Conference paper

Current surgical challenges to an effective and practical use of thoracic organs for transplantation

Espeed Khoshbin*

Royal Brompton & Harefield Hospitals, UK

*E.Khoshbin@rbht.nhs.uk

Abstract

A strategic document entitled Taking Organ Transplantation to 2020 was published in the United Kingdom (UK) by The National Health Service Blood and Transplant (NHSBT) with the aim to enable the UK to match world-class performance in organ donation and transplantation. Its goals were to: Increase the rate of deceased donors per million population, increase organ utilisation rate and hence Increase the rate of deceased donor transplant rate (1).

The definition of organ utilisation according to the NHS BT is 'the action of making ***effective*** and ***practical*** use of organs from identified potential deceased donors' (2).

This editorial reflects the surgical opinions as to the current challenges we face in the UKs thoracic organ transplantation and how organ utilisation may be improved by effective and practical use of organs.

Effective use of organs

If you are effective, you are successfully producing a desired or intended outcome. In transplantation this is through saving lives, relieving symptoms, improving life expectancy and quality of life. This may be achieved through increasing the number of organs transplanted, however the desired outcome is only achieved if the quality of life is restored after transplantation. The likelihood of such outcome will depend on the choice of donor organ, characteristics of the recipient, and through good surgical practice by attention to details. In other words, good donor, good recipient and good surgery equates to good outcome. A phenomenon the author calls lining up the moons. However, there are important practical challenges that need to be overcome to improve organ utilisation.

Practical challenges

Donation

Since the introduction of Max and Keira's law, also known as the Organ Donation Act (Deemed Consent), that went into effect in England on May 20, 2020 (3), adults in England are presumed to agree to donate their organs when they die, unless they opt out in advance. Unfortunately, the implementation of this law coincided with the COVID-19 pandemic which had a negative impact

on the organ donation campaign (4) (5). Nevertheless, there has been an increase in the number of organs referred.

On average a thoracic transplant unit may receive close to a thousand donor referrals each year. However, only a small fraction of that is still utilized (about 6 % according to a local audit). Referrals are turned down for three categories of reasons: Donor past medical history/poor function (PMH/PF), no suitable recipient (NSR), or for logistics restrictions (LR). If a centre declines an organ, it may be utilised by another transplant centre with a suitable recipient, more urgent patient or a recipient higher in the list of priority in the national super urgent waiting list. But when a unit turns down an organ for PMH/PF it is most often turned down by all other centres for obvious reasons. Occasionally an organ tuned down for function by one centre is used successfully by another. This is a potential point for reflection as there may be a learning point that could lead to a positive change in practice. This is a matter for debate at the local donor audit / organ utilisation meeting.

Organ selection

New online services such as the Transplant Path (TP) used by NHS BT have made communication between the transplanting team, national organ retrieval service (NORS) and specialist nurses in organ donation (SNOD) more streamlined (2). Donor information can be constantly updated with new investigations and even images of the organs themselves. However, this system is only as good as the information available to it. Lack of agreement on what are essential investigations in thoracic organ donation creates challenges for efficiency in organ selection. For example, assessment of donor coronary artery disease in the UK remains primitive (6) (7). This assessment is made during the last stage of retrieval by finger palpation of the donor coronary artery, whereas a coronary angiogram at the start of referral would save time and resources that could be directed towards better use of resources. Differentiation between lung consolidation and reversible atelectasis is another challenge. This could be examined using appropriate imaging techniques such as high-resolution thoracic CT or potentially thoracic ultrasound (8) (9).

Donor procurement

The introduction of abdominal NRP (normothermic regional perfusion) to better preserve abdominal organs during a multi visceral donation has led to further complexity in thoracic organ procurement and a fall in the number of lungs procured (10). Collateral venous circulation at the time of the abdominal NRP has led to gross pulmonary congestion and loss of lungs (11). Only a hand full of retrieval surgeons have mastered the art of lung procurement in the presence of abdominal NRP.

Organ preservation- In the last decade we have witnessed an increased complexity of donor preservation. The introduction of the organ care system (OCS™) by TransMedics ^{LTD} initially facilitated longer organ preservation by reducing cold ischaemia. Since then OCS has now been used to assess hearts after DCD (Donation after Circulatory Death) donation (12) (13). Not all UK centres are trained in DCD heart donation. DCD donation without a doubt has increased the availability and utilisation of thoracic organs (14). However, there is increased reports of potentially brain stem dead patients being offered as DCD for lack of physicians to perform brain stem death testing. This would expose hearts to an unnecessary period of warm ischaemia on top of the neuro-hormonal effects of brain death on the retrieved organ and cost implications of using the OCS (15).

Geographic arrangements

The change in the on-call pattern of the NORS teams where at every one time there are only three adult and one paediatric retrieval team covering the whole of the UK has caused controversy regarding the cost vs. benefits of such a system and the time and money spent traveling longer distances potentially using expensive aircrafts (2). Units are generally more familiar with the work of their own retrieval team and express a sense of trust for their own retrieval surgeon's opinion (2). Having said that many countries are beginning to adapt a process or central hub for retrieval of organs which may be couriered to any geographic destination through an efficient transport network (2).

Timing of retrieval

The DOH and NHS BT has planned to streamline organ transplantation in the UK making it more efficient by prior planning making organ implantation a daytime sport. The Sustainability and Certainty in Organ Retrieval (SCORE) programme will no doubt have advantages. Organ retrieval will occur mainly over night when there is more theatre availability and implantation during the day with its advantages for the recipient. The implantation would be performed by a well-rested team and the patient arrives in the intensive care unit (ICU) in daytime hours for the ICU team to make the crucial metabolic and physiologic adjustments. This would facilitate organ allocation and multidisciplinary assessment of donors and recipient selection hence sharing the burden of responsibility. There is however the challenge of coordinating every unit in the UK to simultaneously accept organs within a very short window. Much of the practical challenges with implementation of SCORE need resolving.

Transplantation

Recipient landscape

Following the introduction of the Kaftrio, cystic fibrosis (CF) "miracle drug" the number of patients requiring lung transplantation for CF dramatically decreased (16). This was welcome news for the CF sufferers and reduced lung transplant activity over night. Industrial precautions and secondary prevention campaigns have also reduced the prevalence of end stage heart and lung disease. Although this has reduced the recipient pool it is an opportunity to identify patients that otherwise would not have been referred for transplant assessment through education of primary and secondary care physicians.

Recipient pool

There is also a need to educate or change the perception of recipients to reduce number of restrictions on the type of donors they are prepared to accept. For example, donors of the opposite sex, smokers, drug users or based on their sexual orientation. Donors with Hepatitic C are no longer contraindicated, however recipients will need to be appropriately counselled and consented for the use of these organs (17).

Bridging to transplantation

Our success in bridging patients to transplantation using temporary mechanical support has increased the demand-on intensive care resources (18) (19). There are a variety of temporary extra-corporeal cardiopulmonary support systems, such as extra-corporeal membrane oxygenation (ECMO), Uni and biventricular assist devices (BIVAD) with or without lung support and combined

modalities such as combination of ECMO and Impella. These patients may then satisfy the criteria for super urgent listing. On average patients wait more than one month on the super urgent list depending on their size and blood group (18). There is an additional period of prehabilitation before and rehabilitation after transplant that requires intensive care expertise and resources.

Simultaneous organ implantation

One of the other logistic issues in transplantation is the lack of resources to conduct simultaneous or overlapping implantation of organs in a cardiothoracic setting. There is a relative lack of staff such as perfusionists or out of hours anaesthetists. Adjuncts such as the OCS technologies, Ex vivo lung perfusion (EVLP) and others such as the 10° C fridge may facilitate a delay to enable a second transplant to be accommodated. However, unless there are more resources allocated, logistic challenges will remain an issue. There is also the reality that an organ turned down by one for logistic reasons may be used by another centre.

Increased surgical complexity

There have been progressive changes in terms of increased complexity of the recipient pool. Children with congenital anomalies are living into their adulthood and this survival success has increased the burden of complex patients with adult congenital diseases needing transplantation (20). An increased number of patients bridged to transplantation with a durable left ventricular assist device (LVAD) has significantly increased the demand for surgical expertise (21). As most heart transplants currently occur outside daytime hours, performing complex redo transplantation poses increased risks for the patient, and stress on the implanting team necessitating a need for dual consultant operating. As the number of experienced transplant surgeons is in decline this also will pose a logistic challenge.

Improving donor utilisation

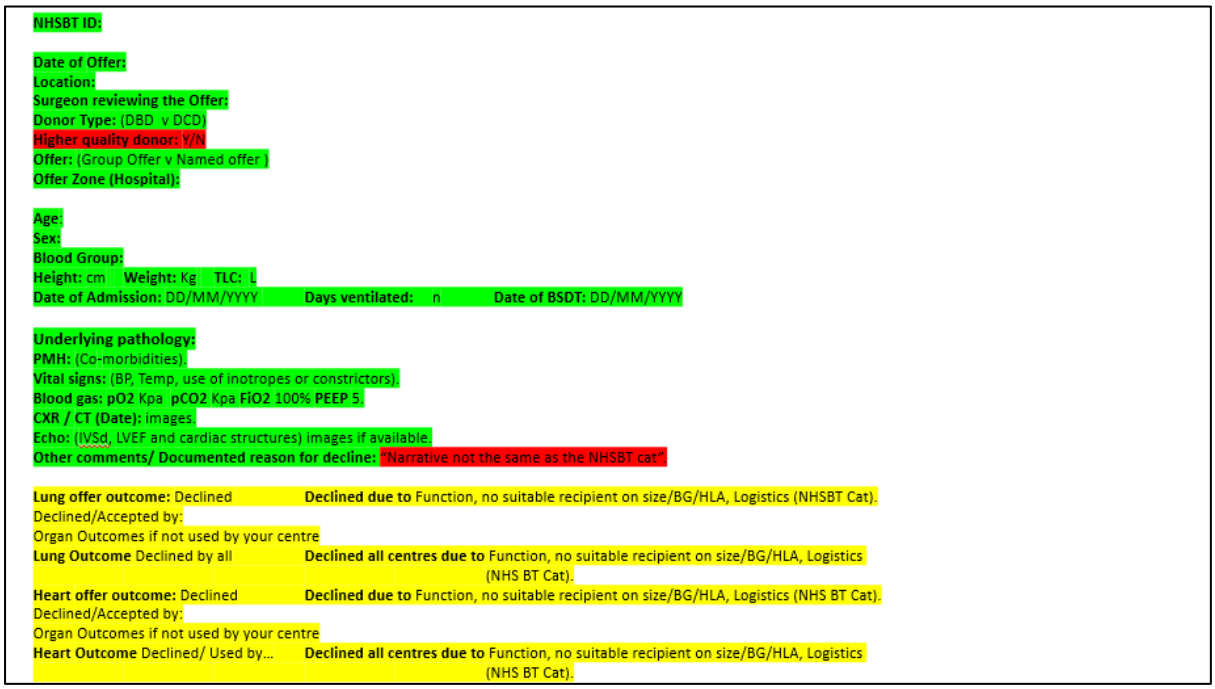
Table 1 summarises how thoracic organ utilisation may be improved. Following the recommendation 3 from the organ utilisation group (OUG) report it was suggested that the way we audit organ utilisation should be standardised nationally. A national donor audit proforma was developed and approved by UK stakeholders.

Table 1. Summary of reasons for organ decline and possible solutions to improve organ utilisation.

Reason for decline	Improving utilisation
Decline for Past Medical History / Poor Function	Follow-up the fate of declined organs Improve a team approach and sharing of the responsibility Improve assessment of organs prior to referral and availability of key invasive investigations Employ novel technology for better assessment and optimisation
Decline for No Suitable Recipient	Identification of potential gaps (Blood Group & Size) Fast tracking recipients of certain desired demographics Review/Refine of our HLA matching practice Establish new links with COPD and ILD groups Increase our visibility at secondary care MDTs

	Increase awareness about our services to other trusts Increase our zonal area by increasing our recipient recruitment Appropriate escalation to urgent and super urgent list
Decline for Logistic Reasons	Ability to perform simultaneous transplants out of hours Prolonged organ preservation techniques Negotiation for delay Increase in bridging capacity for MCS Improving staffing levels through training and retain surgeons Reduce risk of burn out

Table 2. National donor audit proforma. The areas highlighted in green were common practice amongst all centres, yellow areas represent majority and red areas represent minority.



NHSBT ID:

Date of Offer:
Location:
Surgeon reviewing the Offer:
Donor Type: (DBD v DCD)
Higher quality donor: Y/N
Offer: (Group Offer v Named offer)
Offer Zone (Hospital):

Age:
Sex:
Blood Group:
Height: cm **Weight:** Kg **TLC:** L
Date of Admission: DD/MM/YYYY **Days ventilated:** n **Date of BSDT:** DD/MM/YYYY

Underlying pathology:
PMH: (Co-morbidities).
Vital signs: (BP, Temp, use of inotropes or constrictors).
Blood gas: pO2 Kpa **pCO2** Kpa **FiO2** 100% **PEEP** 5
CXR / CT (Date): images.
Echo: (IVSd, LVEF and cardiac structures) images if available
Other comments/ Documented reason for decline: "Narrative not the same as the NHSBT cat"

Lung offer outcome: Declined **Declined due to** Function, no suitable recipient on size/BG/HLA, Logistics (NHSBT Cat).
Declined/Accepted by:
Organ Outcomes if not used by your centre
Lung Outcome Declined by all **Declined all centres due to** Function, no suitable recipient on size/BG/HLA, Logistics (NHS BT Cat).
Heart offer outcome: Declined **Declined due to** Function, no suitable recipient on size/BG/HLA, Logistics (NHS BT Cat).
Declined/Accepted by:
Organ Outcomes if not used by your centre
Heart Outcome Declined/ Used by... **Declined all centres due to** Function, no suitable recipient on size/BG/HLA, Logistics (NHS BT Cat).

Table 3. High quality thoracic donors according to NHS BT definition.

Hearts are considered higher quality when the donor meets all the following criteria:

- Aged less than 50 years
- no history of hypertension
- no history of diabetes
- no history of smoking
- no history of cardiac disease
- LVEF greater than or equal to 50%
- IVS less than or equal to 13 mm
- HBsAg negative
- HCVAb negative
- HIV negative
- HTLV negative
- no adrenaline administered
- no dopamine administered
- no dobutamine administered

Lungs are considered higher quality when the donor meets all the following criteria:

- aged between 16 and 55 years
- no history of malignancy
- HBsAg negative
- HCVAb negative
- HIV negative
- HTLV negative
- no smoking history or age< 30 or smoked less than 20 pack/years
- maximum PO2 greater than or equal to 40 kPA with FiO2 at 100% and PEEP at 5 cmH_2O
- ventilation less than or equal to 7 days

Table 2 shows the essential organ utilisation data while Table 3 shows the criterion for identifying high quality donors hence driving local improvement in organ utilisation. This enabled not only weekly, but also quarterly and yearly audit of donors declined. The fate of organs declined by one centre but accepted by others could be examined. This encourages a team approach to organ utilisation (22).

There is a need for robust evidence to mandate invasive assessment of organs prior to offering, such as invasive coronary angiogram or high-resolution CT coronary angiogram (CTCA). A focussed coronary angiogram would have little implications with respect of the effects of intravenous contrast on abdominal organs but could facilitate efficiency of thoracic organ utilisation.

The use of OCS is evolving. In some instances, following the initial assessment of the DCD heart, the heart is then preserved and transported in the traditional cool box. This practice has a potential advantage of freeing up the DCD retrieval team to attend to the next retrieval earlier and hence improve efficiency and better use of resources.

Efforts have been made to expand the donor pool by accepting donors from extended criteria donors. That is donors of advancing age or sub optimal function. Employing OCS lung or ex-vivo technology for better assessment and optimisation of some organs in particular DCD lungs may increase organ utilisation (13) (23).

Encouraging a team approach to assessment of donors. Identifying potential gaps in the waiting list in terms of size and blood group hence, encouraging physicians to fast-track recipients with desired demographics on to the waiting list. Establishing links with the secondary care referring groups like Chronic Obstructive Pulmonary Disease (COPD) and Interstitial Lung Disease (ILD). Increased surgical visibility at MDTs. Increase awareness about our services to other trusts. Identification and escalation of patients that satisfied criteria for urgent and super urgent listing are amongst multi-disciplinary strategies to improve organ utilisation.

Standardising the process of donor to recipient size matching and HLA protocols to potentially reduce the donor to recipient specific antibody mismatch, would improve organ utilisation and reduce waiting time for suitable donor organs (24).

Conducting simultaneous transplants out of hours is impossible. This is due to the lack of resources. The use of 10° C lung fridge has enabled us to delay the lung transplant until the morning and perform a heart transplant overnight. Donor lungs can be stored in the fridge for more than 12 hours before being utilised. This has enabled us to accept heart and lungs from the same donor (23) (25). Although the heart transplant is performed overnight the lung transplant that is delayed would be performed by a fresh team of surgeons and other health professionals. There also remains the option of negotiating a delay with the SNOD to resolve logistic barriers to organ utilisation.

Training future surgeons

In 2009 the UK's Joint committee for higher surgical training recognised the need to train transplant surgeons to meet the demands for the future (26). A transplant specific training was developed that recruited trainees interested in a career in transplantation. The author reported a review of the fellowship in 2021 and made recommendations. The fellowship was successfully training competent transplant surgeons for the future, but the numbers were not enough. In 2024 together with the Speciality Advisory Committee (SAC) in cardiothoracic surgery we began to reform transplant surgical training in the UK. With the help of the education sub-committee of the Society of Cardiothoracic Surgeons of Great Britain and Ireland (SCTS) a training curriculum was developed. The curriculum was acceptable to the transplant community, quality assessed by the SAC and approved by the SCTS executive. This "Advanced National Fellowships will provide quality-assured training in Cardiothoracic Transplantation and Mechanical Circulatory Support (CT-MCS) in the UK".

Retaining surgical expertise

There is a worldwide shortage of transplant surgeons. Pressure to increase number of transplants in the UK compared to the rest of the world is forcing surgeons to take part in uncomfortable practices. The intensive out-of-hour commitments of the speciality make work life balance difficult to maintain and there are financial disadvantages for this pattern of practice. However, it is hoped that with the start of the SCORE program with multi-disciplinary decision making (Sharing some of the responsibility with the greater team) and daytime implantation some of these challenges will resolve.

References

1. NHS Blood and Transplant. *Taking Organ Transplantation to 2020*. NHSBT; 2013.
2. NHS Blood and Transplant. *Annual Report on Organ Donation and Transplantation 2023/24*. NHSBT; 2024.
3. Organ Donation (Deemed Consent) Act 2019. UK Parliament.

4. Plummer NR, et al. The impact of COVID-19 on organ donation and transplantation in the UK: lessons learned from the first year of the pandemic. Anaesthesia. 2022 Nov;77(11):1237-1250. doi: 10.1111/anae.15833. Epub 2022 Sep 13. PMID: 36099651.

5. Aubert O, et al. COVID-19 pandemic and worldwide organ transplantation: a population-based study. Lancet Public Health. 2021 Oct;6(10):e709-e719. doi: 10.1016/S2468-2667(21)00200-0. Epub 2021 Aug 30. PMID: 34474014; PMCID: PMC8460176.

6. Pober JS, et al. Cardiac allograft vasculopathy: current review and future research directions. Cardiovasc Res. 2021 Nov 22;117(13):2624-2638. doi: 10.1093/cvr/cvab259. PMID: 34343276; PMCID: PMC8783389.

7. Johnstad CM, et al. Coronary angiography utilization in the evaluation of a potential heart donor by age: a narrative review. J Thorac Dis. 2021 Mar;13(3):1864-1868. doi: 10.21037/jtd-20-2547. PMID: 33841974; PMCID: PMC8024806.

8. Chacon-Alberty L, et al. Primary Graft Dysfunction in Lung Transplantation: A Review of Mechanisms and Future Applications. Transplantation. 2023 Aug 1;107(8):1687-1697. doi: 10.1097/TP.0000000000004503. Epub 2023 Jul 20. PMID: 36650643.

9. Soliman-Aboumarie H, et al. The Sound of Silence: The Power of Lung Ultrasound in the Interstitial-Alveolar Syndrome. JACC Case Rep. 2020 Aug 19;2(10):1550-1552. doi: 10.1016/j.jaccas.2020.07.009. PMID: 34317015; PMCID: PMC8302191.

10. Williams JE, et al. Use of Normothermic Regional Perfusion in Circulatory Death Donors for Lung Transplantation in the United States. Clin Transplant. 2025 Mar;39(3):e70135. doi: 10.1111/ctr.70135. PMID: 40103547; PMCID: PMC11925489.

11. Oniscu GC, et al. In situ normothermic regional perfusion for controlled donation after circulatory death--the United Kingdom experience. Am J Transplant. 2014 Dec;14(12):2846-54. doi: 10.1111/ajt.12927. Epub 2014 Oct 3. PMID: 25283987.

12. Ardehali A,et al. PROCEED II trial investigators. Ex-vivo perfusion of donor hearts for human heart transplantation (PROCEED II): a prospective, open-label, multicentre, randomised non-inferiority trial. Lancet. 2015 Jun 27;385(9987):2577-84. doi: 10.1016/S0140-6736(15)60261-6. Epub 2015 Apr 14. PMID: 25888086.

13. Stehlik J, et al. Clinical Outcomes With Normothermic Pulsatile Organ Perfusion in Heart Transplantation: A Report From the OCS Heart Perfusion Registry. Circulation. 2025 Apr;151(13):896-909. doi: 10.1161/CIRCULATIONAHA.124.071743. Epub 2025 Mar 7. PMID: 40052272..

14. Messer S, et al. Outcome after heart transplantation from donation after circulatory-determined death donors. J Heart Lung Transplant. 2017 Dec;36(12):1311-1318. doi: 10.1016/j.healun.2017.10.021. Epub 2017 Oct 24. Erratum in: J Heart Lung Transplant. 2018 Apr;37(4):535. doi: 10.1016/j.healun.2018.02.002. PMID: 29173394.

15. Academy of Medical Royal Colleges. *Code of Practice for the Diagnosis and Confirmation of Death*. 2025 update.

16. Middleton PG, et al. Elexacaftor-Tezacaftor-Ivacaftor for Cystic Fibrosis with a Single Phe508del Allele. *N Engl J Med*. 2019;381:1809-19.

17. Woolley AE, et al. Heart and Lung Transplants from HCV-Infected Donors to Uninfected Recipients. *N Engl J Med*. 2019;380:1606-17.

18. ISHLT Registry Report 2023. *J Heart Lung Transplant*. 2023.

19. Zhou AL, et al. Bridge to transplantation from mechanical circulatory support: a narrative review. J Thorac Dis. 2021 Dec;13(12):6911-6923. doi: 10.21037/jtd-21-832. PMID: 35070375; PMCID: PMC8743412.

20. Mulder BJ. Epidemiology of adult congenital heart disease: demographic variations worldwide. Neth Heart J. 2012 Dec;20(12):505-8. doi: 10.1007/s12471-012-0335-1. PMID: 23225563; PMCID: PMC3515732.

21. Holley CT, et al. Left ventricular assist devices as a bridge to cardiac transplantation. J Thorac Dis. 2014 Aug;6(8):1110-9. doi: 10.3978/j.issn.2072-1439.2014.06.46. PMID: 25132978; PMCID: PMC4133552.

22. NHSBT Organ Utilisation Group Report. 2022.

23. Cypel M, et al. Normothermic Ex Vivo Lung Perfusion in Clinical Lung Transplantation. *N Engl J Med*. 2011;364:1431-40.

24. Tambur AR, et al. Sensitization in Transplantation: Assessment of Risk (STAR) 2017 Working Group Meeting Report. *Am J Transplant*. 2018;18:2571-8.

25. Hoetzenecker K, et al. Prolonged Preservation of up to 24 Hours at 10 °C Does Not Impact Outcomes after Lung Transplantation. Ann Surg. 2025 Apr 1;281(4):664-670. doi: 10.1097/SLA.0000000000006632. Epub 2025 Jan 16. PMID: 39817344; PMCID: PMC11888839.

26. Joint Committee on Surgical Training (JCST). Cardiothoracic Curriculum. 2009.