



Continued Successful Evolution of Extended Criteria Donor Lungs for Transplantation

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Background. In an era of increasing ex vivo lung perfusion (EVLP) use, it remains important to describe what outcomes can be achieved without EVLP, by taking an aggressive approach to donor use to maximize lung transplantation.

Methods. Data for all lung transplant donor referrals to the Alfred Hospital in Melbourne, Australia were collected for 2012 to 2013. Donor variables were analyzed and calculated into a previously validated lung donor score. Lung transplant recipient outcome data included the following: primary graft dysfunction; duration of mechanical ventilation; need for cardiopulmonary bypass extracorporeal membrane oxygenation; intensive care and hospital length of stay; 30-day, 1-year, and 3- to 4-year survival rates; rates of acute rejection and chronic lung allograft dysfunction; and peak and 12-month lung function (forced expiratory volume in 1 second).

Results. Of the 318 lung donor offers, 129 resulted in successful lung transplantation, with an overall donor use rate of 41%. There was no correlation between donor score and any of the recipient outcomes, and excellent short-term and longer-term survival was achieved.

Conclusions. Future studies examining lung transplantation outcomes with EVLP must consider the excellent results that can be achieved by using marginal lungs and conventional donor management. It is important to consider that adopting a strategy of perioperative lung donor evaluation and intervention allows use of what are considered marginal lungs to achieve promising results.

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In an era of increasing demand for donor lungs for transplantation, it is essential that organ donation rates continue to rise. Equally important is that lung donor use opportunities are maximized. In recent years, the potentially available donor pool has been significantly expanded through the use of lung donation after circulatory death and the ability to evaluate and improve lungs further with ex vivo lung perfusion (EVLP).

Notwithstanding, vastly different rates of lung used exist among countries. The 2015 Organ Procurement and Transplantation Network annual report from the United States described a lung procurement rate of 22.2% [1]. Eurotransplant's latest annual report described 32.4% donating lungs [2]. The United Kingdom's Transplant Registry 2015 annual report highlighted a donor use rate of 14.4% [3]. This discordance is likely explained by prevailing attitudes to donor lung management and the subsequent willingness to use supposedly "marginal" or extended criteria lungs for clinical transplantation (Fig 1).

The historical criteria by which donor lungs were categorized as "ideal" (age ≤ 55 years, ABO compatibility, clear chest roentgenogram, ratio of arterial partial pressure of oxygen to fraction of inspired oxygen [PaO₂/FiO₂; P/F ratio] greater than 300, smoking history less than 20 pack-years, absence of chest trauma, no evidence of aspiration or sepsis, no prior cardiopulmonary surgery, a sputum Gram stain absent of organisms, and absence of purulent secretions at bronchoscopy) were devised arbitrarily on the basis of clinical impression and experience rather than clinical trial evidence [4, 5]. Increasingly, data suggest that the historical criteria used to define a lung as "extended" do not result in inferior clinical outcomes [6, 7]. As we improve donor lung use rates from historically poor levels of 15% to closer to 50%, it is important to demonstrate that this increase does not compromise outcomes after lung transplantation.

The Supplemental Material can be viewed in the online version of this article [<http://dx.doi.org/10.1016/j.athoracsur.2017.05.042>] on <http://www.annalsthoracicsurgery.org>.

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Abbreviations and Acronyms

ECMO	= extracorporeal membrane oxygenation
EVLP	= ex vivo lung perfusion
FEV ₁	= forced expiratory volume in 1 second
ICU	= intensive care unit
LOS	= length of stay
PaO ₂	= arterial partial pressure of oxygen
P/F ratio	= ratio of arterial partial pressure of oxygen to fraction of inspired oxygen
PGD	= primary graft dysfunction

At the Alfred Hospital in Melbourne, Australia, we have established and evolved donor management protocols that have not yet included the use of EVLP to optimize donor lung use [8–10]. The aim of this single-center study was to review all lung donor offers received over a 2-year period, assign our previously validated score [11] to all potential donors, and identify donor factors that influence donor lung use and clinical outcomes after lung transplantation.

Patients and Methods

Study Cohort

We performed a retrospective audit of all donor lung offers to the Alfred Hospital over a 2-year period commencing in January 2012. This audit was prompted by the emerging discussion about possible purchase of EVLP technology at our institution. Patients’ data were collected until December 2016, with minimum follow-up of 36 months (see [Supplemental Material](#) for Donor and Recipient Information Sheets). Ethics approval was granted by the hospital’s Human Research Ethics Committee.

Donor Assessment

All donor referrals are communicated to the Alfred Hospital lung transplant physician. Demographic and hemodynamic parameters are collected to allow immediate evaluation, including bronchoscopy, at the donor hospital by the transplant physician, to allow

interventions to influence potentially reversible parameters (low or incongruous ratios of arterial partial pressure of oxygen to fraction of inspired oxygen [P/F ratios], chest roentgenographic changes) [12]. If the patient has imaging changes on chest roentgenogram or a significant smoking history, computed tomography of the chest is requested to allow further assessment. Intravenous antibiotics are commenced empirically or based on known microbial isolates. If atelectasis is suspected, bedside lung recruitment maneuvers, including application of increased positive end-expiratory pressure (at 15 cm H₂O) for short periods (five inspiratory cycles), are instituted. If the P/F ratio remains lower than 300, in cases that were otherwise deemed suitable for transplantation, further lung recruitment is performed in the operating room, and arterial blood gas analysis is performed directly from the four pulmonary veins. Although we do not have a specific algorithm for donor selection, our standard donor criteria guideline is based on serious consideration of all donors younger than 70 years of age, smoking history of less than 20 pack-years, and no significant history of malignant disease. Marginal donors, including those with risk factors for hepatitis B and C, are considered after careful evaluation and frequent discussion among the transplant physicians and surgical team. Smaller marginal donors who are blood group O are vigorously pursued, thus reflecting the demographics of our recipient waitlist.

Donor Lung Score

Donor lung assessment was based on information contained within the donor record as supplied by Donate Life, the national organ donation agency, supplemented by the physician’s assessment. From these data a lung donor score was then calculated (Table 1) [11]. This score was validated in previous Alfred Hospital cohorts and in European and North American lung transplant centers [13, 14].

Donor Lung Use

Donor lung use rates were estimated by calculating the number of donor lung offers that led to a transplant operation. We performed a detailed audit examining the stated reason that each donor lung was deemed unsuitable for transplantation (Table 2). In many cases, the reason for a donor lung offer to be declined was multifactorial, typically a combination of imaging changes and persistently low P/F ratios.

Perioperative and Postoperative Management

Donor-recipient matching was undertaken according to our standard protocol [12]. Lung procurement and preservation followed standard procedures. Careful postoperative fluid management in the intensive care (ICU) setting was used, encompassing respiratory and cardiovascular management algorithms instituted previously described [15, 16]. Most transplants performed were bilateral, a recognition that management of two marginal lungs is simpler than management of one. Only the highest-quality lungs were used for single lung

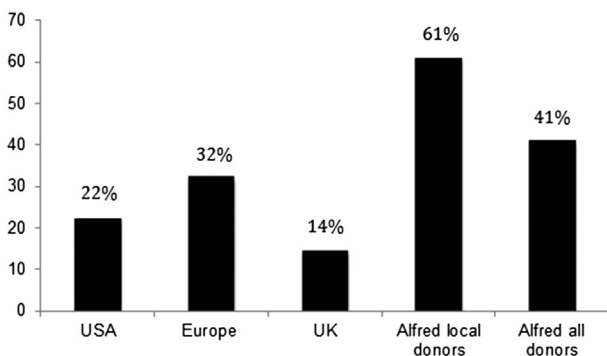


Fig 1. Donor used rate (%) of available donors offered.

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