



Procedural Standards for Deceased Donor Organ Recovery

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**American Society of Transplant Surgeons
Standards and Quality Committee**

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Introduction

Deceased donor organ recovery has been persistently increasing for the last several years. As noted by the OPTN database there are more than 12,000 deceased donor surgeries performed in just the last year. Multiple factors in the last several years have increased reliance on local recovery teams, which include, but are not limited to, recovery team safety ⁽¹⁻⁴⁾, organ allocation system changes, recovery surgeon availability, and, most recently, the SARS-CoV-2 pandemic.

As this shift towards local organ recovery progresses, stakeholders in this area, including the American Society of Transplant Surgeons and organ procurement organizations, have recognized a need for more universal and clearly delineated expectations and procedures surrounding organ recovery as recipient centers increasingly depend on recovery surgeons with whom they are unfamiliar.

While the exact operative approaches to organ recovery remain at the discretion of the procuring surgeon, the end result should meet certain standards to ensure a safe and successful recipient operation, with the best possible long-term outcomes for the graft and recipient.

The transplant community immensely benefits from standardized expectations as it will help in building trust and collegiality among providers with a common goal of helping patients. Communication between the recovery and recipient teams should occur in general, but especially in real time for organs that do not tolerate prolonged ischemic periods. The communication needs to be succinct, accurate, and updated, as necessary. Communication should include static and video images to allow assessment of organ quality.

The most important aspect of organ recovery is transparency and honest communication. Recovery surgeons must report all procurement issues immediately to the recipient team to allow for timely clinical decisions.

Deceased Donor Organ Recovery Standards

Pre-Operatively:

1. The recovery surgeon should review the case beforehand and communicate with the recipient surgeon (i.e. need for extra vessels in a multiorgan recovery).
2. The recovery surgeon should review the donor's surgical history, which might add to the complexity of the case, especially in the case of donation after cardiac death (DCD) recoveries.
3. The recovery surgeon should confer with O.R. team, before surgery, regarding her/his expectations and equipment needs. Performing a huddle before a DCD case is also recommended.
4. Organs can be recovered multiply, or singly. If multiple recovery surgeons are involved in a single case, early communication and mutual expectation setting will result in better case flow.

Intra-Operatively:

1. Any abnormal masses or evidence of infection discovered in or about the donor's body must be carefully documented and reported to potential recipient centers. In most cases, such findings should be biopsied or cultured, as appropriate.
2. Anatomy reports at the point of organ recovery (generally created on a written or computerized form supplied by the recovering OPO) should be reviewed by the recovering surgeon for accuracy before they are signed.
3. If there is surgical damage in the case of extra-renal organs, it should be directly communicated to the recipient surgeon. Surgical damage in kidney recoveries should be carefully documented in the recovering OPO's anatomy report. In the case of damage to any organ type, photo documentation is recommended.
4. Surgical repair of artery or vein defects *is not recommended* and should be left to the discretion of the recipient surgeon. Placement of a single, identifying stitch may be helpful.
5. Recovery surgeons should allow for extra time in the event of unforeseen circumstances or findings in the operating room, or delay on the recipient side.

Post-Operatively:

1. The recovery surgeon should make her/himself available to answer any questions regarding organ recovery, if needed by the recipient surgeon.

NB:

The time taken to recover donor organs influences outcomes in recipients. ⁽⁵⁻⁷⁾ We have included suggested ideal organ recovery times, defined as time elapsed between aortic flush/donor cross-clamp and removal of the organ from the body and placement into cold storage.

These should be regarded as guidelines only, achieved under general circumstances, such as non-operative fields, non-obese donors, recovery surgeon experience, adequate first assistant availability (e.g. fellow, resident, student, or nurse), and recoveries which do not feature more than one surgical team attempting to work in the same space concurrently. Surgical complexity may necessarily lengthen organ recovery times and should be taken into consideration. Recovery teams should anticipate complications and send appropriately trained teams, particularly for DCD recoveries.

In the pages that follow, please find organ-specific recovery guidelines.

Kidney

Kidney recovery can be conducted in both donation after brain death (DBD) and DCD donors.

Initial Inspection (Communication, Photos)

- Any suspicious intra-corporeal masses, traumatic injury, hematoma, peritoneal fluid, or other concerning findings at recovery should be carefully documented.

Recovered Anatomy

Vessels

- Artery(ies) should include an aortic patch.
- Multiple arteries should be preserved on a common patch.
- Left renal vein should be divided at its origin, with a small patch of vena cava.
- The juxta-renal vena cava should be maintained intact with the right renal vein to allow for venous extension (cavoplasty).
- Aortic patch should be equally divided between two kidneys to provide adequate tissue for cannulation.
- In pediatric en bloc donors, the aortic and caval conduits should be divided with adequate length above and below the renal vessels.

Non-Vascular Structures

- Ureters should be divided as inferiorly in the pelvis as possible, leaving a maximum length with the kidney.
- A sheath of fibrofatty tissue should be left intact around ureters (e.g., they should not be “stripped”).

- Gerota's fascia should be cleaned from the upper and mid poles.
- Kidney biopsy sites should be closed by the recovery team, especially if kidneys will be placed on pump.
- Kidney biopsy should be done on the upper pole.
- Ureters should be tagged with appropriate laterality by the recovery team.

Communication

- The cold ischemic times allowable with kidney do not typically demand real-time communication between the recovering and accepting surgeons, but the following items should be well documented in the recovering OPO's anatomy report:
 - any deviations from the above expectations
 - multiple vessels or ureters
 - condition of the artery(ies) and aortic patch - plaque present whether plaque is soft or hard, extent of plaque, extension of plaque into artery(ies)
 - cysts, masses, tissue discolorations, evidence of poor flushing
 - any injury incurred during procurement.
- Verbal recovery surgeon to recipient surgeon communication may be requested by potential recipient centers in cases featuring unusual or incompletely documented anatomy.

Photo Documentation

- These images should be placed in the DonorNet chart:
 - anterior side of kidney graft
 - posterior side of kidney graft
 - intimal surface of aortic patch and origin of renal artery(ies)
 - any unusual finding, injury, or trauma.

Packaging / Delivery

- Pumped: care with arterial tissue handling and sterility should be assured when placing the kidney(s) on a pump.
- Not pumped: standard, UNOS-compliant, triple container cold storage should be utilized for shipping.

Suggested Ideal Recovery Times (Aortic Flush to Organ Removal)

	DBD donor	DCD donor
Kidneys alone	30 min	35 min

Pancreas

The need for pancreas recovery is less frequent and can be challenging due to fragility of the organ and a need for thorough understanding of the relevant anatomy.

Pancreas recovery can be conducted in both DBD and DCD donors.

If the pancreatic recovery is planned commensurately with a small bowel recovery, careful and ongoing communication needs to occur between the two recovery teams as the case progresses, particularly concerning the planned division point of the superior mesenteric artery.

Initial Inspection (Communication, Photos)

- Presence of any of the following should be communicated to the receiving surgeon upon initial visualization of the ventral aspect of the pancreas, and photos should be supplied upon request:
 - any suspicious intra-corporeal masses, traumatic injury, hematoma, or other concerning findings at recovery
 - fatty pancreas • edematous pancreas • woody / firm pancreas • any other anatomic abnormalities identified by the recovering surgeon
- Preferences for enteric lavage (betadine, amphotericin, nothing, etc.) should be established with the potential recipient center at the time of this initial communication.

Recovered Anatomy

Vessels

If liver is also being recovered:

- The splenic artery should be taken between 5-10mm from its celiac axis origin. Using delicate technique, it should be tagged with a small non-absorbable monofilament suture.
- The superior mesenteric artery (SMA) should include a small patch of aorta if there is known absence of a right replaced/accessory hepatic artery.
- The portal vein should be divided roughly 2cm cephalad to the superior mesenteric and splenic venous confluence (Suggested division between liver/pancreas allografts, at the level of the coronary vein)
 - Supply a unilateral common/internal/external iliac arterial “Y-graft” with the pancreatic graft. (Care to avoid traction injury at the bifurcation of the internal and external iliac arteries on the Y-graft)
 - Supply a unilateral common/internal/external iliac vein with the pancreatic graft.

- If the iliac vessels are compromised, this should be communicated in real-time to the potential recipient surgeon. An alternative vascular graft should be identified and recovered.
- The potential recipient centers' (liver and pancreas) wishes regarding flushing (or not) of the inferior mesenteric vein should be discussed.

If liver is not also being recovered:

- The splenic and superior mesenteric arteries may be provided intact on a common aortic patch.
- Supply bilateral common/internal/external iliac arterial "Y-grafts" with the pancreatic graft.
- Supply a unilateral common/internal/external iliac vein with the pancreatic graft.
- *The portal vein should not be unnecessarily manipulated during or after recovery.*
- Special attention should be paid to the origins of the renal arteries as they typically arise from the aorta adjacent to the SMA.

Non-Vascular Structures

- A layer of fibrofatty tissue should remain intact surrounding the glandular tissue.
- The spleen should remain attached to, and supplied with, the pancreatic tail.
- An extensive duodenal "C-loop" should be provided, extending from the distal antrum (proximal to pylorus) to the fourth part of the duodenum or very proximal jejunum. This will later be shortened at the discretion of the recipient surgeon.
- The root of mesentery should be stapled at the time of recovery with vascular loads taking care to stay far away from the pancreatic parenchyma.

Communication

- Any variance from above expectations, or abnormalities discovered subsequent to initial communication, should be reported by the recovering surgeon to the recipient surgeon in real time communication before the organ leaves the recovery OR.

Photo Documentation

- These images should be supplied to the potential recipient surgeon in real-time, upon request, in addition to permanent copies for the DonorNet chart:
 - Ventral surface of pancreatic graft
 - Dorsal surface of pancreatic graft

- o Iliac arterial Y graft and vein graft
- o Any unusual finding, injury or trauma.

Packaging / Delivery

- Standard, UNOS-compliant, triple container cold storage should be utilized for shipping.

Suggested Ideal Recovery Times (Aortic Flush to Organ Removal)

	DBD donor	DCD donor
Kidney& Pancreas only procurements	35-40 min	40 min

Liver

Liver is the second most commonly recovered organ after kidneys.

Liver recovery can be conducted in both DBD and DCD donors.

Initial Inspection (Communication, Photos)

- Presence of any of the following should be communicated to the receiving surgeon upon initial visualization, and photos should be supplied upon request:
 - any suspicious intra-corporeal masses, traumatic injury, hematoma or other concerning findings at recovery
 - fatty organ (identified upon appearance following digital palpation of the liver before cross clamp, or in cases of DCD recoveries, appearance following cross-clamp)
 - The potential recipient center may request a frozen section biopsy in the event of a fatty appearing liver.
 - nodular organ
 - any masses or focal hepatic lesions
 - cysts
 - unusually firm tissue texture
 - any other anatomic abnormalities identified by the recovering surgeon

Recovered Anatomy

Vessels

- Replaced or accessory arterial anatomy should be identified during the recovery, when practical.
 - A replaced or accessory left hepatic artery must be maintained intact with its celiac trunk origin. A 1-2cm stump of the left gastric artery should be left with the left hepatic artery at the former's division in such cases.
 - A replaced/accessory right hepatic artery must be maintained intact with its SMA trunk, and a patch of aorta supplied with that SMA trunk. This is negotiable in the setting of a pancreas or small intestinal donor to maximize utilization of all organs.

In cases where the donor and recipient surgeons feel comfortable dissecting out the hilar anatomy leading towards the SMA during the donor operation,

- the presence or absence of a right accessory or replaced may be definitively reported.
- In cases where either surgeon is not comfortable with this level of dissection, then the presence of a right accessory or replaced artery must be reported on the OPO anatomy report as unknown, but also must be assumed to exist. The course of a potential replaced right hepatic artery should be preserved, even in the absence of a palpable pulse. In these cases, the first 1-2cm of the SMA and a surrounding aortic patch should be supplied with the liver.
- Any other form of replaced arterial anatomy should be recovered in such a way that it can be traced, intact, back to a patch of aorta recovered with the liver graft.
 - Portal vein
 - If pancreas is being taken, the portal should be divided such that the pancreas gets roughly 2cm of the vein (Suggested landmark at the level of the coronary vein).
 - If pancreas is not being taken, the portal can be taken back to its origin at the splenic/superior mesenteric venous confluence. This will be shortened later by the transplanting surgeon.
 - The superior end of the vena cava should be left with a short cuff of vein above the diaphragm. In cases involving recovery of the heart, this may need to be discussed with the chest recovery team prior to cross clamp.
 - The inferior end of the vena cava should be divided shortly above the origin of the renal veins, typically so that the right adrenal vein remains on the liver's side. This allows for a cuff of cava with the liver that can be stapled or sutured closed for piggyback implantation while also allowing the kidney surgeon to extend the length of the right renal vein by transverse cavoplasty.
 - Supply complete and intact common/internal/external iliac venous and arterial grafts with the liver graft (unilateral if a pancreas is also being recovered, bilateral if not).
 - If iliac vessels are injured or clotted or if pancreas recovery is also performed, the liver team should be notified about the limited availability of vessels.

Non-Vascular Structures

- The supraduodenal common bile duct should be ligated distally and divided above the tie.
- The gallbladder should be incised and flushed with saline until the effluent coming from the divided CBD begins to clear.

Communication

- Any variance from above expectations, or abnormalities discovered subsequent to initial communication, should be reported by the recovering surgeon to the recipient surgeon in real time communication before the organ leaves the recovery OR.

- The liver recovery surgeon should be able to comment on the size of the graft. If requested by the recipient center, photos documenting dimension with a ruler overlying the liver should be supplied.

Photo Documentation

- These images should be supplied to the potential recipient surgeon in real-time, upon request, in addition to permanent copies for the DonorNet chart:
 - o Ventral surface of liver graft
 - o Dorsal surface of liver graft
 - o Iliac arterial Y graft and venous graft
 - o Any unusual finding, injury, or trauma.

Packaging / Delivery

- Standard, UNOS-compliant, triple container cold storage should be utilized for shipping.

Suggested Ideal Recovery Times (From Aortic flush to Organ Removal)

DBD donor	DCD donor
35-40 min	40 min

Small Intestine

Initial Inspection (Communication, Photos)

- Presence of any of the following should be communicated to the receiving surgeon upon initial visualization, and photos/videos should be supplied upon request:
 - any suspicious intra-corporeal masses, traumatic injury, hematoma or other concerning findings at recovery
 - edema of mesentery
 - edema of small bowel
 - cyanotic discoloration of bowel
 - absent or poor peristalsis.

Recovered Anatomy

Vessels

- **Liver being procured / Pancreas not being procured**
 - Include aortic patch around SMA. This is negotiable with the liver transplant team when there is a replaced or accessory right hepatic artery arising from the SMA to maximize utilization of all organs.
 - Include a short segment of portal vein.
 - Supply complete iliac and arterial “Y-grafts” with the bowel graft.
- **Liver being procured / Pancreas being procured**
 - Divide SMA and SMV just below pancreas (just below their first jejunal branches) and oversew or tie these vessels on the pancreatic side (also ligate lymphatics).
 - Supply complete iliac and arterial “Y-grafts” with the bowel graft.

Non-Vascular Structures

- **Liver being procured / Pancreas not being procured**
 - Staple divide jejunum close to ligament of Treitz.

- Staple divide colon at splenic flexure and take care to retain intact the vascular mesentery of the ascending and transverse colon.
- Divide pancreas at its neck.
- **Liver being procured / Pancreas being procured**
 - Staple divide jejunum near to ligament of Treitz (can keep whole duodenum and the first 10 cm of jejunum with the pancreatic graft).
 - Staple divide colon at splenic flexure and take care to retain intact the vascular mesentery of the ascending and transverse colon.

Communication

- Any variance from above expectations, or abnormalities discovered subsequent to initial communication, should be reported by the recovering surgeon to the recipient surgeon in real time communication before the organ leaves the recovery OR.

Photo Documentation

- These images should be supplied to the potential recipient surgeon in real-time, upon request, in addition to permanent copies for the DonorNet chart:
 - Frontal photo of the entire bowel graft
 - Photo of the SMA and SMV, clearly showing their length
 - Any unusual finding, injury, or trauma.

Packaging / Delivery

- Standard, UNOS-compliant, triple container cold storage should be utilized for shipping.
- Packed in sufficient extra solution in the bag that the bowel floats freely and does not freeze with the surrounding ice.

Suggested Ideal Recovery Times (From Aortic Flush to Organ Removal)

	DBD donor
Intestinal procurement only	30 minutes

Heart

In the United States DBD (donation after brain death), heart recovery is standardized, these guidelines endorse DBD heart procurement. In the United States, DCD (donation after cardiac death) heart procurement is not standardized and will not be discussed. (Of note, there are two types of DCD heart donation: 1) normothermic regional perfusion (NRP), and 2) ex-situ machine perfusion. In the United States, some centers have begun to trial either or both techniques for DCD heart transplantation. Briefly, DCD NRP, after the patient has passed the donor, oxygenated blood flow is quickly restored (i.e. through cardiopulmonary bypass or extra-corporeal membrane oxygenation (ECMO)) prior to donor procurement cardiectomy. DCD ex-situ machine perfusion, places the heart on machine perfusion after donor cardiectomy.) The committee does not currently endorse guidelines for DCD heart procurement.

Initial Inspection (Communication, Photos)

- Presence of any of the following should be communicated to the receiving surgeon upon initial visualization, and photos should be supplied upon request:
 - Any suspicious cysts, masses or other concerning findings at recovery
 - Anatomical abnormalities (i.e. palpation of CAD (coronary artery disease), aneurysms of the aorta, dilatation of the pulmonary artery, dilated right atrium and/or dilated right ventricle)
 - Central venous pressures (CVP), or right atrial pressures > 12 mmHg
 - New need for pressor or inotropic support or increased need for pressor or inotropic support
 - Persistent left superior vena cava
 - May need to check left atrial pressure
 - Any suspicious extra-cardiac masses, pericardial mass, traumatic injury, hematoma, or other concerning findings at recovery (intracardiac or other organs)
 - If another organ team is performing a biopsy concerning for malignancy
 - Check pulmonary artery pressures (when requested by the recipient's surgeon) to evaluate for pulmonary hypertension (direct pressure measurements)
 - Any other anatomic abnormalities identified by the recovering surgeon.

Recovered Anatomy

Vessels

- For some congenital transplant and/or LVAD (left ventricular assist device) to transplant cases – extra vessels may be necessary – including extra aorta, pulmonary arteries and/or innominate vein.
- The need for extra vessels may be difficult if a lung team is procuring the lungs and may not be possible if lungs are to be procured for extra pulmonary artery for example.

- If the liver is also being procured from the same donor, division of the inferior vena cava just below the right atrium, above the diaphragm.

- Where lungs are being recovered as well, the following should occur:
 - Pulmonary artery cannulation should occur as distally as possible.

 - Division of the pulmonary artery should begin at the site of pulmonary artery cannulation and should be as distal as possible without involving the bifurcation of the pulmonary artery.

 - Pulmonary vein division should be agreed upon by both teams and allow a rim of atrium to remain above the pulmonary veins for the lung team. A good landmark to begin with is a point halfway between the base of the left atrial appendage and the left superior pulmonary vein.

Non-Vascular Structures

- Not applicable

Communication

- Any variance from above expectations, or abnormalities discovered subsequent to initial communication, should be reported by the recovering surgeon to the recipient surgeon in real-time communication before the organ leaves the recovery OR

- communicate any of above mentioned issues

- if there is a lung team

- need for further testing (delays) by other teams

- potential video of the heart

- unusual finding, injury or trauma.

Photo Documentation

- Typically, the recovering surgeon is from the transplant center
- If a recovery surgeon, not from the transplant center is procuring, images and/or video of the heart should be provided to the potential recipient surgeon in real-time, upon request, in addition to permanent copies for the DonorNet chart:
 - Any unusual finding, anatomy, injury or trauma
 - Video of the heart demonstrating contractility
 - Anatomical variances.

Packaging / Delivery

- Standard, UNOS-compliant, should be utilized for transport and per institutional standards.

Suggested Ideal Recovery Times (From Aortic Flush to Organ Removal)

DBD donor	DCD donor
15 -20 min	Per center protocol

Lung

Lung recovery can be conducted in both DBD and DCD donors.

Initial Inspection (Communication, Photos)

- Presence of any of the following should be communicated to the receiving surgeon upon initial visualization, and photos should be supplied upon request:
 - Any suspicious or concerning findings at recovery (i.e., anatomical abnormalities, masses, cysts, trauma, persistence atelectasis that is not improved with lung recovery)
 - any suspicious parenchymal masses, traumatic injury, hematoma, or other concerning findings at recovery (thoracic or other organs) or if another organ team is performing a biopsy concerning for malignancy or any other anatomic abnormalities identified by the recovering surgeon
 - Bronchoscopy concerns – sloughing of the tracheal wall, intra-tracheal masses, bleeding, significant burn injury, infectious. etc, Perform bronchoalveolar lavage
 - Evaluate for emphysematous changes
 - Check pulmonary artery pressures (when requested by recipient’s surgeon) to evaluate for pulmonary hypertension (direct pressure measurements).

Recovered Anatomy

Vessels

- Where the heart is being recovered as well, the following should occur:
 - Pulmonary artery cannulation should occur as distally as possible, at an agreed upon location.
 - Division of the pulmonary artery should begin at the site of pulmonary artery cannulation and should be as distal as possible without involving the bifurcation of the pulmonary artery.
 - Pulmonary vein division should be agreed upon by both heart and lung teams and allow a small rim of atrium to remain above the pulmonary veins for the lung team. Suggested landmark is the point halfway between the base of the left atrial appendage and the left superior pulmonary vein.
- If lungs are split (right and left to different centers), the location for division must be mutually agreed upon by lung procurement teams (Suggested division: pulmonary artery division so the raphe goes with the left lung; bronchus division at the takeoff of the left main bronchus so the trachea goes with the right lung; left atrium divided in the middle with each center getting a similar amount).
- Need for extra pulmonary artery or veins.

Non-Vascular Structures

- Need for extra trachea

Communication

- Any variance from above expectations, or abnormalities discovered subsequent to initial communication, should be reported by the recovering surgeon to the recipient surgeon in real time communication before the organ leaves the recovery OR
- communicate any of above, mentioned issues
- if there is a heart team
- need for further testing (delays) by other teams
- potential video of the lungs inflating, video of bronchoscopy
- unusual finding, injury or trauma.

Photo Documentation

- Typically, the recovering surgeon is from the transplant center.
- If a recovery surgeon, not from the transplant center is procuring, images and/or video of the bronchoscopy or lung should be provided to the potential recipient surgeon in real-time, upon request, in addition to permanent copies for the DonorNet chart:
 - Any unusual finding, injury or trauma
 - Video of the bronchoscopy
 - Anatomical variances.

Packaging / Delivery

- Standard, UNOS-compliant, should be utilized for transport and per institutional standards.

Suggested Ideal Recovery Times (From Aortic Flush to Organ Removal)

DBD donor	DCD donor
30- 35min	Per center protocol

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