance, and quality assurance. My experience includes donor selection, surgical procedure, initiation and management of NRP, assessment of organ viability, coordination with perfusion specialists, and intraoperative and post-retrieval decision-making regarding organ utilisation. In addition to direct clinical practice, I am involved at a national level in the development and refinement of UK NRP protocols, contributing to standardisation of practice, safety frameworks, and clinical governance structure. I also play an active role in national education and training initiatives for NRP, including the design and delivery of structured, competency-based training programmes for surgeons, perfusion specialists, and retrieval teams, aimed at supporting safe and scalable adoption of this technology across the NHS.

		I am further involved in medical workforce development related to NRP, including mentoring, skills acquisition pathways, and service sustainability planning. This includes addressing workforce capacity, competency assurance, and integration of NRP within the National Organ Retrieval Service (NORS) model. I have experience contributing to and interpreting UK-wide NRP activity and outcomes data, including service-level audit and analysis of utilisation, safety, and transplant outcomes. This data-driven approach informs national discussions on effectiveness, equity of access, and future service configuration.
	• Do you know how widely this procedure/technology is used within the NHS or what is the likely speed of uptake?	Within the NHS, abdominal NRP is increasingly adopted but remains variably implemented across centres. Uptake has accelerated over the past 5–7 years, particularly in high-volume transplant and retrieval centres; however, national penetration remains incomplete due to workforce constraints, training requirements, equipment availability, and local funding arrangements. The likely speed of expansion of the National NRP program will escalate due to available national funding in coming years.
	• Is this procedure/technology performed/used by clinicians in specialities other than your own?	The procedure is multidisciplinary and involves clinicians beyond my own specialty, including retrieval surgeons, transplant surgeons, scrub practitioners, per-operative practitioners.

	• If your specialty is involved in patient selection or referral to another specialty for this procedure/technology, please indicate your experience with it.	My specialty plays a direct role in donor selection, intraoperative decision-making, and referral of retrieved organs for transplantation. I have significant experience advising on suitability, functional viability assessment, and allocation decisions arising from NRP-supported retrievals.
2	Please indicate your research experience relating to this procedure (please choose one or more if relevant): (Please highlight your choice(s))	My research experience includes: • Bibliographic research on this procedure • Clinical research involving patients and donor organs • Contribution to service-level data collection, audit, and outcome reporting I have not personally led laboratory-based device development research for NRP circuits, but I have contributed to interpretation and application of published evidence and real-world outcome data within NHS practice.
3	• Does the title adequately reflect the procedure? • Is the proposed indication appropriate? If not, please explain. • Does this have a multi-indication? • How innovative is this procedure/technology, compared to the current standard of care? Is it a minor variation or a novel approach/concept/design?	The title accurately reflects the procedure and its scope. The proposed title: “Use of in-situ abdominal NRP for donor livers following circulatory death” is appropriate and clearly defined. However, the procedure has multi-organ benefits, as it simultaneously supports kidney and pancreas assessment and improves transplant outcomes of these organs. Compared with the current standard of care (static cold storage with rapid retrieval following circulatory death), this procedure represents a **novel conceptual approach**. It re-establishes oxygenated regional circulation after death to reverse warm ischaemic injury and enable functional assessment prior to organ retrieval.

	• Which of the following best describes the procedure (please choose one and highlight your choice):	The first in a new class of procedure.
4	• ~~Have there been any substantial modifications to the procedure technique or, if applicable, to devices involved in the procedure?~~ • ~~Has the evidence base on the efficacy and safety of this procedure changed substantially since publication of the guidance?~~	Not applicable to this procedure
~~5~~	~~Do you think the guidance needs updating?~~	Not applicable to this procedure

Current management

6	Please describe the current standard of care that is used in the NHS	The current standard of care for DCD liver (and other abdominal organs) retrieval is rapid in-situ cold perfusion followed by static cold storage, with organ acceptance decisions based largely on donor characteristics, warm ischaemia time, and macroscopic assessment.
7	Does this procedure/technology have the potential to replace current standard care or would it be used as an addition to existing standard care?	This procedure is not a direct replacement but an adjunct to existing standard care. It enhances current pathways by enabling organ reconditioning and functional assessment prior to retrieval, particularly for marginal DCD donors.

8	• What are the main aims of these procedures or technologies?	**Main aims** • Reduce warm ischaemic injury in DCD organs • Improve organ viability • Objective organ viability assessment • Increase utilisation of donor livers • Reduce post-transplant complications
	• How innovative are they?	**Innovation** The procedure is highly innovative, introducing in-situ physiological reperfusion after death, rather than relying solely on ex-situ preservation.
	• Can you name any technologies which are available in the UK and have this function/mode of action?	**Available UK technologies** • Abdominal NRP using extracorporeal membrane oxygenation (ECMO)-based circuits
	• Are there any competing or alternative procedures available to the NHS which have a similar function/mode of action to this?	**Competing or alternative procedures** • Ex-situ normothermic machine perfusion (NMP) • Hypothermic oxygenated perfusion (HOPE)
	• If so, how do these differ from the technology/procedure indicated here?	These alternatives differ by being applied after organ retrieval rather than restoring in-situ circulation, and they do not address donor warm ischaemia in the same manner. Also, these technologies are organ selective compare to NRP that address multiple organs simultaneously in more physiological setting and in earlier stage (when some type of tissue injury can be reversed).

9	Approximately how many people each year would be eligible for an intervention with this procedure/technology, (give either as an estimated number, or a proportion of the target population)?	Approximately **150–300 DCD liver donors per year in the UK** could be eligible for abdominal NRP, representing a significant proportion of controlled DCD donors whose livers are currently declined or used with caution.

Potential patient benefits and impact on the health system

10	What do you consider to be the potential benefits to patients from using this procedure/technology?	• Increased access to transplantation • Reduced rates of primary non-function and early allograft dysfunction • Lower incidence of ischaemic cholangiopathy • Improved graft and patient survival
11	• Are there any groups of patients who would particularly benefit from using this procedure/technology? • Are there any groups in which these technologies would be less effective or would be less likely to benefit? • Are there any potential equality issues that should be considered for this condition and technology?	**Groups most likely to benefit** • Recipients of DCD livers • Patients awaiting transplantation with prolonged waiting times **Less likely to benefit** • Donation after brain death (DBD) pathways • Very low-risk DCD donors where standard cold storage is sufficient **Equality considerations** Variation in access between regions may create inequity if NRP capability is not uniformly available nationally.

12	What do you consider to be the potential benefits to the system from using this procedure/technology? Could it lead, for example, to a reduced number of appointments, improved care pathway, more efficient NHS staff time use?	• Improved organ utilisation efficiency • Reduce incidence of post-transplant complications. • Reduced need for re-transplantation • Better use of retrieval and transplant workforce time • Potential long-term cost savings through improved graft longevity
13	What clinical facilities (or changes to existing facilities) are needed to do this procedure/implement this technology safely?	• ECMO/NRP circuits and consumables • Trained perfusion and retrieval teams • Governance frameworks and audit infrastructure
14	Is any specific training needed in order to use the procedure/technology with respect to efficacy or safety?	Yes. Specific training is required for: • Surgical procedure (cannulation) and circuit management • Perfusion troubleshooting • Viability assessment interpretation • Multidisciplinary team coordination Structured competency-based training and mentoring are essential for safe implementation.

Safety and efficacy of the procedure/technologies

15	What are the potential harms of the procedure/technology? Please list any adverse events and potential risks (even if uncommon) and, if possible, estimate their incidence: • Adverse events reported in the literature (if possible, please cite literature) • Anecdotal adverse events (known from experience) • Theoretical adverse events	**Reported adverse events** • Vascular injury during cannulation • Circuit-related complications • Uncontrolled bleeding **Anecdotal events** • Technical failure leading to abandonment of NRP • Organ injury **Theoretical risks** • Prolonged donor operation time Overall incidence is low when performed by trained teams.
16	Please list the key efficacy and safety outcomes for this procedure/technology? Please suggest the most appropriate method of measurement for these outcomes and the timescales over which these should be measured (where appropriate) and if there are any challenges in collecting key outcomes.	**Efficacy outcomes** • Liver utilisation rate • Early allograft dysfunction • Graft and patient survival at 1, 3, and 5 years **Safety outcomes** • Procedure-related complications • Ischaemic cholangiopathy rates Outcomes should be measured via national transplant registries with longitudinal follow-up.

17	Please list any uncertainties or concerns about the efficacy and safety of this procedure/technology?	• Long-term biliary outcomes beyond 5 years • Optimal viability thresholds • Cost-effectiveness at national scale
18	Is there controversy, or important uncertainty, about any aspect of the procedure/technology?	There is ongoing debate regarding ethical considerations, donor intervention timing, and standardisation of protocols, though consensus is increasing.
19	If it is safe and efficacious, in your opinion, will this procedure be carried out in (please choose one and highlight your choice):	A minority of hospitals, but at least 10 in the UK. Currently delivered by 6 of 10 National Organ Retrieval Teams
20	Please list any abstract, real-world evidence, conference proceedings or any major trials or registries that you are aware of for this topic. Please note that NICE will do a comprehensive literature search; we are only asking you for any very recent abstracts or conference proceedings which might not be found using standard literature searches. You do not need to supply a comprehensive reference list but it will help us if you list any that you think are particularly important. If you would like to share any studies which are confidential	• UK national NRP registry data • NHSBT Organ Utilisation and Outcomes reports • International observational cohort studies from Spain, Italy, and the UK

	due to their publication status, please contact us via email.	
21	Is there any research that you feel would be needed to address uncertainties in the evidence base?	• Randomised or matched comparative studies versus ex-situ perfusion • Health economic analyses • Standardised viability criteria validation

Further Comments

22	Please suggest potential audit criteria for this procedure/technology. If known, please describe: – Beneficial outcome measures. These should include short- and long-term clinical outcomes, quality-of-life measures and patient-related outcomes. Please suggest the most appropriate method of measurement for each and the timescales over which these should be measured. – Adverse outcome measures. These should include early and late complications. Please state the post procedure timescales over which these should be measured:	**Beneficial outcome measures:** • Organ utilisation rate (measured at retrieval and transplant) • Early allograft dysfunction at 7 days • Graft survival at 1 and 5 years **Adverse outcome measures:** • Procedure-related complications (intraoperative) • Ischaemic cholangiopathy within 12–24 months

23	Please add any further comments on your particular experiences or knowledge of the technologies.	Based on extensive real-world NHS experience, abdominal NRP represents a transformative advance in DCD organ retrieval. With appropriate governance, training, and national coordination, it has the potential to substantially improve transplant outcomes and equity of access across the UK.

Date of questionnaire completion

DD/MM/YY **17 Dec 2025**

NICE National Institute for Health and Care Excellence

Professional Expert Questionnaire

Technology/Procedure name & indication: **IP1890 In situ normothermic regional perfusion**

Your information

Name:	Ian Currie
Job title:	Associate Medical Director (Retrieval)
Organisation:	NHS Blood and Transplant
Email address:	[redacted]
Professional organisation or society membership/affiliation:	British Transplant Society
Nominated/ratified by (if applicable):	Professor D Manas, Medical Director, NHS Blood and Transplant
Registration number (GMC)	4321266

How NICE will use this information:

The information that you provide on this form will be used to develop guidance on this procedure.

☐ Please tick this box if you would like to receive information about other NICE topics.

Your advice and views represent your individual opinion and not that of your employer, professional society or a consensus view. Your name, job title, organisation and your responses, along with your declared interests will also be published online on the NICE website as part of public consultation on the draft guidance, except in circumstances but not limited to, where comments are considered voluminous, or publication would be unlawful or inappropriate.

For more information about how we process your data please see our privacy notice.

■ I give my consent for the information in this questionnaire to be used and may be published on the NICE website as outlined above. If consent is NOT given, please state reasons below:

Agree

Please answer the following questions as fully as possible to provide further information about the procedure/technology and/or your experience.

1	Please describe your level of experience with the procedure/technology, for example: Are you familiar with the procedure/technology?	I am highly experienced with the technology and clinical practice of Normothermic Regional Perfusion. I am one of the two surgeons who worked together to implement this technology in Edinburgh Transplant Centre in 2012, a program which now has 7 consultants and 5 perfusion specialists. I now lead educational programs to teach this technology and support new centres with direct supervision of practice across the UK. I am the principle author of the various NHSBT documents which provide regulatory structure to NRP in the UK, and I have an ongoing responsibility to assure the safety and clinical conduct of NRP in the UK as part of my work with NHSBT.
	Have you used it or are you currently using it? – Do you know how widely this procedure/technology is used in the NHS or what is the likely speed of uptake? – Is this procedure/technology performed/used by clinicians in specialities other than your own? – If your specialty is involved in patient selection or referral to another specialty for this	It is used in 6 out of 10 abdominal organ retrieval centres in the UK. It is hoped that the remaining 4 centres will start in the next few years, but the technology remains un-commissioned which is an impediment to development. At the moment, about 1 in 6 of the appropriate donor type is attended by an NRP team (voluntary basis, un-funded). No

	procedure/technology, please indicate your experience with it.	This is not applicable.
2	– Please indicate your research experience relating to this procedure (please choose one or more if relevant):	I have done bibliographic research on this procedure. I have done research on this procedure in laboratory settings (e.g. device-related research). I have done clinical research on this procedure involving data gathered by NHSBT and my own service regarding NRP in organ donors. I have published this research. I have had no involvement in research on this procedure. Other (please comment)
3	Does the title adequately reflect the procedure? Is the proposed indication appropriate? If not, please explain. How innovative is this procedure/technology, compared to the current standard of care? Is it a minor variation or a novel approach/concept/design? Which of the following best describes the procedure (please choose one):	Yes The proposed indication is not stated on this form, however, the proposed indication is the resuscitation of organs for transplantation in deceased organ donors who have died after circulatory determination of death ('DCD' donors). This is not established practice. It is highly innovative. The current standard delivers fewer organs which are of poorer quality. This technique doubles the number of livers for transplant in the DCD donor group and extends the life of kidney transplants by 2-3 years. It is entirely novel in its approach and is revolutionary. Definitely novel with safety and efficacy data now showing a very high degree of organ quality. The first in a new class of procedure – agree.

4	Does this procedure/technology have the potential to replace current standard care or would it be used as an addition to existing standard care?	It would replace current standard of care in DCD donors.
5	Have there been any substantial modifications to the procedure technique or, if applicable, to devices involved in the procedure? Has the evidence base on the efficacy and safety of this procedure changed substantially since publication of the guidance?	The technique is still evolving but much less now than was the case previously. The equipment is also being improved but the current devices are close to idealised. No guidance has been published, aside from technical documents published by NHSBT to guide teams in the technical and knowledge bases of NRP. The evidence base extends regularly. These continue to attest to the safety and efficacy of the technique.

Current management

6	Please describe the current standard of care that is used in the NHS.	DCD donors are those who are not brain dead. These are now the majority of deceased donors in the UK. Currently, these donors have life-sustaining care withdrawn, undergo cardiac arrest, are pronounced dead and then have ultra-rapid surgery to pass cold preservative solution into the blood vessels supplying the donor organs. The delay between the cessation of circulation and the preservation stage leads to oxygen starvation in the organs, which is damaging to the organs. These organs are therefore of poorer quality than organs obtained from brain-

		dead donors, where the preservation takes place within seconds of the circulation stopping. NRP restores warm blood perfusion to the donor organs after death. This reverses the oxygen starvation, and then allows the cold preservation to occur within seconds of the blood flow being stopped at the end of NRP. It is the restoration of blood flow for a certain time which both reverses oxygen starvation and allows blood tests to show the organs are healthy during NRP which brings the huge benefits. It is a disruptive technology which promises to revolutionise DCD organ donation and transplant.
7	Are you aware of any other competing or alternative procedure/technology available to the NHS which have a similar function/mode of action to this? If so, how do these differ from the procedure/technology described in the briefing?	The only related technology is ex-situ normothermic perfusion. This is where an organ is placed on a machine after removal from the body. One machine is needed for each organ after they are removed from the donor, and the warm perfusion and can be instituted perhaps 1-2 hours after death. This is in contrast to the technology in question (NRP), where all the organs can be perfused at the same time within a few minutes of death. Ex situ perfusion is not a replacement technology for in situ perfusion, as the results of ex situ perfusion in UK are not as good as NRP, and ex-situ perfusion is a lot more expensive than NRP.

Potential patient benefits and impact on the health system

8	What do you consider to be the potential benefits to patients from using this procedure/technology?	The number of transplants possible is significantly increased using this technology. It doubles the number of DCD liver transplants possible and adds 2-3 years of dialysis-free survival to kidney transplants. A specialised version of this technique, Thoraco-abdominal normothermic regional perfusion (TANRP), can allow heart and lung retrieval as well which increases the number of hearts and lungs for transplant. This latter technique, TANRP, is even more novel than NRP, and is very much in the development stage in the UK with only a few dozen cases reported so far. Although it was invented in the UK, many countries are utilising TANRP in increasing numbers now. Its introduction in the UK depends on the outcome of a safety trial which is yet to start.
9	Are there any groups of patients who would particularly benefit from using this procedure/technology?	Patients who are not prioritised by the national liver allocation scheme have an increased chance of death on the waiting list. These patients will benefit in particular. There are a great many patients who are not prioritised in this way. At any one time, only the top 5-10% are being considered by the national allocation scheme. Patients with liver cancer, patients who need a second transplant or patients who are young are specifically disadvantaged.
10	Does this procedure/technology have the potential to change the current pathway or clinical outcomes to benefit the healthcare system? Could it lead, for example, to improved outcomes, fewer hospital visits or less invasive treatment?	Yes. Published data show reduced intensive care stay, reduced re-admission rates and reduced re-transplant rates when NRP is used to recover DCD livers before liver transplant. It is truly a remarkable development. They also suggest reduced need for interim dialysis after kidney transplant prior to the new kidney starting to work (‘Delayed Graft Function’).
11	What clinical facilities (or changes to existing facilities) are needed to do this procedure/technology safely?	Specialised equipment is needed, but this equipment is readily available in the UK with all the required market approvals already in place for clinical use. No changes are required in terms of NHS estate.

		New staff are required however. A new team of donor perfusion specialists are required in each centre, which would be 5 staff (band 7) and 1 clinical lead (Band 8) in addition to the normal retrieval team. Surgeons require specialist training and a consultant surgeon is needed at the donor operation to make sure that NRP is successful. Organ retrieval is so specialised that organ retrieval teams travel by van and plane all over the UK to attend donor hospitals to perform organ retrieval surgery. It cannot be done by any other surgeon or surgical team. It is only done by 10 abdominal teams and 6 cardiothoracic teams for the entire UK.
12	Is any specific training needed in order to use the procedure/technology with respect to efficacy or safety?	Considerable training and supervised experience is required to ensure safety. We have training programs in place. A number of staff members across the UK are already trained and can support training of new staff. This is not to say that such an undertaking will be straight forward but it is possible to train new staff members in support of a fully established national NRP program.

Safety and efficacy of the procedure/technology

13	What are the potential harms of the procedure/technology? Please list any adverse events and potential risks (even if uncommon) and, if possible, estimate their incidence: Adverse events reported in the literature (if possible, please cite literature) Anecdotal adverse events (known from experience)	Surgical operations can go wrong. This is not related to the skill of the operator. Even the very best surgeons have operations go wrong. In organ retrieval surgery, which is exceptionally major surgery, it relates to the very high speed and complexity that is a central part of DCD organ retrieval surgery. It is also fair to say that there no surgery has a zero complication rate. Again, this relates to the nature of surgical operations in humans. NRP has specific complications/harms which only occur in NRP. These are mentioned here. Procedure-specific adverse events — Consequences. Failure to cannulate the vessels (1-2%). — Failure to initiate warm blood perfusion Delayed cold preservation Organ injury and/or loss. Catastrophic Bleeding (1-2%) — Failure of perfusion (NB; combined cases with the cardiothoracic team are uncommon — Organ injury and/or loss.

	Theoretical adverse events	but have a much higher risk of severe bleeding. Because these are uncommon, incidence isn't known but could be as high as 20-40% of all such combined cases. Techniques are being developed and implemented successfully to reduce this rate. Blood Clotting (less than 0.5%) Failure of perfusion. Organ injury and/or loss. It is important to point out that the development of NRP in the UK is at a point whereby such central statistics for complications are not possible to collate. There is a central register of cases with NHS Blood and Transplant, however, the central collation of specific complications is not possible with a non-commissioned service. Academic studies may collate such data in future, or if the service were to be commissioned, centralised data could be collated then.
14	Please list the key efficacy outcomes for this procedure/technology?	Key Efficacy Outcomes; Liver utilisation (livers transplanted/livers accepted for transplant) Liver graft failure rate in 1st year (graft loss (re-transplant and/or re-listing for transplant) Kidney utilisation Kidney egfr at 1 year post-transplant Kidney delayed graft function post-transplant Kidney graft failure rate in 1st year (return to dialysis and/or re-listing for transplant) Pancreas utilisation Pancreas graft failure rate in 1st year Organ loss due to surgical damage (liver, kidney, pancreas; collected by NHSBT)

		In the near future, it is hoped that hearts and lungs could also be retrieved using this technique (TANRP).
15	Please list any uncertainties or concerns about the efficacy and safety of this procedure/?	There are no concerns about the safety or efficacy of this procedure. It is true that the rate of severe bleeding and potential organ loss in combined cases with cardiothoracic and abdominal surgical teams remains a serious concern. Efforts are being made all over the UK to improve this. These efforts are showing significant success but the matter is not yet resolved. Despite this, organ utilisation after these very challenging cases is still satisfactory with improvements being seen month by month.
16	Is there controversy, or important uncertainty, about any aspect of the procedure/technology?	The only issue which is sensitive is the requirement to ensure that blood flow to the donor's brain does not occur. In the UK, we have developed the technique so that any flow towards the donor's head would be instantly revealed at the very start, before blood perfusion was properly established. This would allow the surgeon to stop the perfusion and move the various clamps, so ensuring that the blood can't flow to the donor's head. This technique is far superior to those used elsewhere in the world. Thoraco-abdominal NRP, in which the organs of the chest are also perfused (but not the head) is more controversial than NRP as it is thought by some that it is more likely to result in brain perfusion. In the UK, this technique is being developed in a trial which will use the most sophisticated surgical and imaging techniques to demonstrate that blood flow does not travel to the brain in TANRP. Nonetheless, the technique of TANRP remains a source of anxiety in those professional groups who are not familiar with vascular anatomy, physiology and surgery. Published evidence shows that neither NRP nor TANRP leads to brain perfusion (Royo-Villanova et al., 2023; AJT; https://doi.org/10.1016/j.ajt.2023.09.008)
17	If it is safe and efficacious, in your opinion, will this procedure be carried out in (please choose one):	Most or all district general hospitals. X A minority of hospitals, but at least 10 in the UK. Fewer than 10 specialist centres in the UK.

		Cannot predict at present. The nature of organ retrieval surgery means that it is carried out in any donor hospital in the UK. Donor hospitals are those with an intensive care unit (>200 hospitals in UK). Aside from that restriction, the technique can be carried out in any hospital in the UK where there are organ donors. The teams generally will have all the devices they need to carry out the procedure without relying on the donor hospital technology.

Abstracts and ongoing studies

18	Please list any abstracts or conference proceedings that you are aware of that have been recently presented / published on this procedure/technology (this can include your own work). Please note that NICE will do a comprehensive literature search; we are only asking you for any very recent abstracts or conference proceedings which might not be found using standard literature searches. You do not need to supply a comprehensive reference list but it will help us if you list any that you think are particularly important.	Abstract sources; British Transplant Society (BTS), European Society of Transplantation (ESOT), International Liver Transplant Society (ILTS), European Liver and Intestinal Transplant Society (ELITA) are all likely sources of recent abstracts. Maintaining the permanence principle of death during normothermic regional perfusion in controlled donation after the circulatory determination of death: Results of a prospective clinical study. Royo-Villanova et al., Am J Transplant; 2023; doi: 10.1016/j.ajt.2023.09.008 Improved Organ Utilization and Better Transplant Outcomes With In Situ Normothermic Regional Perfusion in Controlled Donation After Circulatory Death. Oniscu et al., Transplantation 2023;107: 438–448. Meinders, A.M., Hobeika, M.J. & Currie, I. Normothermic Regional Perfusion in Donation After Circulatory Death for Liver Transplantation: A Narrative Review. *Curr Surg Rep* **12**, 15–25 (2024). https://doi.org/10.1007/s40137-024-00383-2
19	Are there any major trials or registries of this procedure/technology currently in progress? If so, please list.	The technique is so successful that a trial would be near impossible to justify. There is a study planned in Kings College Hospital this year but it has not started yet.
20	Please list any other data (published and/or unpublished) that you would like to share.	

Other considerations

21	Approximately how many people each year would be eligible for an intervention with this procedure/technology, (give either as an estimated number, or a proportion of the target population)?	This year, there will be nearly 900-1000 DCD organ donors in the UK. All of them could undergo NRP. At the moment, about 1 out of 6 DCD donors are attended on a voluntary, unfunded basis in the UK (121/667 DCD donors April -November 2023). These donors will provide on average 0.5-1 extra organs per donor for transplant when NRP is used.
22	Please suggest potential audit criteria for this procedure/technology. If known, please describe: − Beneficial outcome measures. These should include short- and long-term clinical outcomes, quality-of-life measures and patient-related outcomes. Please suggest the most appropriate method of measurement for each and the timescales over which these should be measured. − Adverse outcome measures. These should include early and late complications. Please state the post procedure timescales over which these should be measured:	**Beneficial and adverse outcome measures suggested for audit purposes.** Liver utilisation (livers transplanted/livers accepted for transplant) Liver graft failure rate in 1st year (graft loss; re-transplant and/or re-listing for transplant and/or death from graft failure without re-listing or re-transplant) Kidney utilisation Kidney egfr at 1 year post-transplant Kidney delayed graft function post-transplant (use of dialysis in 1st week with specific exceptions) Kidney graft failure rate in 1st year (return to dialysis and/or re-listing for transplant) Pancreas utilisation Pancreas graft failure rate in 1st year (return to insulin use on a daily basis). NB; the definitions of the above (eg; pancreas graft failure) are subject to improving criteria and the most recent definitions should be sought in consultation with experts in the Kidney Advisory Group, Liver Advisory Group and Pancreas Advisory Group, all of NHSBT. Some numerical scoring systems can be applied to early liver function. (MEAF and EAD are current examples). Data to support such scores would help in outcome analysis. All transplant types; Length of stay on index (transplant) admission; ITU stay/Critical Care stay/total hospital stay Readmission rate (number of readmissions in year 1 post-transplant) and total duration of stay Mortality in 1st year post transplant Primary non-function (graft never functions) Biopsy proven rejection in 1st 3 months post-transplant (liver and kidney; pancreas is uncommonly biopsied) Transplant survival (graft loss and/or death in 1st year after transplant). Adverse outcome measures not already mentioned; Liver; biliary stricture requiring endoscopic or surgical intervention in 1st year MR cholangiography diagnosis of ischaemic cholangiopathy Hepatic artery thrombosis in 1st year Kidney

		Ureteric stricture requiring radiological or surgical intervention Urinary leak Pancreas No further indices recommended. Donor Events Organ loss due solely to surgical damage at donor operation (collected by NHSBT) Early cessation of NRP in the organ donor (NRP lasts 2 hours; early cessation would be defined as cold preservation with less than 120 minutes warm perfusion) Use of more than 6 units of blood in abdominal-only NRP and use of more than 10 units in combined donors (cardiothoracic organ retrieval and abdominal organ retrieval) PROMs Patient-related outcome measures have been markedly under-used in transplantation to date. However, recent publications have attempted to synthesise available studies to give the highest quality overview of published works (below). It is difficult to recommend a specific PROM to use, given the developing status of PROMs in organ transplantation. **Advice from the organ-specific advisory groups at NHSBT is very strongly recommended** to ensure that the chosen PROMs have the support of the clinical communities. Liver Transplant Vedadi et al. Patient-reported outcomes and patient-reported outcome measures in liver transplantation: a scoping review. Qual Life Res. 32:2435-2445. doi: 10.1007/s11136-023-03405-1. Renal Transplant Fletcher et al.; Symptom burden and health-related quality of life in chronic kidney disease: A global systematic review and meta-analysis. DOI: 10.1371/journal.pmed.1003954 Pancreas Transplant No published studies

Further comments

23	If you have any further comments (e.g. issues with usability or implementation, the need for further research), please describe.	***It is strongly recommended that expert opinion is sought on the above outcome measures from the Kidney Advisory Group, Liver Advisory Group and Pancreas Advisory Group, all of NHSBT. This will ensure that the chosen outcome measures have the approval of the different clinical communities which this work seeks to serve. Failure to do this could jeopardise value, credibility and clinical applicability.***

NICE National Institute for Health and Care Excellence

Declarations of interests

Please state any potential conflicts of interest relevant to the procedure/technology (or competitor technologies) on which you are providing advice, or any involvements in disputes or complaints, in the previous **12 months** or likely to exist in the future. Please use the NICE policy on declaring and managing interests as a guide when declaring any interests. Further advice can be obtained from the NICE team.

Type of interest *	Description of interest	Relevant dates	
		Interest arose	Interest ceased
Choose an item.	IP owner for an as yet unpublished liver function score which determines liver function post-transplant.	**Prior to 2020**	**Continues**
Choose an item.			
Choose an item.			

I confirm that the information provided above is complete and correct. I acknowledge that any changes in these declarations during the course of my work with NICE, must be notified to NICE as soon as practicable and no later than 28 days after the interest arises. I am aware that if I do not make full, accurate and timely declarations then my advice may be excluded from being considered by the NICE committee.

Please note, all declarations of interest will be made publicly available on the NICE website.

Print name:	**Ian Currie**
Dated:	**16.01.24**

View results

Respondent

1 Anonymous

31:24
Time to complete

This questionnaire is only to be completed and submitted by Health and care practitioners

This questionnaire should be completed by those whose role is, or is directly related to, one of the specialisms below. For each assessment, we engage with professionals with expertise relevant to the topic under evaluation. By completing this questionnaire, you acknowledge and consent to being considered for the role of professional expert on this assessment.
Please indicate which option best describes your area of expertise. If there is no option which you feel relates to your role, please select 'Other' and let us know your role and why you think we should include your knowledge and expertise on the assessment.
For expressions of interest and/or to share your lived experience please email pip@nice.org.uk

Note:
Please ensure all necessary edits or amendments are completed on your questionnaire before the portal close date. A final submission pull will be conducted after closure, and the portal will then be locked. Any changes made after the closing date will not be included in the final submission.
https://techcommunity.microsoft.com/blog/microsoftformsblog/you-can-now-save-and-edit-your-survey-responses/3865033

1. Which option below best relates to your own role? You will be asked to supply your job title and organisation in the next section.
If your role is not listed but you feel it ought to be included, please select 'Other' and let us know your role and why you think we should include your knowledge and expertise on the assessment.

- ○ Consultant liver transplant surgeon
- ◉ Consultant Hepatologist
- ○ Nurse specialising in transplantation or donation
- ○ Perfusionist or specialist in organ procurement
- ○ Transplant co-ordinator
- ○ Interventional radiologist
- ○ Consultant in anaesthesia
- ○ Intensive care consultant
- ○ Other

2. Topic Title

IPG10405 (IP1890) – In-situ normothermic regional perfusion of the abdomen for donor livers following circulatory death (provisional title), interventional procedures assessment

3. Name: *

Prof Matthew Armstrong

4. Job title *

Professor of Transplant Hepatology and Liver Medicine. Centre Director for Birmingam liver unit

5. Organisation

Liver Unit, Queen Elizabeth University Hospital Birmingham

6. Email Address

[redacted]

7. Professional organisation or society membership/affiliation

GMC 6103019. FRCP

8. Nominated/ratified by (if applicable)

BLTG have nominated me as the transplant hepatology representative

9. Registration number (e.g. GMC, NMC, HCPC) *

6103019

Consent to publish response

How NICE will use this information: The information that you provide on this form may be used to develop guidance on this topic.

Your advice and views represent your individual opinion and not that of your employer, professional society or a consensus view. Where relevant your name, job title, organisation and your responses, along with your declared interests may be published online on the NICE website as part of public consultation on the draft guidance, except in circumstances but not limited to, where comments are considered voluminous, or publication would be unlawful or inappropriate.

Please note: if consent is not given, you will not be eligible for the role of professional expert on this assessment.

For more information about how we process your data please see our privacy notice.

10. I give my consent for the information in this questionnaire to be used and may be published on the NICE website as outlined above. If consent is NOT given, please state reasons below: *

- [x] Yes, I give my consent for the information in this questionnaire to be used and may be published on the NICE website as outlined above.
- [ ] No, I do not give my consent for the information in this questionnaire to be used and it may not be published on the NICE website as outlined above.
- [ ] Other

11. If you do not consent to us publishing your response, please explain why below:

Experience

Please answer the following questions as fully as possible to provide further information about the procedure/technologies and/or your experience

12. Please describe your level of experience with the procedure/technologies, for example:

- Are you familiar with the procedure/technologies?
- Have you used it or are you currently using it? If so, please indicate your experience with this.
- Do you know how widely this procedure/technology is used in the NHS? Is this procedure/technology performed/used by clinicians in specialities other than your own?

8 years experience with patient allocation and post transplant care for Organox (NMP). Key member of the team that has design and approach funding an NRP service. 3 years of experience of receiving NRP outputs and donor criteria.

13. Please indicate your research experience relating to this procedure or technology (please choose one or more if relevant): (Please highlight your choice(s))

- [x] I have done bibliographic research on this procedure or technology
- [ ] I have done research on this procedure or technology in laboratory settings (e.g. device-related research).
- [x] I have done clinical research on this procedure or technology involving patients or healthy volunteers.
- [ ] I have published this research.
- [ ] I have had no involvement in research on this procedure or technology.
- [ ] Other

Interventional procedure related questions ONLY

Please skip 12 - 16 - if a DG/EVA/MTAC/LSA topic (information can be found on your email invite)

14. Does the title adequately reflect the procedure?

IPG10405 (IP1890) – In-situ normothermic regional perfusion of the abdomen for donor livers following circulatory death (provisional title), interventional procedures assessment

YES very much so

15. Is the proposed indication appropriate? If not, please explain.

YES

16. Does this have a multi-indication?

YEs - but will this overlap with benefits for kidney/heart and lung or will they be separate documents

Current management

17. Please describe the current standard of care that is used in the NHS

ad hoc - based on availability of NRP. All centres now NO longer used cold storage DCDs. If non-marginal DCD most centres use HOPE to reduce biliary complications - however there is good evidence that NRP functional assessment at donor site increase organ utilisation and reduces PNF

18. Does this procedure/technology have the potential to replace current standard care or would it be used as an addition to existing standard care? Where would the technologies/procedure fit in the care pathway?

YEs - realistically the ambition should be that all DCDs are retrieved with NRP

19.
- What are the main aims of these procedures or technologies?
- How innovative are they?
- Can you name any technologies which are available in the UK and have this function/mode of action?
- Are there any competing or alternative procedures available to the NHS which have a similar function/mode of action to this?
- If so, how do these differ from the technology/procedure indicated here?

Main aim = all DCDs are retrieved with NRP
This will hugely increase the DCD donor pool, which is critical in an environment of lack of DBD offers
Current machine perfusion is divided into NMP (organox, at recipient site), HOPE (bridge for life, at recipient site) and NRP at donor site (however this service does not have geographical equal access

20. Approximately how many people each year would be eligible for an intervention with this procedure/technology, (give either as an estimated number, or a proportion of the target population)?

This will likely increase UK transplant by 25% (ie an extra 250 transplants per year)

Potential patient benefits and impact on the health system

21. What do you consider to be the potential benefits to patients from using this procedure/technology?

More access to liver transplant, less burden of transplant waiting list, lower mortality

22.
- Are there any groups of patients who would particularly benefit from this procedure/technology?
- Are there any groups in which the technology would be less effective or would be less likely to benefit?
- Are there any potential equality issues that should be considered for this condition and procedure/technology?

All transplant waiting list patients - but in particular regrafts, young patients and rare diseases - who ultimately are disadvantaged from the DBD NLOS system

23.
- What do you consider to be the potential benefits to the system from using this procedure/technology?
- Could it lead, for example, to a reduced number of appointments, improved care pathway, more efficient NHS staff time use?

100% - small waiting times for transplant, less death, etc

24. What clinical facilities (or changes to existing facilities) are needed to do this procedure/implement this technology safely?

7 centre retrieval teams with 24/7 NRP retrieval ability with NRP and perfusionist support

25. Is any specific training needed in order to use the procedure/technology with respect to efficacy or safety?

Yes

Safety and efficacy of the procedure/technologies

26. What are the potential harms of the procedure/technology?

- Please list any adverse events and potential risks (even if uncommon) and, if possible, estimate their incidence:
- Adverse events reported in the literature (if possible, please cite literature)
- Anecdotal adverse events (known from experience)
- Theoretical adverse events

at present NRP set up is not straight forward and is conultant led. If set up wrong would lead to reperfusion of the brain in-situ and would delay donor death - which is a disaster. Other risks include vascular donor damage which will impact on recipient success

27. Please list the key efficacy and safety outcomes for this procedure/technology? Please suggest the most appropriate method of measurement for these outcomes and the timescales over which these should be measured (where appropriate) and if there are any challenges in collecting key outcomes.

Transplant waiting list mortality, DCD organ utilisation (ie decline rates), Transplant survival, graft survival

28. Please list any uncertainties or concerns about the efficacy and safety of this procedure/technology?

NRP is well proven - however staff training and funding will be the main challenge

29. Is there controversy, or important uncertainty, about any aspect of the procedure/technology?

geographical equality

30. If it is safe and efficacious, in your opinion, will this procedure be carried out in (please choose one):

- [x] Most or all district general hospitals
- [ ] A minority of hospitals, but at least 10 in the UK
- [ ] Fewer than 10 specialist centres in the UK
- [ ] Cannot predict at present

31. Are you aware of any additional issues which would prevent (or have prevented) this procedure/technology being adopted in your organisation or across the wider NHS? This could include costs, resource, staffing for example.

This is a service that will have to go to all hospitals to retrieve donor organs and shouldnt be limited to certain hospitals. The intervention is mobile via the SNOD/retrieval teams

32. Please list any abstract, real-world evidence, conference proceedings or any major trials or registries that you are aware of for this topic.
Please note that NICE will do a comprehensive literature search; we are only asking you for any very recent abstracts or conference proceedings which might not be found using standard literature searches. You do not need to supply a comprehensive reference list but it will help us if you list any that you think are particularly important. If you would like to share any studies which are confidential due to their publication status, please contact us via email.

AJT Volume 25, Issue 8, Supplement 1S748August 2025
The Impact of Normothermic Regional Perfusion on the Utilization and Post-Transplant Outcomes for Liver Transplant
Y. Endo · A. Nair · K. Tomiyama · R. Hernandez-Alejandro · Y. Bekki

Am J Transplant
. 2019 Jun;19(6):1745-1758. doi: 10.1111/ajt.15241. Epub 2019 Feb 1.
In situ normothermic perfusion of livers in controlled circulatory death donation may prevent ischemic cholangiopathy and improve graft survival
BrowZine Journal Cover
Christopher J E Watson 1 2 3, Fiona Hunt 4, Simon Messer 5, Ian Currie 4, Stephen Large 5, Andrew Sutherland 4, Keziah Crick 3, Stephen J Wigmore 4 6, Corrina Fear 3, Sorina Cornateanu 4, Lucy V Randle 7, John D Terrace 4, Sara Upponi 8, Rhiannon Taylor 9, Elisa Allen 9, Andrew J Butler 1 2 3, Gabriel C Oniscu 4 6

33. Is there any research that you feel would be needed to address uncertainties in the evidence base?

NA

34. Please suggest potential audit criteria for this procedure/technology. If known, please describe:

- Beneficial outcome measures - These should include short- and long-term clinical outcomes, quality-of-life measures and patient-related outcomes. Please suggest the most appropriate method of measurement for each and the timescales over which these should be measured.
- Adverse outcome measures - These should include early and late complications. Please state the post procedure timescales over which these should be measured.

QIP - organ ultisation and graft survival UK wide

Further Comments

35. Please add any further comments on your particular experiences or knowledge of the procedure/technology.

na

Contact confirmation

Please indicate if you would like to opt in to NICE contacting you regarding other technologies/treatments in the future for your advice, or if you would only like to be contacted regarding this specific technology:

36. Please select what NICE may contact you about: *

- (●) NICE can use my details to contact me for advice on this and future assessments.
- ( ) NICE can use my details to contact me for advice on this topic only, but not for others.

37. Date *

20/11/2025

NICE National Institute for Health and Care Excellence

Interventional Procedures Advisory Committee: Committee Interests Register

Topic: IPG10405 (IP1890) - In-situ normothermic regional perfusion of the abdomen for livers donated after controlled circulatory death

NICE's declaration of interest policy can be accessed here

Name	Role with NICE	Type of interest	Description of interest	Interest arose	Interest declared	Interest ceased	Comments
Rick Body	Standing Committee Member (Chair)	Financial	Nil	N/A	17/04/2026	N/A	
		Non-Financial and Professional	Nil	N/A	17/04/2026	N/A	
		Indirect	Nil	N/A	17/04/2026	N/A	
Simon Bach	Standing Committee Member (Vice-Chair)	Financial	Nil	N/A	25/04/2026	N/A	
		Non-financial, personal and professional interests	Nil	N/A	25/04/2026	N/A	
		Indirect	Nil	N/A	25/04/2026	N/A	
Angus McNair	Standing Committee Member	Financial	Nil	N/A	27/04/2026	N/A	
		Non-financial, personal and professional interests	Nil	N/A	27/04/2026	N/A	

		Indirect	Nil	N/A	27/04/2026	N/A	
Augusto Azuara-Blanco	Standing Committee Member	Financial	Nil	N/A	18/04/2026	N/A	
		Non-financial, personal and professional interests	Nil	N/A	18/04/2026	N/A	
		Indirect	Nil	N/A	18/04/2026	N/A	
Christopher Adams	Standing Committee Member	Financial	Nil	N/A	17/04/2026	N/A	
		Non-financial, personal and professional interests	Nil	N/A	17/04/2026	N/A	
		Indirect	Nil	N/A	17/04/2026	N/A	
Conrad Harrison	Standing Committee Member	Financial	Nil	N/A	17/04/2026	N/A	
		Non-financial, personal and professional interests	Nil	N/A	17/04/2026	N/A	
		Indirect	Nil	N/A	17/04/2026	N/A	
Dawn Lee	Standing Committee Member	Financial	Nil	N/A	07/01/2026	N/A	
		Non-financial,	Nil	N/A	07/01/2026	N/A	

		personal and professional interests					
		Indirect	Nil	N/A	07/01/2026	N/A	
Mahmoud Elfar	Standing Committee Member	Financial	Nil	N/A	27/04/2026	N/A	
		Non-financial, personal and professional interests	Nil	N/A	27/04/2026	N/A	
		Indirect	Nil	N/A	27/04/2026	N/A	
Marwan Habiba	Standing Committee Member	Financial	Nil	N/A	05/05/2026	N/A	
		Non-financial, personal and professional interests	Nil	N/A	05/05/2026	N/A	
		Indirect	Nil	N/A	05/05/2026	N/A	
Noemi Muszbek	Standing Committee Member	Financial	Nil	N/A	19/04/2026	N/A	
		Non-financial, personal and professional interests	Nil	N/A	19/04/2026	N/A	
		Indirect	Nil	N/A	19/04/2026	N/A	
Paddy Storrie		Financial	Nil	N/A	04/05/2026	N/A	

	Standing Committee Member	Non-financial, personal and professional interests	Nil	N/A	04/05/2026	N/A	
		Indirect	Nil	N/A	04/05/2026	N/A	
Patrick Farrell	Standing Committee Member	Financial	Nil	N/A	07/05/2026	N/A	
		Non-financial, personal and professional interests	Nil	N/A	07/05/2026	N/A	
		Indirect	Nil	N/A	07/05/2026	N/A	
Sandeep Singh Randhawa	Standing Committee Member	Financial	Nil	N/A	27/04/2026	N/A	
		Non-financial, personal and professional interests	Nil	N/A	27/04/2026	N/A	
		Indirect	Nil	N/A	27/04/2026	N/A	
Stuart Smith	Standing Committee Member	Financial	Nil	N/A	17/04/2026	N/A	
		Non-financial, personal and professional interests	Nil	N/A	17/04/2026	N/A	
		Indirect	Nil	N/A	17/04/2026	N/A	

Suvitesh Luthra	Standing Committee Member	Financial	Nil	N/A	18/04/2026	N/A	
		Non-financial, personal and professional interests	Nil	N/A	18/04/2026	N/A	
		Indirect	Nil	N/A	18/04/2026	N/A	
Tim Kinnaird	Standing Committee Member	Financial	Nil	N/A	25/04/2026	N/A	
		Non-financial, personal and professional interests	Nil	N/A	25/04/2026	N/A	
		Indirect	Nil	N/A	25/04/2026	N/A	
Veena Soni	Standing Committee Member	Financial	Nil	N/A	17/04/2026	N/A	
		Non-financial, personal and professional interests	Nil	N/A	17/04/2026	N/A	
		Indirect	Nil	N/A	17/04/2026	N/A	
Elijah Ablorsu	Professional Expert	Financial	Nil	N/A	01/12/2025	N/A	
		Non-financial, personal and	Nil	N/A	01/12/2025	N/A	

		professional interests					
		Indirect	Nil	N/A	01/12/2025	N/A	
Ian Currie	Professional Expert	Financial	I have received an honorarium for a presentation to Chang Gung Medical Week (Taiwan) 2024 wherein I presented the challenges and benefits of implementing an NRP program at national level (Developing a National Program in DCD donation; Roles for Normothermic Regional Perfusion and Ex-Situ Machine Perfusion).		01/12/2025		
		Financial	I also received an honorarium for a presentation 'UK National Organ Retrieval Service; Building a High-Performance Team' for the Community of Practice; Recovery and Preservation in the United States.		01/12/2025		
		Financial	I am a member of an advisory board for 'Stimuliver', a company which is developing stem-cell based therapies for liver disease patients. I have not received any payments or any other benefits from this relationship.		01/12/2025		
		Financial	I am the owner of a company (Grange and Stone Ltd) which is not trading. Its objective is to provide educational and training materials to support best practice in organ retrieval.		01/12/2025		
		Non-financial, personal and	I am a trustee in a Charity 'Edinburgh Perfusion SCIO' which teaches delegates from all over the world how		01/12/2025		

		professional interests	to perform NRP. For these meetings, small grants are paid from various commercial companies (Getinge, Organox, Sysmex, Abbot, Global Transplant Solutions, XVIVO) which supports us to ensure these meetings can happen. These payments do not result in any personal benefit to me. These meetings occur twice a year. I have been involved in this since 2018, although the charity is a recent development.				
		Non-financial, personal and professional interests	I am a researcher and have raised research grant funding (non-commercial) to support work which aims to understand the benefits of NRP. I have a PhD student who is supported by NHSBT to explore assessment of livers on NRP and have a research program looking into the psychological underpinnings of the discussions around donor family agreement to permit their loved one to donate organs. I have had research interests in NRP since 2014 and transplantation since 2000.		01/12/2025		
		Non-financial, personal and professional interests	I have written a recent review about cholangiopathy in machine perfusion, which compares NRP with machine perfusion and discusses the outcomes in terms of graft function and survival (Currie and Hunt, 2025). This reviews a wide breadth of literature and confirms the benefits of NRP in liver transplantation.		01/12/2025		

		Indirect	It is not clear to me whether the following is relevant, but I make numerous presentations about NRP as part of my work with NHSBT, where I am representing NHSBT as an Associate Medical Director. I make no financial gain from these presentations. This is NHS work, where I promote the best interests of the patients based on published evidence		01/12/2025		
Matthew Armstrong	Professional Expert	Financial	Nil	N/A	21/11/2025	N/A	
		Non-financial, personal and professional interests	Nil	N/A	21/11/2025	N/A	
		Indirect	Nil	N/A	21/11/2025	N/A	
Harriet Myfanwy Charles	Patient expert	Financial	Nil	N/A	25/03/2026	N/A	
		Non-financial, personal and professional interests	Nil	N/A	25/03/2026	N/A	
		Indirect	Nil	N/A	25/03/2026	N/A	
Jim Kilpatrick	Patient expert	Financial	Nil	N/A	15/03/2026	N/A	
		Non-financial, personal and	Chairman, Treasurer and Patient Carer with the Royal Victoria Hospital Liver Support Group, Belfast. This is	09/2018	15/03/2026	Ongoing	

		professional interests	an independent charity registered in Northern Ireland (NIC: 100892) to provide non-medical support to liver patients and their carers across Northern Ireland.				
		Indirect	Nil	N/A	15/03/2026	N/A	