Organ and tissue procurement from DBD donors

Recommendations for the topic of preparation and conducting of organ

procurement for transplantation

Version 2.1 - February 2023



CNDO Nationaler Ausschuss für Organspende Comité National du don d'organes

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1.0

Summary

1.1 Objective

Optimal preparation and conducting of organ procurement for transplantation as well as organ conditioning.

The adapted organ procurement technique for donation after cardiocirculatory death (DCD) donors is dealt with in more detail in Module 9: "Identification, reporting and treatment of a DCD donor".

1.2 Principle

Rapid replacement of blood circulating within the organs with cold perfusion solution minimizing organs metabolism and enabling their procurement, transport and preparation for transplantation.

1.3 Quality control

Quality control of procurement and transport methods must be regularly executed to guarantee organ and tissue integrity as well as the maintenance of preservation temperature during procurement and transport. A Standard Operation Protocol (SOP) was developed by the Swisstransplant Procurement and Transport Working Group (STAPT, V.6, 03.2018) for multi-organ procurement from a DBD donor. This applies as the reference for this Module.

2.0 Organ and tissue procurement

2.1 Tasks of the intensive care unit

- Donor detection and donor reporting as per the Swiss Donation Pathway, Module 1
- Determination of death in the context of organ transplantation (diagnosis of brain death)
- Medical-ethical guidelines of the Swiss Academy of Medical Sciences (SAMS) or the regional/local guidelines based on the latter
- Support of relatives and requesting organ donation enquiry as per the Swiss Donation Pathway, Module 2
- Treatment and monitoring of the DBD donor as per Modules 3 and 4 of the Swiss Donation Pathway
- Transport of the donor to the operating theatre

2.2 Coordination of procurement

Hospital-specific prerequisites for procurement

Whether organ procurement is possible on site or whether a donor transfer to a procurement hospital is required has to be clarified with donor hospitals (donor detection hospitals). If the donor cannot be transported or relatives refuse transfer to another hospital, it has to be discussed whether procurement can be conducted on site under consideration of the local circumstances (personnel and structural). Subject to mutual agreement, the donor hospital personnel can be supported by the medico-surgical team of the transplant centre.

Procurement teams

The personnel required for organ procurement consists of:

- Operating theatre: instrument (scrub) nurse and theatre nurses
- Anaesthesia: medical and nursing staff
- Surgical procurement teams (heart, lungs, abdominal team)
- Coordinator with special training in organ procurement (hereinafter the "organ procurement coordinator")

If one of the three removal teams (heart, lungs or abdominal) is unable to adhere to the previously agreed organ removal time (traffic, weather), this has to be taken into consideration regarding planned surgery, permitting the donor's clinical condition.

Procurement may also be delayed to ensure optimal preparation of the potential transplant recipient. Delays must be approved by the Swisstransplant Medical Advisor. The Medical Advisor consults with the procurement hospital. The period of time is to be kept as short as possible.

Crucial factors for organ and tissue procurement:

- Consideration of the donor's consent regarding organs for procurement (all organs / specific organs only)
- Donor's clinical condition and quality of organs and tissue
- Procurement sequence (heart, lungs, intestine (if allocated), liver, pancreas and kidneys; finally tissue removal)

In principle, each procurement team is responsible for its procurement equipment itself or ensures that equipment can be provided by the procurement hospital:

- Surgical instruments, special equipment and drugs
- Preservation solutions
- Sufficient quantity of sterile ice for each procured organ
- Packaging material (perfusion machines)

The (external) procurement teams are welcomed by the organ procurement coordinator, familiarized with the facilities (changing room, operating theatre), and introduced to the surgical teams already present and the other personnel directly involved in the organ procurement.

Time required for preparation, perfusion and organ procurement

Depending on the number of organs to be procured, four to eight hours are to be planned for procurement. This time allowance is non-binding and depends on the physical condition of the donor (obesity, previous operations) and the routine of the surgical teams.

Preparation with perfusion

Action item	Time required
Preparation in the operating theatre	30 min.
Abdominal	1 – 1.5 hrs
With whole pancreas procurement	2.5 hrs
With split liver	4 – 6 hrs

Organ procurement

	Organ	Time required	
Thorax	 Heart (preparation and procurement) 	30 min.	
	 Lungs (preparation and procurement) 	30 min.	
Abdomen	- Liver	30 min.	
	- Pancreas	30 min.	
	– Kidneys	30 min.	

	Abdomina	l team		Heart team Lung team	All	All		Abdomi- nal team
Procedure	Sterno- tomy and laparato- my	Inspection and pal- pation of abdominal organs	Abdo- minal prepara- tion	Inspection and pre- paration of heart and lungs	Cannu- lation abdomi- nal and cardiac	Clamping of the aor- ta/start of organ perfusion	Procure- ment of 1. Heart 2. Lungs 3. Liver 4. Pancreas 5. Kidneys	Wound closure, tho- rax/ab- domen
Time	30	10	50* 110** 330***	20	30	20	15**** 30 pro Organ	20
			Beating he	art			Cardiac arrest	:

*Abdominal **With whole pancreas ***With split liver ****Heart and lungs

Tissueprocurement

Tissue	Time required
Cornea	45 min.
Auditory ossicles	60 min.
lliac vessels	30 min.

Equipment for preparation, procurement, shipping and tissue typing

Equipment

The instrument (scrub) nurse and non-sterile assisting staff prepare the operating theatre, including the equipment required:

- Sterile ice (approx. 8 l)
- Transport boxes
- 151 of preservation solutions are required for multi-organ procurement

Equipment

The instrument nurse and the circulating nurse prepare the instruments for the standard laparotomy, the sternotomy (with the corresponding saw) and the vascular instruments. Special surgical instruments (e.g. special clamps, staplers, cannulas, perfusion sets, bags and transport containers) and drugs are usually brought along by the procurement teams.

Specific preservation solutions

The organ-specific preservation solutions are to be brought along by the procurement teams in a cooler (attention: preservation solution should not come into direct contact with ice).

Organs	Preservation solutions
Heart	4 I Cardioplegic solution (St. Thomas® and lidocaine; depen- ding on explantation team: also Celsior® solution)
Lungs	41 Perfadex*
Liver, pancreas, kidneys	151 IGL-1°

Procurement report, material for tissue typing

A corresponding procurement report is to be completed for each procured organ. A copy remains in the procurement hospital filed in the donor's medical records. The original is enclosed with the organs; a further copy remains with the transplant coordinator following transplantation.

2.3 Procedure in the operating theater

Recommendations

- Strict adherence to asepsis technique
- Availability of the operating theatre for a period of four to eight hours as of the arrival of the donor; the duration is dependent on the number and operation type (in situ liver split takes longer) of the organs planned for procurement

In the case of a stable donor, the time of organ procurement can be adapted to more urgent surgical or obstetric procedures. Informing the stakeholders involved at an early stage is necessary to clarify whether the operating theatre occupancy is likely to disrupt the elective theatre schedule, and whether additional personnel (e.g. a transplant coordinator or surgical nursing theatre staff) can be provided by the transplant centre.

A time-out, which is to be documented in writing and submitted to Swisstransplant within seven days, is carried out prior to each multi-organ procurement (the responsibility for adherence to the process and submission of the documents lies with the organ procurement coordinators).

Surgical procedure and removal teams

Standardized sequence of the surgical teams:

- Abdominal team
- Heart team
- Lung team

The procurement teams have to behave appropriately at all times during the procurement. The required specialist qualification as well as knowledge of the multi-organ procurement in Switzerland are the responsibility of the transplant centre. It is recommended that trainee procurement surgeons are to be shadowed on at least three occasions by an experienced colleague.

Abdominal team

The abdominal team normally performs the sternotomy and the laparotomy. Inspection and palpation of the thoracic, mediastinal and abdominal organs (including the pelvic region) are then carried out by each respective team.

Abdomen

Careful inspection and palpation of liver, pancreas and kidneys as well as other organs to rule out any anomaly or pathology potentially constituting a contraindication for procurement of one or all organs, namely:

- Detection of a malignancy or an abnormal finding requires clarification of the further procedure (if possible, with the biopsy result, if available) by the Swisstransplant Medical Advisor.
- Inspection / palpation of the hilum of the liver and the supplying arterial hepatic vessel (attention: atypical or accessory hepatic arteries) as well as the distal transection of the choledochus. If pancreas procurement is planned, the omental bursa is opened.
- The abdominal surgeon then exposes the iliac arteries, the aorta and the vena cava to prepare for the insertion of the perfusion cannula into the common iliac artery. The aorta is exposed at the hiatus of the diaphragm in order to prepare for clamping.
- Alternatively, the super rapid procurement technique can be applied, merely with the exposure and cannulation of the common iliac artery for the insertion of a double-balloon catheter (DCD procurement).
- The aortic cannula is connected to the cold abdominal perfusion solution via an infusion line and put up on an infusion stand (possibly with a pressure cuff).

Attention! Check precisely that there are no air bubbles in the cannulas or tubes!

To avoid clot formation at the cannulas, heparin $(300 \, \text{IU/kg})$ is given to the donor at least two minutes before cannula insertion into the vessels.

Once the heart and lungs are prepared, the aortic cannula is inserted at the level of the iliac bifurcation or into the right common iliac artery, with the left common iliac artery clamped (to include any existing lower renal pole arteries in the perfusion process). Optionally, a suction cannula for the venous blood is installed in the vena cava. If the perfusion situation is unclear, additional perfusion can be installed (e.g. if dissections occur).

If the **donor is unstable**, the aortic cannula is inserted without further preparation immediately after the laparotomy. At the same time, the preservation solutions are prepared to ensure fast perfusion in the event of cardio-circulatory arrest.

The abdominal surgeon then clears the operating field for the thoracic teams.

Heart team

Inspection of the heart and – depending on findings – final decision on heart procurement. If a malignant process is suspected or there are abnormal findings, the further procedure is discussed following consultation with the Swisstransplant Medical Advisor. If a fast-track biopsy is intended, it has to be ensured that diagnostics are carried out prior to cross-clamping whenever possible.

If the heart is regarded as unsuitable for transplantation, it can be removed for cardiac valve homografts if the appropriate consent is provided (procedure: preparation of the vessels (inferior vena cava, superior vena cava, pulmonary artery, ascending aorta) and cannulation of the ascending aorta for perfusion with cardioplegic solution).

Lung team

Opening of both pleural cavities for inspection and palpation of the lungs. Depending on findings, final decision on lung procurement, followed by cannulation of the pulmonary artery for perfusion. Perfusion is carried out without applying pressure by putting the perfusion bag up approximately 30 cm above the heart (e.g. Perfadex[®]).

Organ perfusion

When all teams are ready (organs prepared, all cannulas inserted, all perfusion systems vented, heparin administered, 0.5 mg Prostin administered into the pulmonary artery), the abdominal surgeon clamps the aorta below the diaphragm following consultation of the other surgical teams; this marks the **start of cold ischaemia** (cross-clamp time). Simultaneous closure of the superior vena cava, followed by clamping of the aorta. After making two incisions, one in the left auricle of the heart and the other in the inferior vena cava directly at the right atrium, flushing of the thoracic organs with the preservation solution is to be commenced.

At the same time as the aorta below the diaphragm is clamped by the abdominal surgeon, the ascending aorta is clamped by the cardiac surgeon, and flushing of abdominal organs is commenced. The blood is drained off via the incision made at the inferior vena cava above the diaphragm by the cardiac surgeon, and is progressively replaced with the cold preservation solution. If a cardiac surgeon is absent, this incision is made by the thoracic surgeon. Perfusion of abdominal organs via an arterial cannula.

At start of organ perfusion, crushed sterile ice (prepared in advance) or sterile ice-cold water is placed in the two body cavities to additionally cool organs as rapidly as possible from outside. It must be ensured that suction equipment is emptied in advance to enable optimal aspiration of additional body fluid volume at the site.

The surgical teams check the continuous flow of the preservation solutions and changes of organ colour.

Following perfusion and organ cooling, the heart is removed first. The thoracic team then takes over.

The lungs continue to be ventilated until procurement. Prior to final procurement, the lungs are partially insufflated with $50\% O_{2^{n}}$ then the trachea is closed with a stapler and the organ procured. The abdominal organs are then removed.

In particular circumstances depending on the recipient, the heart is procured including the pulmonary bifurcation of the pulmonary artery and/or the entire inferior vena cava.

Appropriate coordination among all involved teams prior to procurement is crucial to avoid organ lesions or inadequate organ procurement.

The organ procurement coordinator is to be informed of the start time of cold ischaemia (cross-clamp time) and procurement of individual organs.

Procedure of pancreatic islet cell procurement

To carry out the preparation of the islet cells, the pancreas should be procured immediately after liver procurement or en bloc together with the liver. Rapid and complete cooling of the pancreas to approximately 4° C is the prerequisite for achieving the highest possible quality and quantity of the extracted islet cells. To achieve this, the omental bursa is opened and the pancreas is cooled with 3 - 4 litres of iced water and embedded all around in crushed ice/soft ice immediately after aortic clamping and prior mobilization of the spleen. During liver procurement, it is crucial to ensure that the pancreas remains embedded completely and all around in crushed ice/soft ice; replenishing is otherwise necessary. Immediately after procurement, the pancreas should be adequately packed (see section on "Conditioning of the organs") and transported to a laboratory suitable for islet cell preparation. The maximum cold ischaemia time should not exceed eight hours.

The quality of the procured islet cells depends extensively on the procurement technique and adequate cooling. Inadequate cooling (warm ischaemia) has a devastating effect on the number and functionality of the islet cells.

Sequence of organ and tissue removal

Organ removals

- Heart
- Lungs
- Liver
- Pancreas
- Small intestine (rarely procured)
- Kidneys
- Arterial and venous iliac vessels for liver and pancreas implantation (separate packaging)
- Spleen (for immunology laboratories at the respective transplant centres)

Subsequently, closure of the sternotomy and laparotomy by means of single-layer Everett suture, skin stapling and dressing.

The responsible procurement surgeons (abdominal, heart and lung) are to ensure that an operation report documenting the above steps and highlighting any noteworthy findings is available within 48 hours. This report is to be submitted to Swisstransplant within seven days following multi-organ procurement at the latest.

Tissue procurement

Tissue procurement is possible up to 48 hours following cardiocirculatory arrest. Following organ procurement, the ocular procurement personnel is called in to procure the cornea considered for transplantation. The cornea can be procured either in the operating theatre, in the pathology department, at the undertaker or in the forensics department. The procured bulbs are replaced with prostheses, and the eyelids are then closed with acrylic adhesive or intracutaneous sutures.

Organ conditioning

(Standards as per STAPT dated 25 February 2018; Swisstransplant Procurement and Transport Working Group, SOP for multi-organ procurement) The organs are packaged in a total of three sterile bags:

- The first bag contains at least 500 ml sterile, cold preservation solution (without ice and air); the organ should be completely covered by the preservation solution.
- This bag is then placed into a second sterile bag containing sterile "cold" NaCl 0.9%.
- This is then placed into a third, empty bag (without air).

After packaging, the organ is stored in a cooler that is three-quarters full with crushed, non-sterile ice or the organ is placed in the vital pack (cooled with tectonic plates). In exceptional situations, packaging can be carried out by the local team if the process is known. Otherwise, it must be ensured that the procurement teams are appropriately staffed and qualified.

The organ must be prevented from coming into direct contact with ice at all times during transport!

Material and documents for transporting each organ

- Immediate labelling of all organs after packaging (which organ, ST No. and blood group).

- A copy of the procurement report must be enclosed with each organ leaving the operating theatre. The report must be filled out correctly and completely by the responsible procurement surgeon. Any organ lesions during or after procurement is to be notified.
- All blood vials must be labelled with the Swisstransplant donor number (ST No.) and enclosed with each organ (unless the blood vials have already been sent off for prospective T-cell cross-matching).
- Enclose a section of spleen for the histocompatibility laboratory analysis with each abdominal organ procured.
- For liver and pancreas only: enclose iliac vessels (artery and vein).
- Transport document (Swisstransplant)

If the organ is accompanied by the procurement team, the procurement team is responsible for the appropriate packaging of procured organs. In cooperation with the procurement teams, the organ procurement coordinator is responsible for appropriate labelling of organs and transport containers and enclosing the required accompanying documents.

In cooperation with the procurement team, the organ procurement coordinator is responsible for the appropriate packaging and labelling organs sent without accompaniment of the procurement team (unaccompanied).

Organ stability

The cold ischaemia time is crucial for the stability and function of the organs. The cold ischaemia time is defined as the period of time from aortic clamping of the donor (cross-clamp time) until the time of reperfusion of the organ in the recipient (definition as per SOAS, the allocation system used in Switzerland).

The procurement report must contain the time of aortic clamping, the removal time and the reperfusion time of the organs.

The maximum ischaemia times between aortic clamping and reperfusion in the recipient (cold ischaemia time) are specified per organ in the following:

Organs	Maximum time tolerated until reperfusion
Heart	4 hrs
Lungs	6-8 hrs
Liver, (small intestine)	12hrs DBD, <8hrs DCD
Pancreas/islet cells	8 hrs
Kidneys	24 hrs

The cold ischaemia time should be kept as short as possible, as this influences the organ function immediately after transplantation.

Maximum transport time

Organs	Transport time / mode for removal teams
Heart, lungs	2.5 hrs helicopter/aircraft/ambulance
Liver, islet cells, small intestine, pancreas	3 hrs helicopter/aircraft/ambulance/taxi (4h for DBD liver or unaccompanied)
Kidneys	20 hrs taxi

Transport is carried out subject to the responsibility of Swisstransplant according to the agreed criteria with respect to mode of transport, time frame and urgency. Deviations from these criteria are only possible following approval by the Swisstransplant Medical Advisor, requiring a clear medical justification by the responsible surgeon.

As cross-match results of donor and potential recipient are relevant for kidneys, sufficient time usually remains to transport the organs by taxi. However, the cold ischaemia time should also be kept as short as possible.

More information: Swiss Donation Pathway, module 8: "Organization of transport"

2.4 Post-procurement phase

Reinstatement of the donors's body

Needless to say, the deceased donor is treated with dignity and respect by all persons present before, during and after organ procurement. On completion of the procurement surgery, all cannulas and catheters are to be removed and the puncture sites closed. The body is washed and covered with a fresh gown and a sheet. The donor's body is then transferred to the mortuary or – depending on the circumstances at the respective hospita – to the appropriate location. The donor's body is hereby released for the funeral.

If a forensic examination is planned for the donor following procurement, all cannulas, catheters and the tracheal tube are to be kept in situ.

Taking care of the donor's relatives following donation

Throughout the entire organ donation process, the family is supported by the organ procurement team (see also module 2: "Taking care of next of kin and communication").

Anaesthesia sheet	 Time of aortic clamping (cross-clamp time) Name of the hospital's procurement surgeons
Operation report	Time-outOperation reportProcurement report
Medical history	- Complete and return to the intensive care unit
Electronic database registry	- SOAS, complete data
Serology results	Transfer to the tissue bankTransfer to the National Allocation Office
Histology results	 Transfer to the tissue bank Transfer to the National Allocation Office

Patient dossier

The National Allocation Office forwards the findings directly to the affected transplant centres and files them in the donor's dossier in the SOAS.

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Changes

Date	Version	Changes
February 2023	2.1	Corrections
December 2020	2.0	Revision
March 2018	1.3	New logo
August 2014	1.2	Packaging of organs
April 2014	1.1	Layout, perfusion solutions
June 2006	1.0	Original version

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