doi:10.1510/icvts.2010.263624

INTERACTIVE CARDIOVASCULAR AND THORACIC SURGERY

Interactive CardioVascular and Thoracic Surgery 12 (2011) 799–805

www.icvts.org

Best evidence topic - Cardiopulmonary bypass

Should double lung transplant be performed with or without cardiopulmonary bypass?☆

Myura Nagendran[a,*], Mahiben Maruthappu[a], Kapil Sugand[b]

[a]*Green Templeton College, University of Oxford, Woodstock Road, Oxford OX2 6HG, UK*
[b]*Department of Surgery, Kingston Hospital, Kingston upon Thames, Surrey KT2 7QB and St George's London Healthcare Trust, London, UK*

Received 10 December 2010; accepted 19 January 2011

Summary

A best evidence topic in cardiothoracic surgery was written according to a structured protocol. The question addressed was whether double lung transplantation should be performed with or without cardiopulmonary bypass (CPB) in order to improve postoperative clinical outcomes. Altogether 386 papers were found using the reported search, of which 14 represented the best evidence to answer the clinical question. The authors, journal, date and country of publication, patient group studied, study type, relevant outcomes and results of these papers are tabulated. All 14 papers assessed a range of postoperative outcomes and broadly speaking, six papers found significantly worse outcomes with CPB use, six found no difference and two found a mixture of both depending on the specific outcomes assessed. Dalibon et al. [J Cardiothorac Vasc Anesth 2006;20:668–672] found that mortality was significantly worse in the CPB group at 48 h, one month and one year [$P=0.001$, odds ratio (OR)$=246.1$; $P=0.083$, OR$=2.6$; $P=0.001$, OR$=5.3$, respectively]. Other papers revealed poor outcomes in the CPB group in a range of measures including diffuse alveolar damage ($P=0.009$), chest radiograph infiltrate score ($P=0.005$), longer intubation time ($P=0.002$), longer intensive care unit stay ($P=0.05$), and greater incidence of pulmonary reimplantation response ($P=0.03$). However, Myles et al. [J Cardiothorac Vasc Anesth 1997;11:177–183] found that only acute postoperative outcomes were significantly worse in their CPB group ($P<0.001$); medium- and long-term survival outcomes were not significantly different ($P=0.055$). de Boer et al. [Transplantation 2002;73:1621–1627] even found that there was an improved one-year survival rate with CPB use (OR$=0.25$, $P=0.038$) and that the number of human leukocyte antigen DR (HLA-DR) mismatches influenced this effect. Those papers suggesting no deleterious effects of CPB generally measured similar postoperative outcomes to those mentioned above, with one study also assessing incidence of primary graft failure, which was not significantly different ($P=0.37$). We conclude that CPB should continue to be used where clinically indicated for a specific reason (for example, where there is pulmonary hypertension or a requirement for concomitant cardiac repair). However, given that the evidence for using CPB for all elective cases is relatively weak, and the fact that there are strong arguments in the literature for both methods, either approach would be clinically acceptable.
© 2011 Published by European Association for Cardio-Thoracic Surgery. All rights reserved.

Keywords: Cardiopulmonary bypass; Lung transplantation; Postoperative outcomes; Thoracic surgery

1. Introduction

A best evidence topic was constructed according to a structured protocol. This is fully described in the ICVTS [1].

2. Three-part question

In patients undergoing [double lung transplantation] is an [off-pump] approach superior to [cardiopulmonary bypass] in terms of [postoperative clinical outcomes].

3. Clinical scenario

You are at a national conference hearing about the benefits of performing bilateral sequential lung transplants (BSLTx) without cardiopulmonary bypass (CPB). An eminent speaker from the floor then stands up and contends that there has been no compelling evidence from outcome studies on the deleterious effects of CPB in lung transplantation. He continues to say that some evidence points toward CPB aiding in the prevention of lung damage by establishing a stable and controlled reperfusion period in addition to providing greater technical access and improving general haemodynamic stability. You resolve to check the literature yourself.

4. Search strategy

Medline database (1950 to September 2010) using OVID SP interface

[exp Lung Transplantation/OR double lung transplant.mp. OR bilateral lung transplant.mp] AND [exp Cardiopulmonary Bypass/OR bypass.mp]

Additionally, the following were also searched for further relevant studies: references of all resulting papers, Coch-

☆ This work was presented as a poster at the SCTS Annual Meeting, London, UK, 20–22 March 2011.

*Corresponding author. Tel.: +44-7912556717; fax: +44-1865274796.
E-mail address: myura.nagendran@medschool.ox.ac.uk (M. Nagendran).

© 2011 Published by European Association for Cardio-Thoracic Surgery

Downloaded from https://academic.oup.com/icvts/article/12/5/799/830917 by U.S. Department of Justice user on 16 August 2022

Table 1. Best evidence papers

Author, date and country, Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
Ferrer et al., (2007), Transplant Proc, Spain, [2] Single centre retrospective cohort study (level IIb)	Seventy-nine emphysema patients underwent bilateral LTx between 1993 and 2005	One month mortality	OR = 34.0 95% CI: 13.8–83.0 $P < 0.0001$	CPB had the greatest predictive value for early mortality among the assessed variables. However, this could be due to the CPB being performed in more severe patients
Pochettino et al., (2007), J Cardiothorac Vasc Anesth, USA, [3] Single centre retrospective cohort study (level III)	Twenty-six patients undergoing BLTx between 1998 and 2003 of which 10 underwent Tx with CPB support whilst eight had no support	ICU stay (median days and range)	8.7 days no support (1–20) 2.8 days CPB (1.8–56.8) $P > 0.05$	Authors concluded that CPB is associated with decreased incidence of early graft infection when used for both lungs. Possibly due to decontamination of operative field before graft implantation. However, note that sample size is extremely small and authors recommend further research
		Hospital stay (median days and range)	22.8 days no support (9.2–39.3) 22.1 days CPB (12.4–57.8) $P > 0.05$	
		Mechanical ventilation duration (median days and range)	1.3 days no support (0.3–16.6) 0.5 day CPB (0.3–38.5) $P > 0.05$	
		30-day mortality	OR = 0.003 95% CI: 0.00–0.12 $P < 0.0001$	
Aigner et al., (2007), Eur J Cardiothorac Surg, Austria, [4] Single centre retrospective cohort study (level IIb)	Three-hundred and six patients undergoing LTx between 2001 and 2006 of which CPB was used in 27 patients and no extracorporeal support in 149 patients. In the no support group, six required postoperative ECMO support due to PGD	Intubation time (median days and range)	1.5 days no support (0–50) 17.5 days CPB (2–67)	Main focus of study is on ECMO use. Comparison of CPB and no support groups is incidental. Consequently, the CPB sample size is very small
		ICU stay (median days and range)	5.5 days no support (1–55) 23.5 days CPB (10–87)	
		Hospital stay (median day and range)	23 days no support (8–124) 51 days CPB (26–87)	
		Three-month survival rate	OR = 5.1 95% CI: 2.1–12.3 $P < 0.001$	
		One-year survival rate	OR = 5.9 95% CI: 2.6–13.2 $P < 0.001$	
		Three-year survival rate	OR = 4.7 95% CI: 2.4–9.4 $P < 0.001$	
Dalibon et al., (2006), J Cardiothorac Vasc Anesth, France, [5] Single centre retrospective cohort study (level IIb)	One-hundred and forty patients undergoing LTx between 1993 and 2003 of which 72 were bilateral LTx	48 h mortality	OR = 246.1 95% CI: 5.6–10237.8 $P = 0.001$	Authors highlight that there is poorer prognosis in unplanned vs. planned CPB, hence an argument for initiating CPB earlier when indicated Authors also highlight difficulty in separating underlying condition from other variables. Note that results are not specifically separated into double and single LTx
		One-month mortality	OR = 2.6 95% CI: 0.99–6.80 $P = 0.083$	
		One-year mortality	OR = 5.3 95% CI: 2.11–13.41 $P = 0.001$	
Szeto et al., (2002), J Thorac Cardiovasc Surg, USA, [6]	Fifty COPD patients undergoing bilateral LTx between 1991 and 2000. Fourteen underwent	ICU stay (median days)	Four days, no support Four days, CPB $P = 0.44$	Restriction of sample group to COPD patients only removes a degree of confounding variables.

(Continued on next page)

Downloaded from https://academic.oup.com/icvts/article/12/5/799/830917 by U.S. Department of Justice user on 16 August 2022

Table 1. *(Continued)*

Author, date and country, Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
Single centre retrospective cohort study (level IIb)	elective CPB for 218.3± 75.4 min, 36 control patients	Hospital stay (median days)	16 days, no support 15.5 days, CPB $P=0.74$	However, sample size is still small
		30-day mortality	OR=0.84 95% CI: 0.31–2.31 $P=0.599$	
		One-year survival rate	OR=0.67 95% CI: 0.32–1.40 $P=0.333$	
		Three-year survival rate	OR=0.78 95% CI: 0.44–1.37 $P=0.385$	
de Boer et al., (2002), Transplantation, The Netherlands, [7]	Sixty-two emphysema patients undergoing bilateral LTx between 1990 and 2000.	Mechanical ventilation (days)	4.9±6.9, no support 4.5±6.3, CPB $P=0.641$	Results demonstrate survival benefit of CPB support during bilateral LTx in emphysema patients, though no significant difference in some postoperative outcomes. The survival benefit was most strongly present in the group with two HLA-DR mismatches compared to 0 or 1
Single centre retrospective cohort study (level IIb)	Thirty-five underwent Tx with CPB support and 27 without support	ICU stay (days)	9.4±11.7, no support 8.8±7.4, CPB $P=0.439$	
		One-year survival rate	OR=0.25, 70% CI: 0.13–0.5 $P=0.038$	
Khan et al., (1999), Chest, USA, [8]	Ninety-nine patients undergoing LTx between 1990 and 1995 of which 35 were bilateral. Thirty-seven of the 99 patients required CPB during surgery	Incidence of PRR	OR=2.5 95% CI: 1.1–5.9 $P=0.038$	CPB use significantly increased risk and severity of PRR
Single centre retrospective cohort study (level IIb)				Note that results are not specifically separated into double and single LTx
Sheridan et al., (1998), Ann Thorac Surg, USA, [9]	Twenty-three patients undergoing BLTx between 1994 and 1997. Four underwent LTx with unplanned CPB support (they were excluded from the study) and 19 without support	CXR infiltrate score	First lung 0.84±0.21, 1 h postoperative 0.95±0.21, 24 h postoperative $P=0.15$ Second lung 0.47±0.14, 1 h postoperative 0.84±0.21, 24 h postoperative $P=0.72$	No acute or chronic differences between first and second lungs transplanted without CPB. Study recommends that BLTx can be performed without CPB in non-pulmonary hypertensive patients. Authors acknowledge small sample size and retrospective nature of study. The paper only assesses those patients operated on without CPB
Single centre retrospective analysis (level III)		Quantitative, split function lung perfusion scan (% with abnormal perfusion)	First lung 21%, three months postoperative 30%, 12 months postoperative $P=0.44$ Second lung 36%, three months postoperative 20%, 12 months postoperative $P=0.65$	
Christie et al., (1998), Chest, USA, [10]	One-hundred patients undergoing LTx between 1991 and 1996 of which	Incidence of PGF	OR=1.6 95% CI: 0.5–5.1 $P=0.518$	There was an observed trend toward more frequent use of CPB in the PGF

(Continued on next page)

Downloaded from https://academic.oup.com/icvts/article/12/5/799/830917 by U.S. Department of Justice user on 16 August 2022

Best Evidence Topic

Table 1. *(Continued)*

Author, date and country, Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
Single centre retrospective cohort study (level IIb)	47 were bilateral. Twenty-four of the 100 patients required CPB during surgery			positive group though this was not significant Note that results are not specifically separated into double and single LTx
Gammie et al., (1998), J Thorac Cardiovasc Surg, USA, [11] Single centre retrospective cohort study (level IIb)	Ninety-four patients undergoing bilateral LTx between 1990 and 1995. Thirty-seven underwent Tx with CPB support and 57 without support	CXR infiltrate score	0 h postoperative 1.3±0.18, no support 2.4±0.17, CPB $P=0.005$ 24 h postoperative 1.0±0.16, no support 1.8±0.17, CPB $P=0.005$	Study found CPB associated with significant allograft dysfunction post-transplant. Recommends avoiding CPB for bilateral LTx except in pulmonary hypertension and other clearly indicated conditions
		Intubation time (median days)	Two days, no support 10 days, CPB $P=0.002$	
		ICU stay (median days)	8.5 days, no support 16 days, CPB $P=0.05$	
		30-day mortality	OR=2.07 95% CI: 0.56–7.68 $P=0.309$	
		One-year survival rate	OR=0.96 95% CI: 0.53–1.72 $P=1.000$	
Myles et al., (1997), J Cardiothorac Vasc Anesth, Australia, [12] Single centre retrospective case analysis (level III)	Sixty-four patients undergoing bilateral LTx before February 1996. Twenty underwent Tx with CPB support and 44 without support	Extubation time (median hours)	27 (5–420) h, no support 50 (24–1800) h, elective CPB $P<0.001$ 27 (5–420) h, no support 50 (24–1032) h, unplanned CPB $P=0.009$	Significant difference in extubation time and ICU stay. However, no significance with regard to hospital stay and 12-month survival suggesting that long-term effect of CPB is not deleterious. Authors acknowledge that small sample size lends itself to a possible type II error
		ICU stay (days)	3 (1–28) days, no support 7 (3–75) days, elective CPB $P<0.001$ 3 (1–28) days, no support 6 (4–46) days, unplanned CPB $P=0.004$	
		Hospital stay (days)	24 (6–127) days, no support 31 (7–92) days, elective CPB $P=0.055$ 24 (6–127) days, no support 34 (20–92) days, unplanned CPB $P=0.076$	
		12-Month survival (univariate risk ratio)	1.0 (95% CI: 0.75–1.33), unplanned CPB 0.9 (95% CI: 0.58–2.54), all CPB	
Hlozek et al., (1997), Perfusion, USA, [13]	Seventy-four patients undergoing LTx between 1993 and 1997 of which	One-year mortality rate (all patients)	OR=1.38 95% CI: 0.77–2.50 $P=0.295$	No major significant differences in survival between CPB and no

(Continued on next page)

Downloaded from https://academic.oup.com/icvts/article/12/5/799/830917 by U.S. Department of Justice user on 16 August 2022

Table 1. *(Continued)*

Author, date and country, Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
Single centre retrospective cohort study (level IIb)	27 were bilateral. Thirty-six patients had emphysema and were further analysed as a homogenous group	One-year mortality rate (emphysema patients)	OR=1.20 95% CI: 0.63–2.31 *P*=0.617	support groups. Similar results with emphysema sub-group (intubation time was the only significantly different factor)
		Intubation time (emphysema patients)	2.5 days, no support five days, CPB *P*=0.02	Note that results are not specifically separated into double and single LTx
		ICU stay (emphysema patients)	Two days, no support 4.5 days, CPB *P*=0.12	
Triantafillou et al., (1994), Ann Thorac Surg, USA, [14]	Sixty-eight patients undergoing bilateral LTx between 1988 and 1993. Eighteen underwent Tx with CPB support and 50 without support	Days to extubation	2.8±2.2 days, no support 4.2±3.1 days, CPB Not statistically significant	No significant difference in outcome measures between CPB and no support groups. Concludes that bypass should be readily available for bilateral LTx. Donor lung dysfunction was responsible for the CPB use in more than half of the patients in the CPB group
Single centre retrospective cohort study (level IIb)		ICU stay (days)	5.2±6.5 days, no support 5.6±3.8 days, CPB Not statistically significant	
		Days to $RApO_2$ >60 mmHg	9.2±10 days, no support 11.6±10.4 days, CPB Not statistically significant	
Aeba et al., (1994), Ann Thorac Surg, USA, [15]	One hundred patients undergoing LTx between 1990 and 1992 of which 38 were bilateral (18 with CPB, 20 without support)	PaO_2/PAO_2	0.60±0.22, no support 0.42±0.15, CPB *P*=0.006	Significant differences in acute postoperative and survival outcomes. Study concludes that CPB use interacts with preservation injury to exaggerate pulmonary dysfunction
Single centre retrospective cohort study (level IIb)		Diffuse alveolar damage presence	OR=7.9 95% CI: 1.7–36.9 *P*=0.013	
		Actuarial one-month patient survival (all LTx patients)	OR=4.8 95% CI: 1.7–13.7 *P*=0.001	Note that some results (one-month survival) are not specifically separated into double and single LTx

Note: Almost none of the reported papers used odds ratios or confidence intervals in assessing dichotomous variables, such as mortality. In these cases, odds ratios, 95% confidence intervals and *P*-values were calculated using an online two-way contingency table analysis (found at: http://statpages.org/ctab2x2.html). Source values for this analysis were retrieved from the results given in the original paper. CPB, cardiopulmonary bypass; PRR, pulmonary reimplantation response; PGF, primary graft failure; ICU, intensive care unit; OR, odds ratio; CI, confidence interval; ECMO, extracorporeal membrane oxygenation; COPD, chronic obstructive pulmonary disease; HLA-DR, human leukocyte antigen DR; LTx, lung transplant; BLTx, bilateral lung transplant; Tx, transplant; $RApO_2$, right atrial partial pressure of oxygen; CXR, chest radiograph.

rane Review Database and NHS Evidence and National Institute for Health and Clinical Excellence (NICE).

5. Search outcome

Three hundred and eighty-six papers were found using the reported Medline search. Major exclusion criteria included single lung transplantation and the exclusive use of extracorporeal membrane oxygenation (ECMO). From the search, 14 papers were identified that provided evidence addressing the specific question. These are presented in Table 1.

6. Results

Paucity of level 1 evidence was a major limitation to this analysis and all 14 papers were retrospective observational studies with small sample sizes (range 26–306) in varied patient populations. Almost none of the reported papers used odds ratios (ORs) or 95% confidence intervals (CIs) in assessing dichotomous variables, such as mortality. These were calculated for this analysis using an online two-way contingency table (found at: http://statpages.org/ctab2x2.html) and the source values from the original paper. Continuous variables were also not reported using ORs or CIs, weakening the conclusions that can be drawn.

Dalibon et al. [5] assessed mortality rates after lung transplantation with and without CPB. At one month and one year, there was greater mortality in the CPB group (*P*=0.083, OR=2.6 and *P*=0.001, OR=5.3, respectively).

Aeba et al. [15] found significant differences in a range of outcome measures. Specifically, CPB patients were more likely to have diffuse alveolar damage (*P*=0.013, OR=7.9), worse gas exchange as measured by PaO_2/PAO_2 (*P*=0.006) and reduced one-month survival (*P*=0.001, OR=4.8) compared to the non-CPB group.

Gammie et al. [11] found that CPB was associated with significant allograft dysfunction post-transplant. There was significantly greater chest infiltrate score (*P*=0.005), longer intubation time (*P*=0.002) and intensive care unit (ICU) stay (*P*=0.05), but 30-day mortality was not significant (*P*=0.309, OR=2.07) in the CPB group.

Aigner et al. [4] were primarily studying ECMO support but assessed the effect of CPB as well. The CPB group had

Downloaded from https://academic.oup.com/icvts/article/12/5/799/830917 by U.S. Department of Justice user on 16 August 2022

Best Evidence Topic

longer durations than those operated with no extracorporeal support in acute postoperative outcomes, such as intubation, ICU and hospital stay. Assessment of chronic survival rates at three months, one year and three years revealed a similar pattern with lower survival rates in the CPB group than those operated on without CPB ($P<0.001$, OR=5.1, 5.9, 4.7, respectively).

Szeto et al. [6] restricted their sample to 50 COPD patients to reduce the confounding effect that different pretransplant lung conditions would have on the outcome of the analysis. They found that both acute (ICU and hospital duration) as well as chronic (one month, one year, three-year survival rates) outcome measures were not significant between the CPB and non-CPB groups ($0.44<P<1.0$, OR=0.67–0.84).

de Boer et al. [7] took a similar approach to Szeto et al. by assessing only emphysematous transplant patients. They found no significant difference in mechanical ventilation duration or ICU duration but there was an improved one-year survival rate in the CPB group (OR=0.25, $P=0.038$). This survival benefit was most evident in patients with two human leukocyte antigen DR (HLA-DR) mismatches suggesting a possible immunological basis for the CPB effect. Ferrer et al. [2] also looked specifically at emphysematous patients and found that CPB was used in a higher proportion of patients who died within one month than in survivors ($P<0.0001$, OR=34.0). Triantafillou et al. [14] did not observe any significant difference in intubation time, ICU duration or number of days before a right atrial partial pressure of oxygen ($RApO_2$) of >60 mmHg postoperatively.

Khan et al. [8] found that CPB use significantly increased the risk and severity of a pulmonary reimplantation response ($P=0.038$, OR=2.5), whilst Christie et al. [10] observed only a non-significant trend toward more frequent CPB use in patients positive for primary graft failure ($P=0.518$, OR=1.6).

Myles et al. [12] found that extubation time was longer in both elective and unplanned CPB ($P<0.001$, $P=0.009$, respectively) as well as a longer ICU duration ($P<0.001$, $P=0.004$, respectively). However, medium- and long-term outcomes, such as hospital stay duration and 12-month survival risk ratio were not significant in either of the two CPB subsets.

7. Clinical bottom line

No randomised control trials have assessed whether double lung transplantation should be performed with CPB. The retrospective analyses and cohort studies in this best evidence topic (BET) present conflicting data with some studies showing a significant clinical disadvantage to CPB use [2, 4, 5, 8, 11, 15], some showing no difference [3, 6, 9, 10, 13, 14] and some showing both depending on the postoperative outcomes assessed [7, 12]. On balance, CPB should continue to be used where clinically indicated for a specific reason. For example, in cases of pulmonary hypertension, CPB can prevent sudden increases in pulmonary pressure (reducing the likelihood of acute right-sided heart failure) as well as preventing haemodynamic collapse during clamping of the pulmonary artery [16]. Given that the evidence for using CPB for all elective cases is relatively weak, and the fact that there are strong arguments in the literature for both methods [16, 17], either approach would be clinically acceptable.

References

[1] Dunning J, Prendergast B, Mackway-Jones K. Towards evidence-based medicine in cardiothoracic surgery: best BETS. Interact CardioVasc Thorac Surg 2003;2:405–409.

[2] Ferrer J, Rodriguez E, Roman A, Bravo C, Roldan J, Hermosilla E, Canela M. Factors related to postoperative mortality in lung transplantation for emphysema. Transplant Proc 2007;39:3317–3322.

[3] Pochettino A, Augoustides JG, Kowalchuk DA, Watcha SM, Cowie D, Jobes DR. Cardiopulmonary bypass for lung transplantation in cystic fibrosis: pilot evaluation of perioperative outcome. J Cardiothorac Vasc Anesth 2007;21:208–211.

[4] Aigner C, Wisser W, Taghavi S, Lang G, Jaksch P, Czyzewski D, Klepetko W. Institutional experience with extracorporeal membrane oxygenation in lung transplantation. Eur J Cardiothorac Surg 2007;31:468–473.

[5] Dalibon N, Geffroy A, Moutafis M, Vinatier I, Bonnette P, Stern M, Loirat P, Bisson A, Fischler M. Use of cardiopulmonary bypass for lung transplantation: a 10-year experience. J Cardiothorac Vasc Anesth 2006;20:668–672.

[6] Szeto WY, Kreisel D, Karakousis GC, Pochettino A, Sterman DH, Kotloff RM, Arcasoy SM, Zisman DA, Blumenthal NP, Gallop RJ, Kaiser LR, Bavaria JE, Rosengard BR. Cardiopulmonary bypass for bilateral sequential lung transplantation in patients with chronic obstructive pulmonary disease without adverse effect on lung function or clinical outcome. J Thorac Cardiovasc Surg 2002;124:241–249.

[7] de Boer WJ, Hepkema BG, Loef BG, van der Bij W, Verschuuren EA, de Vries HJ, Lems SP, Ebels T. Survival benefit of cardiopulmonary bypass support in bilateral lung transplantation for emphysema patients. Transplantation 2002;73:1621–1627.

[8] Khan SU, Salloum J, O'Donovan PB, Mascha EJ, Mehta AC, Matthay MA, Arroliga AC. Acute pulmonary edema after lung transplantation: the pulmonary reimplantation response. Chest 1999;116:187–194.

[9] Sheridan BC, Hodges TN, Zamora MR, Lynch DL, Brown JM, Campbell DN, Grover FL. Acute and chronic effects of bilateral lung transplantation without cardiopulmonary bypass on the first transplanted lung. Ann Thorac Surg 1998;66:1755–1758.

[10] Christie JD, Bavaria JE, Palevsky HI, Litzky L, Blumenthal NP, Kaiser LR, Kotloff RM. Primary graft failure following lung transplantation. Chest 1998;114:51–60.

[11] Gammie JS, Cheul Lee J, Pham SM, Keenan RJ, Weyant RJ, Hattler BG, Griffith BP. Cardiopulmonary bypass is associated with early allograft dysfunction but not death after double-lung transplantation. J Thorac Cardiovasc Surg 1998;115:990–997.

[12] Myles PS, Weeks AM, Buckland MR, Silvers A, Bujor M, Langley M. Anesthesia for bilateral sequential lung transplantation: experience of 64 cases. J Cardiothorac Vasc Anesth 1997;11:177–183.

[13] Hlozek CC, Smedira NG, Kirby TJ, Patel AN, Perl M. Cardiopulmonary bypass (CPB) for lung transplantation. Perfusion 1997;12:107–112.

[14] Triantafillou AN, Pasque MK, Huddleston CB, Pond CG, Cerza RF, Forstot RM, Cooper JD, Patterson GA, Lappas DG. Predictors, frequency, and indications for cardiopulmonary bypass during lung transplantation in adults. Ann Thorac Surg 1994;57:1248–1251.

[15] Aeba R, Griffith BP, Kormos RL, Armitage JM, Gasior TA, Fuhrman CR, Yousem SA, Hardesty RL. Effect of cardiopulmonary bypass on early graft dysfunction in clinical lung transplantation. Ann Thorac Surg 1994;57:715–722.

[16] Marczin N, Royston D, Yacoub M. Pro: lung transplantation should be routinely performed with cardiopulmonary bypass. J Cardiothorac Vasc Anesth 2000;14:739–745.

[17] McRae K. Con: lung transplantation should not be routinely performed with cardiopulmonary bypass. J Cardiothorac Vasc Anesth 2000;14:746–750.

Downloaded from https://academic.oup.com/icvts/article/12/5/799/830917 by U.S. Department of Justice user on 16 August 2022

eComment: To pump or not to pump in lung transplantation – question solved?

Author: ***Clemens Aigner,*** *Department of Cardio-Thoracic Surgery, Medical University of Vienna, Vienna, Austria*

doi:10.1510/icvts.2010.263624A

The authors summarize the best available evidence regarding the use of cardiopulmonary bypass (CPB) in lung transplantation by assessing 14 papers published since 1994. The main confounding factor in most of the papers is a clear difference in the groups with and without CPB regarding pre-transplant condition and indication for lung transplantation. In those papers dealing with chronic obstructive pulmonary disease (COPD) patients only no constant benefit of CPB could be demonstrated. The clinical bottom line drawn by the authors is that CPB should continue to be used where clinically indicated [1]. This is certainly the correct conclusion, yet it is a weak bottom line that can be drawn after 17 years of discussing the topic. No prospective randomized trials regarding the intraoperative use of extracorporeal support have been published. During these years significant advances in various aspects of lung transplantation took place, however the use of extracorporeal support during lung transplantation is still very much depending on the individual center's experience.

As suggested by the authors, using extracorporeal support when clinically indicated, currently is the most reasonable approach according to the available literature. Some centers, including ours, use extracorporeal membrane oxygenation (ECMO) routinely instead of CPB [2]. Other centers still prefer CPB if extracorporeal support is required, however the exact indications for its use vary greatly. So far it has not been clearly solved which method is preferable. When analyzing outcomes, especially in series with limited patient numbers, frequently a learning curve needs to be taken into account. The familiarity of the entire team with one approach and attention to details in coagulation management, substitution of blood products, hemodynamic management and technical issues are certainly keys to successful outcome.

The question remains whether there is an urgent need for more evidence regarding this topic? When combining all the available literature no clear-cut advantage of either approach could be demonstrated. The chances of receiving significant differences in a randomized controlled trial are low and the actual impact on outcome is probably limited. Therefore, it is unlikely that a large randomized trial will be performed addressing this question.

References

[1] Nagendran M, Maruthappu M, Sugand K. Should double lung transplant be performed with or without cardiopulmonary bypass? Interact CardioVasc Thorac Surg 2011;12:799–805.

[2] Aigner C, Wisser W, Taghavi S, Lang G, Jaksch P, Czyzewski D, Klepetko W. Institutional experience with extracorporeal membrane oxygenation in lung transplantation. Eur J Cardiothorac Surg 2007;31:468–473; discussion 473–474.

Downloaded from https://academic.oup.com/icvts/article/12/5/799/830917 by U.S. Department of Justice user on 16 August 2022