# Initial outcomes of using allografts from donation after cardiac death donors for liver transplantation in New South Wales

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## Abstract

**Objectives:** To report the early outcomes of the initial selection and use of donation after cardiac death (DCD) donor livers for transplantation in New South Wales, following a guidelines implementation process.

**Design and setting:** Review of database and medical records from the Australian National Liver Transplantation Unit and the NSW Organ and Tissue Donation Service for DCD activity including organ donor offers and retrievals, from 1 July 2007 to 31 December 2010.

**Main outcome measures:** Acceptance and utilisation rates of livers from DCD donors, and patient and graft outcomes after liver transplantation.

**Results:** Of the potential 84 DCD donor offers, 45 were declined, and 15 of the 39 attempted retrievals provided livers for transplantation. The most common reason for non-retrieval of the liver was the time to declaration of death exceeding 30 minutes after withdrawal of treatment (14 donors), followed by abnormality in the donor liver (eight donors). Data on early outcomes for liver transplant recipients showed a median peak aspartate aminotransferase of 3667 U/L (range, 919–11 264 U/L), but no delayed graft function. Four patients developed biliary complications (two within 3 months and two later). Patient and graft survival were 100% at a median follow-up of 15 months.

**Conclusions:** As a result of the re-establishment of multiorgan donation through the DCD pathway, 15 (18%) of the selected DCD donors provided livers for transplantation. Patient and graft survival rates were excellent, and the rate of intra- and postoperative complications was acceptable. Hence, the selective transplantation of DCD donor liver allografts will continue to be pursued and the outcomes followed.

Despite liver transplantation being an established treatment modality in Australia, there continues to be a significant disparity between donor liver availability and demand.[1] One way to reduce this gap is to maximise the use of extended-criteria deceased donor livers, with donation after cardiac death (DCD) being one such option.[2] However, the additional warm ischaemia time (WIT) incurred during the DCD donation process has led to a higher reported incidence of complications.[3,4]

Until recently, all deceased donor liver transplants in Australia were performed with liver allografts retrieved from donors after brain death. However, prior to brain death legislation being established within all jurisdictions, all the early experience in deceased donor organ transplantation was done solely with DCD renal allografts.[5] In New South Wales in the 1980s, when transplantation of the other solid organs became a reality with donation after brain death, the practice of DCD renal transplantation all but ceased. All the preliminary experience with liver transplantation in Europe and the United States was with the use of DCD liver allografts,[6,7] but the focus switched to donation after brain death after the recognition of brain death as an entity and the enactment of legislation.

With controlled DCD organ donation becoming re-established internationally in the 1990s,[8-10] reports then emerged of reasonable outcomes in renal followed by liver and then lung transplantation.[11-14] Hence, interest was rekindled in NSW with respect to the DCD pathway for organ donation. This culminated in the release of a jurisdictional policy guideline document by NSW Health in 2007, which also facilitated the development of collaborative multiorgan retrieval surgical protocols between the Australian National Liver Transplantation Unit (ANLTU) and the regional lung transplant unit for DCD donors.[15]

## Methods

Data collected prospectively from 1 July 2007 to 31 December 2010 were analysed. Donor data were obtained from the NSW Organ and Tissue Donation Service, while data on the acceptance and utilisation of the DCD livers for transplantation were obtained from the ANLTU database. Patient and graft outcomes data were also obtained from the ANLTU database, as well as hospital records, with a minimum of 6 months' recipient follow-up. The study was approved by the South Eastern Sydney and Illawarra Area Health Service and Sydney South West Area Health Service ethics review panels. Statistical analysis was performed with StatsDirect version 2.7.8 (StatsDirect).

### ANLTU protocol for liver retrieval from DCD donors

The ANLTU protocol based on international best practice is outlined in the Appendix (online at mja.com.au).[15-18]

### Selection of recipients

Before listing, all potential liver transplant recipients were evaluated by a multidisciplinary liver transplant team. Informed consent about the possibility of the use of a DCD liver allograft was obtained. Patients were accepted onto the liver transplant waiting list in accordance with the Transplantation Society of Australia and New Zealand consensus statement protocols.[19] Donor livers were preferentially allocated to recipients in

1 Rates of acceptance of and livers retrieved from donation after cardiac death donors

| Year | Donor offers | Non-acceptance of offer for liver transplantation | Livers retrieved for transplantation/ potential suitable donors |
|---|---|---|---|
| 2007 | 6 | 5 | 1/1 |
| 2008 | 16 | 8 | 2/8 |
| 2009 | 26 | 14 | 4/12 |
| 2010 | 36 | 18 | 8/18 |

whom the surgical hepatectomy was expected to be straightforward, in an attempt to limit the cold ischaemia time of the donor liver to less than 8 hours.[14]

### Liver transplant process

Liver transplantation was performed with standard operative techniques. A routine postimplantation postreperfusion biopsy sample of the liver was obtained for histological testing, including the grading of steatosis.[20] Recipients were managed postoperatively according to ANLTU protocols.

### Outcome measures

Data on the donors included donor demographics, underlying cause of death, and the outcomes of the donation and surgical retrieval process. Data on early outcomes (within the first 3 months) were obtained for 14 of the transplanted livers. This included liver allograft function and recipient intraoperative and postoperative course (including biliary and vascular complications). Late outcome data included significant recipient complications as well as recipient and graft survival. Primary non-function and initial poor graft function were defined according to previous publications.[20]

## Results

### Acceptance of donor offers for liver transplantation by the transplant team

The number of DCD offers steadily increased over the first 3.5 years as seen in Box 1, with acceptance rates being relatively consistent after the first year. Forty-five of 84 donor offers were not accepted mostly because the donor parameters fell outside of the ANLTU DCD acceptance criteria. The most common reason for non-acceptance was advanced donor age alone (21/45), followed by medical abnormalities combined with advanced donor age (12/45), isolated medical abnormalities (8/45), and other factors (4/45), including organisational logistics and withdrawal of consent for donation. However, thirty-five of these 45 potential DCD donors subsequently provided other organs for transplantation.

### Outcomes of the planned DCD surgical retrieval

Surgical retrieval teams travelled to donor hospitals of 39 potential DCD donors during the study period. The liver was successfully retrieved for subsequent transplantation in 15 of these donors. There was no difference in demographics between the donors where the liver was successfully able to be retrieved and the donors where it was not. The median γ-glutamyl transpeptidase level was higher in the donors where the liver was not retrieved (81 IU/L) compared with the donors where it was retrieved (47 IU/L).

For the DCD donors where the liver was successfully retrieved, the location of the potential donor at the time of withdrawal of treatment was within the intensive care unit (ICU) in 12 donors, and in the operating theatre complex for the remaining three. The median time from withdrawal of treatment to declaration of death was 11 minutes (range, 4–19 minutes). The subsequent median WIT was 26 minutes (range, 17–35 minutes). The most common reason for non-retrieval of the liver was that death did not occur within the predetermined time frame of less than 30 minutes (14/24 donors), followed by an abnormality detected in the donor liver (8/24 donors) and unforeseen issues with logistics (2/24 donors). Of the 39 donors where liver retrieval was attempted, 25 provided other organs for transplantation.

### Outcomes of DCD liver transplants

There were 13 adult and one paediatric recipients, with a median age of 57 years (range, 4–63 years). One donor liver was not used. All the recipients underwent primary liver transplantation. The paediatric recipient received an urgent transplant with a cutdown of a DCD donor liver. The underlying primary liver diseases were hepatitis C virus (six patients), postalcoholic cirrhosis (four patients), hepatocellular carcinoma (three patients) and fulminant hepatic failure (one patient). At the time when a potential donor was identified, 11 recipients were at home, two were hospitalised and the paediatric recipient was in the ICU. The median cold ischaemia time was 7.7 hours (range, 4.9–9.7 hours). The patient and graft outcomes are shown in Box 2, with a median patient follow-up period of 14.8 months (range, 4–39 months).

The early outcomes were favourable, with no primary non-function or significant initial poor graft function despite the peak serum aspartate aminotransferase levels. This was despite five allografts having moderate isolated microvesicular steatosis on

2 Patient and graft outcomes of donation after cardiac death liver transplantation

| Outcome | < 3 months after transplant | > 3 months after transplant |
|---|---|---|
| Early graft function | | |
| Median peak AST level (range) | 3667 IU/L (919–11 264 IU/L) | |
| Median AST level on Day 3 (range) | 371 IU/L (92–1375 IU/L) | |
| Biliary complications | | |
| Bile leak | 1/14 | — |
| Anastomotic stricture | 1/14 | 2/14 |
| Vascular complications | | |
| Portal vein thrombosis | 1/14 | — |
| Hepatic artery stenosis | 1/14 | — |

AST = aspartate aminotransferase. ◆

postreperfusion biopsy and one having moderate macrovesicular steatosis. The two vascular complications occurred within the first 3 months, and the hepatic artery stenosis was managed with percutaneous balloon dilatation on two occasions. The one case of early bile leak necessitated reoperation and revision of the biliary anastomosis. An anastomotic stricture of the Roux-en-Y was then diagnosed 3 months later, and corrected through endoscopic management (dilatation). The one patient with an early anastomotic biliary stricture underwent endoscopic retrograde cholangiopancreatography (ERCP) and stenting.

The two patients with anastomotic biliary stricture after 3 months required ERCP and stenting. For both patients, multiple ERCPs and stent changes have been required. In one patient there was also biliary sludge and stone formation. One of these two patients required no further stents after 13 months.

## Discussion

Since the re-establishment of organ donation through the DCD pathway in NSW, it has become possible to undertake liver transplantation with liver allografts from DCD donors. However, the relatively high rate of non-acceptance of DCD liver offers during the study period reflects the ANLTU acceptance criteria, which are based on known outcomes of DCD liver transplantation internationally.[4,21,22]

The high percentage of attempted donor retrievals resulting either in non-retrieval or discarding of the liver is consistent with the nature of the DCD process; additionally, in potential donors, death must occur within a short time frame such that the resulting WIT is less than 30 minutes.[3,14] The number of liver allografts discarded at the time of retrieval because of steatosis or perfusion abnormality is also consistent with other reported experience.[12]

The liver allograft outcomes are consistent with other reports including for the rate of biliary complications.[23] Although ischaemic cholangiopathy was not seen in this small series, this may reflect both the short follow-up period and the relatively small number of cases compared with other reported series.[3] The increased incidence of vascular complications including hepatic artery stenosis,[23] along with the increased requirement for retransplantation, was not seen in this initial experience with DCD liver allografts.[22]

As the results from the initial experience with the use of liver allografts from DCD donors have proven to be favourable, the ANLTU has made a decision to raise the upper age limit for potential donors to 50 years. As the utility of DCD organ donation remains limited, with only 18% of the donors providing liver allografts, the more common practice of obtaining liver allografts through donation after brain death appears to be a more resource-efficient option.

**Competing interests:** No relevant disclosures.

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