

Transplantation of Organs from Deceased Donors with Meningitis and Encephalitis: a UK Registry Analysis

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Running Title:

Meningitis/Encephalitis donors in the UK

Abbreviations:

M/E, Meningitis/Encephalitis; KME, Known Cause Meningitis/Encephalitis; UKME, Unknown Cause Meningitis/Encephalitis; DBD, donation after brain death; DCD, donation after circulatory death; SD, Standard Deviation; UK, United Kingdom; US, United States; UKTR, United Kingdom Transplant Registry; NHSBT, NHS Blood and Transplant; Potential Donor Audit, PDA; SaBTO, The Advisory Committee for the Safety of Blood, Tissues and Organs; BMI, Body Mass Index; SPK, Simultaneous Kidney Pancreas Transplant

Abstract

Deceased organ donors where the cause of death is meningitis or encephalitis are a potential concern because of the risks of transmission of a potentially fatal infection [to recipients](#). Using the UK Transplant Registry, a retrospective cohort analysis of deceased organ donors in the UK was undertaken to better understand the extent to which organs from deceased donors with meningitis and encephalitis (of both known and unknown cause) have been used for transplantation, and to determine the associated recipient outcomes. Between 2003 and 2015, 258 deceased donors with meningitis and encephalitis were identified and the causative agent was known in 188 (72.9%). These donors provided 899 solid organs for transplantation (455 kidneys and 444 other organs). The only recorded case of disease transmission was from a donor with encephalitis of unknown cause [at time of transplantation](#) who transmitted a fatal nematode infection to two kidney transplant recipients. [A further 3 patients \(2 liver and one heart recipient\) died within 30 days of transplantation from a neurological cause \(cerebrovascular accident\) with no suggestion of disease transmission.](#) Overall, patient and graft survival in recipients of organs from donors with meningitis and encephalitis were similar to those for all other types of deceased organ donor. Donors dying with meningitis and encephalitis represent a valuable source of organs for transplantation. The risk of disease transmission is low but where the causative agent is unknown caution is required.

Introduction

The demand for organs for transplantation far exceeds supply and increasing consideration is being given to the use of organs from sub-optimal donors, including those perceived to pose a potential increased risk of disease transmission to the recipient (1,2). Donors who have died as a result of meningitis or encephalitis are of potential concern because of the risk of transmitting life threatening meningitis or encephalitis to the immunocompromised recipient (2,3). This risk was highlighted by a recent case in the United Kingdom (UK) where an encephalitis of unknown cause was transmitted from the donor and killed both renal transplant recipients (4). Cases of meningitis and encephalitis transmission have been observed in the United States (US) and Europe, with the transmission often proving fatal (5-13). The risk of disease transmission needs to be evaluated and balanced against the potential benefit of providing additional donor organs for transplantation to the recipient population. UK guidelines from the Advisory Committee on the Safety of Blood, Tissues and Organs (SaBTO) (2011) state that 'Material from cases of meningo-encephalitis for which no infection is identified should not be used for donation'. The guidelines also state that 'if there is any possibility of acquisition of a neurotropic infection from abroad the donation is contraindicated owing to the risk of rabies, West Nile virus or other exotic neurotropic infections'. However, there is a caveat in the guidance that recognises there may be a clinical need for transplantation of such urgency that it is appropriate to consider the use of organs and tissues for life-preserving purposes from donors who would not otherwise be considered eligible to donate, due to a known or perceived risk of disease transmission (14). SaBTO guidance also states that 'if bacterial meningitis has been confirmed, but there is no visible damage or local infection in the organ or tissues required at retrieval, the donation of the organs,

tissues and cells are acceptable' for transplantation (14).

US guidance (2013) also states that donors dying of encephalitis without a proven cause should likely be avoided' (15). The UK and US guidance is mirrored by that from the Council of Europe (2015), which states that 'if the aetiology of an active infection cannot be established the donor is not a suitable candidate for donation'(16).

Despite current guidance, organs from donors where the cause of meningitis and encephalitis is not known continue to be used for transplantation, as clinicians balance the risk of donor transmitted disease against the risk of death on the waiting list whilst awaiting a graft. In this study we reviewed the UK experience, to better understand the extent to which organs from deceased donors with meningitis or encephalitis (of both known and unknown cause) have been used for transplantation, and to determine the associated recipient outcomes.

Methods

Identification of deceased donors who died of Meningitis and Encephalitis

The UK Transplant Registry (UKTR) held by NHSBT was examined to identify deceased donors between 1st January 2003 and 31st December 2014, where the cause of death was meningitis and/or encephalitis, and who donated one or more organs for transplantation. All UK deceased donors whose cause of death was coded in the UKTR as 'meningitis' were readily identified. However, the designated codes for cause of death in the UKTR are limited to any one of 65 possible causes and there is no code for encephalitis on the registry currently, leaving the data entry team the option of coding cases of encephalitis as 'meningitis', 'infection-type unclassified', 'other', 'other-please specify' and 'unknown' and using the free text entry to specify

encephalitis as the cause of death. All free text entries in the registry for donors whose primary cause of death was coded as ‘meningitis,’ were fully reviewed to identify if the infection had been recorded as viral, bacterial, was not known or was unstated, and whether the causal infectious agent had been recorded. For deaths coded as ‘infection-type unclassified’, ‘other’, ‘other-please specify’ and ‘unknown’, free text entries were searched using the search terms ‘Meningitis’, ‘Encephalitis’, ‘Meningo-encephalitis’, and common misspellings of these terms to identify any additional donors where the cause of death was meningitis/encephalitis and to find whether the causal agent had been identified. The information on organ donors entered into the UKTR is that entered at time of donation, and any subsequent changes in cause of death or in causative agent for meningitis or encephalitis are relayed to the recipient centres but not changed on the registry.

Identification of potential donors who died of Meningitis or Encephalitis

The Potential Donor Audit (PDA), held by NHSBT, is a prospectively collected registry of all patients aged less than 80 years who died in critical care units of all acute hospitals in the UK. The PDA inclusion criteria changed over the study period, with the upper age limit increasing from 75 to 80 years in 2013. From 2013, cardiothoracic intensive care units were also included in the audit. In 2009, the PDA changed the wording of the questions being asked and allowed more reasons to be given for why potential donors did not become solid organ donors. The PDA was examined to identify all non-proceeding potential donors who died of meningitis or encephalitis over the study period. Potential organ donors were identified in the same way as those in the UKTR, with cause of death coding supplemented by free-text searches.

Identification of recipients who received organs from donors who died of known and unknown causes of meningitis and encephalitis

Recipients of organs from donors who died of known and unknown causes of meningitis/encephalitis in the UK between 1st January 2003 and 31st December 2014 were identified using the UKTR. Information on recipient survival and death censored graft survival was extracted from the UKTR.

Prior to 2010, recipient centres were expected, according to UK guidance, to report any adverse outcomes in recipients relating directly to the organ donation process to NHS Blood and Transplant (NHSBT), including, in the case of donors with meningitis/encephalitis, transmission of the causal agent. This reporting requirement became mandatory when the new European Union Organ Donation Directive (EUODD) guidelines came into effect (2010) and was written into UK law in the Quality and Safety of Organs for Transplantation Regulations (2012).

Statistical Analysis

Principal univariate analyses reported deceased donor and recipient characteristics by donor meningitis and encephalitis status (known cause meningitis and encephalitis (KME), unknown cause meningitis and encephalitis (UKME), other) using percentages, means or median and standard deviations or interquartile ranges as appropriate. Univariate analysis was carried out using t-test for continuous data. Comparisons between groups were made using χ^2 -tests for categorical data, and unpaired difference tests for continuous data (one-way ANOVA if normality can be assumed, Kruskal-Wallis test otherwise).

Kaplan-Meier curves were used to compare death-censored graft survival and patient survival across donor cause of death groups. The univariate log-rank test was used to calculate p-values from this.

All analyses were performed using Statistical Analysis System (SAS) (version 9.3) and P-values less than 0.05 were deemed to be statistically significant (17). Human Leukocyte Antigen (HLA) mismatch level was defined according to UK allocation policy for kidneys from brain-death donors and was based on the mismatch between donor and recipient at the HLA-A, -B, and -DR loci: level 1 was a 0/0 HLA-A, -B, and -DR mismatch; level 2 was a 0 HLA-DR plus 0/1 HLA-B mismatch; level 3 was a 0 HLA-DR plus 2 HLA-B mismatch or a 1 HLA-DR plus 0/1 HLA-B mismatch; and level 4 was a 2 HLA-DR or a 1 HLA-DR plus 2 HLA-B mismatch' (18). The United Kingdom Model for End-Stage Liver Disease (UKELD) score was used when assessing differences in liver recipient characteristics. This score is calculated based on the patient's international normalized ratio (INR), serum creatinine, serum bilirubin, and serum sodium (19).

Results

Identification of donors who died from meningitis or encephalitis

A total of 258 (2.4%) of the 11,530 deceased donors, who donated one or more organs for transplantation, were identified as having died of a meningitis or encephalitis over the 12 year study period. Of the 258 organ donors identified, 214 (1.9%) were directly coded by the UKTR as having died of meningitis (figure1). A further 44 donors were not coded as meningitis but it was clear from free text entries that they had died of meningitis or encephalitis/meningo-encephalitis. Further analysis of free text entries in the UKTR for these donors showed that 221 (85.7%)

had meningitis and the remaining 37 (14.3%) had encephalitis or meningo-encephalitis.

There were 221 organ donors who died from meningitis of which 169 (76.5%) had a bacterial cause, 2 (1.4%) a viral cause. In 43 (19.5%) of cases the aetiology of the meningitis was unknown and in 7 (3.2%) it was unstated (figure 1). Thirty-seven donors died from encephalitis and/or meningo-encephalitis, for which a bacterial cause was thought to be responsible in 11 (29.7%), a viral cause in 6 (16.2%) and in 20 (54.1%) of cases, the cause was unknown. Where the cause of meningitis or encephalitis was known, the causative infectious organism was stated in 63% of meningitides and 19% of encephalitides (Table 1). Most of the bacterial meningitides were attributed to a streptococcal or meningococcal cause.

The UK Potential Donor Audit was scrutinized to identify potential organ donors aged less than 80 years with meningitis or encephalitis that did not proceed to organ donation and therefore were not entered on the organ donor transplant registry.

Over the 12-year study period, a total of 692 non-proceeding potential organ donors died of meningitis/encephalitis and did not donate organs for transplantation. Of these potential donors, 84 (12%) had encephalitis and 608 (88%) had meningitis.

Information recorded in the PDA regarding diagnosis was limited, but manual review of the free text entries revealed that 38 non-proceeding potential donors had meningitis of unknown aetiology at time of death, 35 had a bacterial cause of for meningitis, and one had viral meningitis. The majority of non-proceeding potential donors did not have a causative agent stated for their meningitis. Of those non-proceeding potential donors with encephalitis, 25 had viral encephalitis, 22 had encephalitis of unknown aetiology and 4 had a bacterial cause. Again the majority of

non-proceeding potential donors did not have a causative agent for their encephalitis stated.

Whereas the number of potential donors who died of meningitis or encephalitis was greater in the latter part of the [12-year](#) study period, the number of actual organ donors dying of meningitis or encephalitis remained relatively constant throughout the study period (figure 2). Clinical details entered in the potential donor audit of why potential donors did not proceed to organ donation were limited. However, analysis of the reasons coded in the database or available in free text entries indicated that 112 (18.7%) of the 692 potential organ donors were declined based on their cause of death i.e. meningitis and encephalitis.

Characteristics of donors who died of meningitis and encephalitis

The clinical characteristics of the 221 organ donors with meningitis and the 37 donors with encephalitis were very similar and were, therefore, combined and compared to those donors who died of all other causes during the study period (Table 2). Organ donors who died of meningitis or encephalitis were younger and more often donation after brain death (DBD) than donation after circulatory death (DCD) donors. They also, on average, donated more organs and more of the donated organs were transplanted. Overall, donors with meningitis or encephalitis had a lower body mass index (BMI), a lower incidence of hypertension and of cardiac disease, and were less often smokers.

Characteristics of recipients receiving organs from donors who died of meningitis and encephalitis

The 258 organ donors with meningitis and encephalitis provided a total of 899 solid organs that were transplanted. These included 455 kidneys, 237 livers, 71 hearts, 44 lungs, 7 heart and lung, 72 pancreas glands and 13 other solid organ transplants. The types of organs transplanted were similar in deceased donors with known and unknown causes of meningitis and encephalitis (data not shown).

Kidney Transplant Recipients

UK centres transplanted a total of 455 kidneys from donors who died of known and unknown causes of meningitis and encephalitis. All 24 UK transplant centres accepted kidneys from donors with both KME and UKME (figure 3). Over the entire study period, these comprised 1-11% of the total number of renal transplants performed (figure 3). There was no clear relationship between the volume of transplant activity at a particular transplant centre and the proportion of transplants performed using kidneys from donors with KME and UKME. The clinical characteristics of recipients who received kidneys from donors who died with an unknown cause and those with a known cause (bacterial or viral) of meningitis or encephalitis are shown separately and are compared with the recipients of organs from donors without meningitis or encephalitis (Table 3). There were no major clinical differences between recipients who received kidneys from donors who died of known and unknown causes of meningitis and encephalitis. Overall recipients who received kidneys from donors with meningitis or encephalitis were markedly younger than those who received kidneys from deceased donors who died from other causes.

The recipients of kidneys from donors with UKME and KME received kidneys, which had a better HLA-match than those from donors who died from other causes.

Liver Transplant Recipients

The clinical characteristics of the 237 liver transplant recipients who received livers from organ donors with KME and UKME are shown in supplementary table 1 along with the characteristics of recipients of livers from donors who died of all other causes. The recipients of livers from KME donors and UKME donors were significantly younger than recipients of livers from donors who died of all other causes. Livers from UKME donors were more frequently allocated to recipients on the super-urgent waiting list (the most urgent category).

Heart Transplant Recipients

Over the study period 71 hearts were transplanted from donors who died of meningitis and encephalitis (supplementary table 2). Recipients from donors who died of meningitis/encephalitis were younger, and were much more likely to require a heart urgently in comparison to recipients of hearts from donors who died of all other causes (supplementary table 2).

Recipient outcomes after transplantation

Of the 899 recipients who received transplants from donors with UKME and KME there were 2 early deaths attributable to donor transmission of encephalitis. The donor was a 39-year-old male who died in hospital with a meningo-encephalitis of unknown aetiology. The renal recipients, males aged 67 and 42, died of encephalitis 17 days and 19 days respectively following transplantation. On post-mortem examination, the

transmitted organism was found to be the nematode infection *Halicephalobus gingivalis*. It is the first documented UK case and first documented human-to-human transmission of this organism, and the 6th, 7th and 8th documented cases of human infection. The UKTR did not include any other reports of death, graft loss or major morbidity secondary to disease transmission from any of the other donors with

UKME or KME. Only one other of the 455 recipients of kidneys from donors with UKME or KME died within 30 days of transplantation, and death in this case was attributed to cardiovascular disease, giving a thirty day mortality of 0.7%, which is similar to the thirty-day mortality in renal transplant recipients who received kidneys from donors who died of all other causes (153 deaths in 19,095 recipients (0.8%)). In the 444 recipients of non-renal organs from donors with UKME and KME, there were 14 deaths within 30 days (3.2% 30 day mortality rate vs. 3.7% in recipients of organs from donors without UKME or KME), of which 3 deaths were attributed to a neurological cause and in all of these this was a cerebrovascular accident (CVA). Of the three deaths from CVA, one recipient died of an ischemic stroke 11 days after receiving a liver from a donor with an unknown cause of encephalitis who also donated 2 kidneys for transplantation, one recipient died of a stroke (type unstated) 28 days after receiving a liver from a donor with a unknown cause of meningitis who also donated 2 kidneys for transplantation, and one recipient died of a haemorrhagic stroke 12 days after receiving a heart from a donor with *E.coli* meningitis who donated 2 kidneys and a liver for transplantation. In none of these three patients was any mention made in the free text entries to suggest the CVAs were in any way related to the transmission of infection.

Overall patient survival was significantly better in recipients of kidneys from donors with KME (p=0.002). After adjustment using cox proportional hazard model the

survival advantage was secondary to lower donor age, lower recipient age, a greater proportion being DBD donors and the donors possessing fewer comorbidities ($p=0.06$) (data not shown). Death censored graft survival for recipients of kidneys from donors with KME was greater than that for recipients of kidneys from donors who died of any other cause of death, but this difference failed to reach statistical significance (Figure 4). Patient and graft survival was similar for kidney recipients from UKME donors and recipients from donors who died from other causes. Death Censored graft survival and patient survival were comparable for heart and liver recipients from UKME and KME donors when compared to all other cause of death heart and liver transplant recipients (Figure 5 and supplementary figure 1).

Discussion

The present UK registry analysis was undertaken to determine the extent to which organs from deceased donors who died of meningitis or encephalitis were transplanted in the UK, and to determine the outcome of recipients who received such organs. Over the 12-year study period, a total of 899 organs were transplanted from 258 donors who died of meningitis or encephalitis. The number of actual organ donors who died of meningitis or encephalitis over the 12-year study period remained relatively constant, and all UK transplant units accepted organs from such donors for transplantation. In the case of kidney transplants, there was evidence that the threshold for accepting kidneys from donors who died of meningitis or encephalitis varied between centres, but such variability did not correlate with [the](#) volume of transplant activity undertaken by the centre.

While donors with meningitis or encephalitis comprised only a small proportion (2.3%) of the total number of deceased organ donors over the study period, they made

an important contribution to transplant activity, leading to 455 kidney transplants and 444 non-renal transplants. Moreover, such donors tended to be younger with favourable donor characteristics and overall they donated more organs per donor. The majority (66%) of the entire donor cohort in this analysis who died of meningitis had a known cause of meningitis and therefore the use of their organs for transplantation was not, according to current UK guidelines, contraindicated. Nevertheless a large number (34%) of those who donated organs died of an unknown or unstated cause of meningitis or encephalitis. Use of organs from such donors is cautioned in the UK guidelines, although it is recognised that their use in life saving situations may be appropriate. In the present study, donors with an unknown cause of meningo-encephalitis donated not only life saving organs but most (91%) donated at least one kidney for transplantation. We cannot exclude the possibility that, at least in some of these donors, additional [reassuring](#) clinical information relating to the aetiology of the meningo-encephalitis ([e.g. expert opinion suspecting a bacterial cause that could not be proven](#)) may have been made available to the transplanting centres, but was not recorded in the registry.

In the present study, there was no recorded incidence of transmission of the causative agent for meningitis or encephalitis from any of the donors where the causative agent was identified prior to donation. [It is important to appreciate that clinical decision making informed the use of organs from donors with meningitis or encephalitis/meningo-encephalitis](#) and it cannot be assumed that if organs from the potential, rather than actual, organ donors with a known cause of meningitis had been used that they also would not have posed a risk of disease transmission. One (2.7%) of the 37 organ donors with encephalitis (representing one (5%) of the 20 organ donors with an unknown cause of their encephalitis) transmitted infection to two renal

allograft recipients. In both cases the transmitted infection, which was subsequently shown to be the nematode *H.gingivalis*, was fatal. There were no other recorded cases of disease transmission for patients who died of an unknown cause of meningitis and encephalitis. Overall, recipients of organs from donors who died as a result of a meningitis or encephalitis (known or unknown causes) had similar patient and graft survival to that observed in recipients of organs from donors who died from other causes. Where a bacterial cause of donor meningitis or encephalitis/ meningo-encephalitis was identified, this information would have been available to the recipient transplant centres and it is likely that most, if not all, recipients of such organs would have received prophylactic antibiotic treatment in keeping with clinical guidelines.

The number of actual organ donors with meningitis or encephalitis was around a third of the number of potential donors identified from the UK potential donor audit dying with meningitis or encephalitis but whose organs were not used for transplantation. This figure is considerably higher than the overall percentage of actual to potential organ donors identified from the UK potential donor audit (20). Unfortunately, the data available in the UK PDA was not sufficiently detailed to allow us to determine precisely why potential donors with meningitis and encephalitis did not proceed to become actual organ donors, but in at least 18.7% of cases the reason cited was the underlying cause of death, and presumably concern by recipient centres about disease transmission. However, it is impossible to estimate how many of these unused potential organ donors could have transmitted a fatal disease to recipients, and hence how many potential lives were saved through not using these organs for transplantation.

The findings arising from the present analysis may allow clinicians at transplanting centres to make a more informed decision about the risks of disease transmission when considering the use of organs from potential donors with meningitis and encephalitis. The decision to transplant an organ from a donor with meningitis and/or encephalitis, especially where the cause is unknown, should be taken after fully informing the potential recipient of the associated risks.

There are several published case studies, that describe examples of donor-derived infection causing meningitis and encephalitis in transplant recipients (5-13). A wide range of pathogens responsible for such disease transmission have been implicated and often it had not been clear before organ transplantation that the donors had meningitis and encephalitis (5-13). An emerging concern in the US is the transmission of West Nile Virus (WNV) from affected donors to transplant recipients, which has been seen in 8 different clusters. Transmission of Lymphocytic Choriomeningitis Virus (LCMV), Balamuthia Mandirallis and Rabies have also been reported (5-13). In the clusters of donor derived infection of meningitis and encephalitis, a wide variety of causes of death of the donors were reported, ranging from urinary tract infection, diabetic ketoacidosis, trauma and stroke (5,9-11,21,22). The current literature suggests that the risk of donor transmission of meningitis and encephalitis is omnipresent and exclusion of such donors, who are often relatively young and previously healthy, would not fully address this risk because, in reported cases, the cause of donor death was not always known to be meningitis and encephalitis. It was not possible from the analysis undertaken for the present study to determine the number of donors with unrecognized meningitis or encephalitis.

There are also other limitations to the present study; encephalitis and meningo-encephalitis were not specifically coded as a cause of death in the UKTR. Nor are the

definitions made clear so there may have been some lack of consistency and accuracy between the diagnosis of encephalitis, meningitis and meningo-encephalitis. There is a possibility that the numbers quoted in this paper are an underestimate of those who died from these causes. Attempts were made to minimize this possibility by using multiple search terms (and common misspellings of these), and careful review of the free text entries. There is a possibility that cases of disease transmission from donors with meningitis or encephalitis were not reported to NHSBT, as the reporting requirement only became part of UK law in 2012. However, over the entire study period NHSBT has had close oversight of all UK transplant units and it is very unlikely that any transmission of meningitis or encephalitis occurred without NHSBT being made aware of this. Moreover analysis of the causes of death in the 14 patients who died within 30 days after receiving organs from donors with UKME or KME showed that only 3 were listed as dying from neurological cause (all CVA), and in none of these was infection noted as a contributory cause of death. A further limitation of this analysis is its applicability to the wider global transplant community. Given the relatively limited geographical area of the UK there is limited variation in infectious pathogens. Hence, in other much larger countries, such as the US, where different infectious agents vary geographically and by time of year, additional consideration should be given to the risk that donors with meningitis or encephalitis may pose and what organism could be causing there illness.

Conclusion

Organ donors who die from meningitis and encephalitis represent a relatively small but important cohort of donor organs. In donors where the causative agent of meningitis is known to be bacterial, the risk of disease transmission is very low, although it is important to ensure that recipients of organs from such donors receive appropriate prophylactic anti-microbial therapy. For organs where the causative agent is not known, the risk of disease transmission is greater, and more caution should be exercised in the use of such organs, as highlighted in various clinical guidelines. The risk of potentially fatal disease transmission should, however, be balanced against the clinical benefit of an organ transplant and the present study provides national data that may help guide this decision.

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Disclosure

The authors of this manuscript have no conflicts of interest to disclose as described by the Journal Transplant Infectious Diseases.

Figure Legend

Figure 1. Figure 1: Flow diagram for organ donors identified as dying from meningitis/encephalitis'

Figure 2. The number of non-proceeding potential organ donors with meningitis and encephalitis and, the number of actual organ donors with meningitis and encephalitis

Figure 3 .Total number of deceased donor kidneys transplanted in UK renal transplant centres (designated A-X) from the 1st of January 2003 to 1st of January 2015.

Figure 4. Graft and Patient Survival for recipients of kidneys from organ donors who died of known and unknown causes of meningitis and encephalitis, and organ donors who died from all other causes

Figure 5. Graft and Patient Survival for recipients of livers from organ donors who died of unknown and known causes of meningitis and encephalitis, and organ donors who died from all other causes

Supplementary Figure 1. Graft and Patient Survival for recipients of hearts from organ donors who died of unknown and known causes of meningitis and encephalitis, and organ donors who died of all other causes

Table 1. Causal infectious agents in organ donors who died from meningitis and encephalitis

Table 2. Clinical characteristics of organ donors who died of known and unknown causes of meningitis and encephalitis and donors who died from all other causes

Table 3. Clinical characteristics of kidney transplant recipients from organ donors who died of known and unknown causes of meningitis and encephalitis, and from donors who died of all other causes.

Supplementary table 1. Clinical characteristics of liver transplant recipients from organ donors who died of known and unknown causes of meningitis and encephalitis, and from donors who died of all other causes

Supplementary table 2. Clinical characteristics of heart transplant recipients from organ donors who died of known and unknown causes of meningitis and encephalitis, and from donors who died of all other causes

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