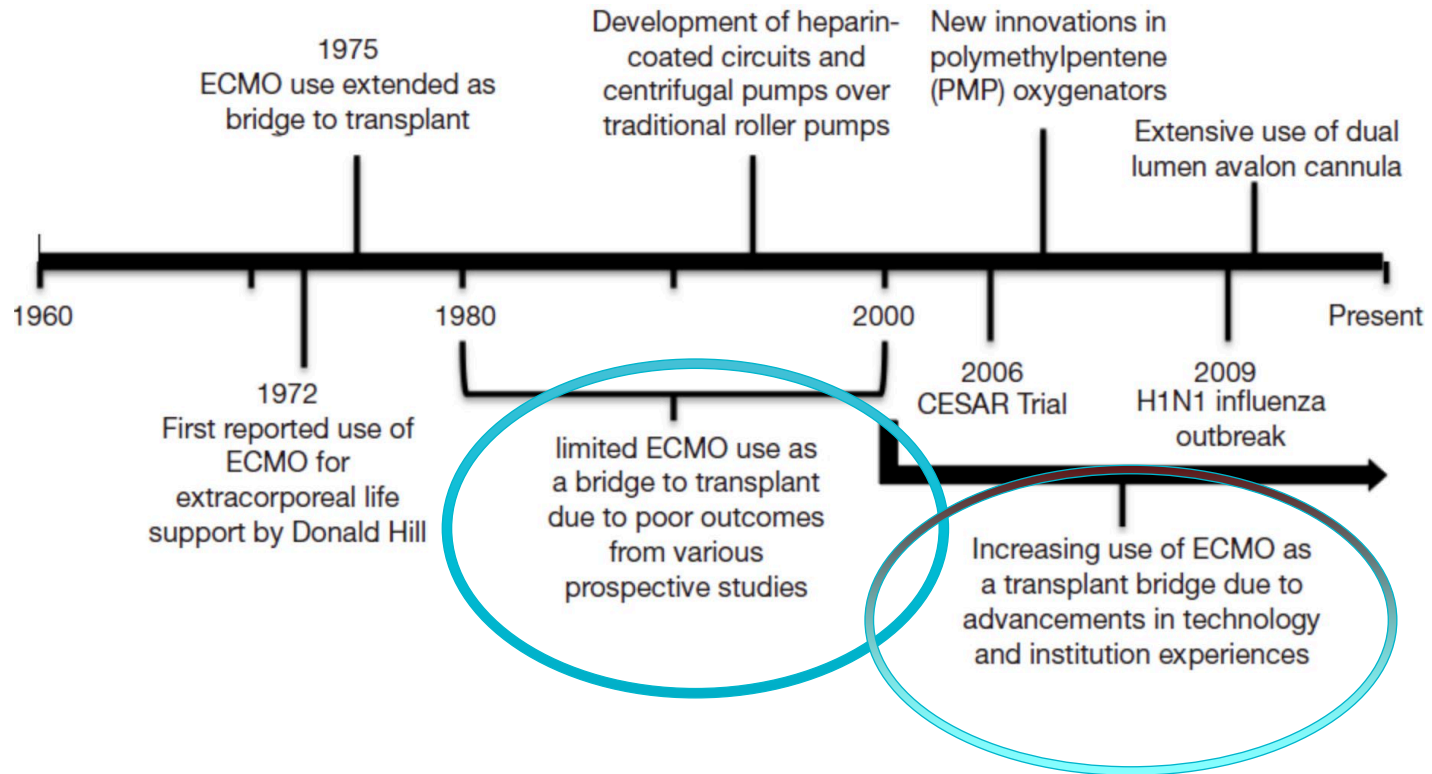

ECMO a transplantace plic

Robert Lischke

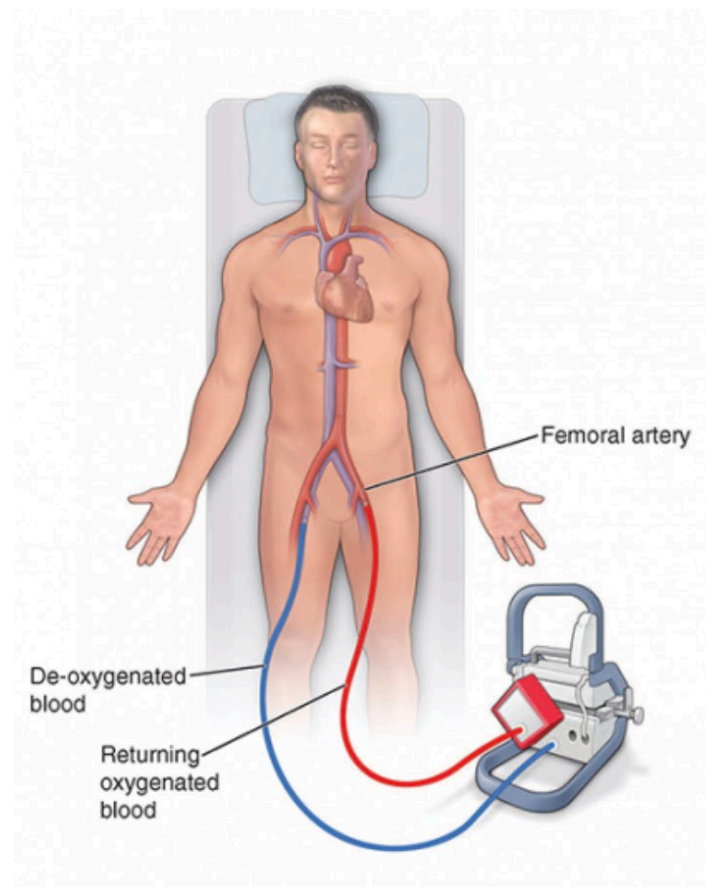
III. chirurgická klinika 1.LF UK a FN Motol
Národní Program Transplantace Plic

VÝVOJ VYUŽITÍ ECMO



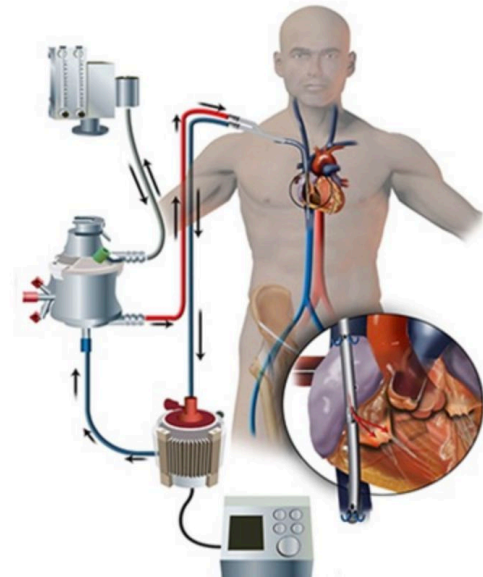
BEZ ECMO NELZE TX PLIC PROVÉST

- ECMO u transplantace plic
 - Podpora srdeční a/nebo respirační funkce
 - Dny až týdny
- Využití mimotělního oběhu a/nebo mimo operační sál



ECMO U Tx PLIC

- předoperační ECMO - bridging to Tx (recovery, decision)
- peroperační ECMO
- pooperační ECMO
 - profylakticky
 - akutně (PGD)
- VA ECMO, VV ECMO, VAV ECMO
- centrální x periferní kanylace



ECMO u Tx PLIC

- předoperační ECMO - bridging to Tx (recovery, decision)

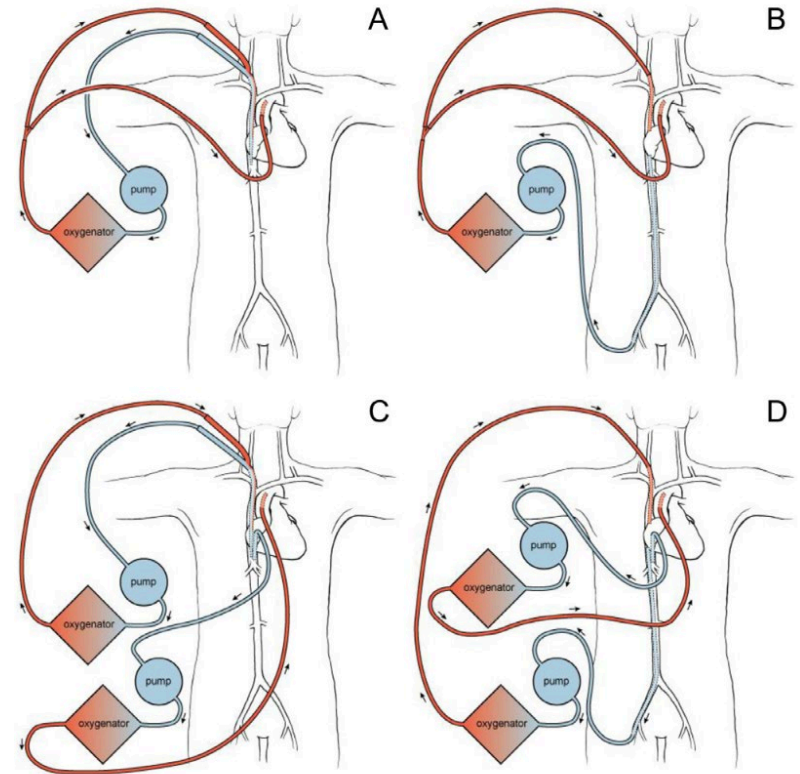
- peroperační ECMO

- pooperační ECMO

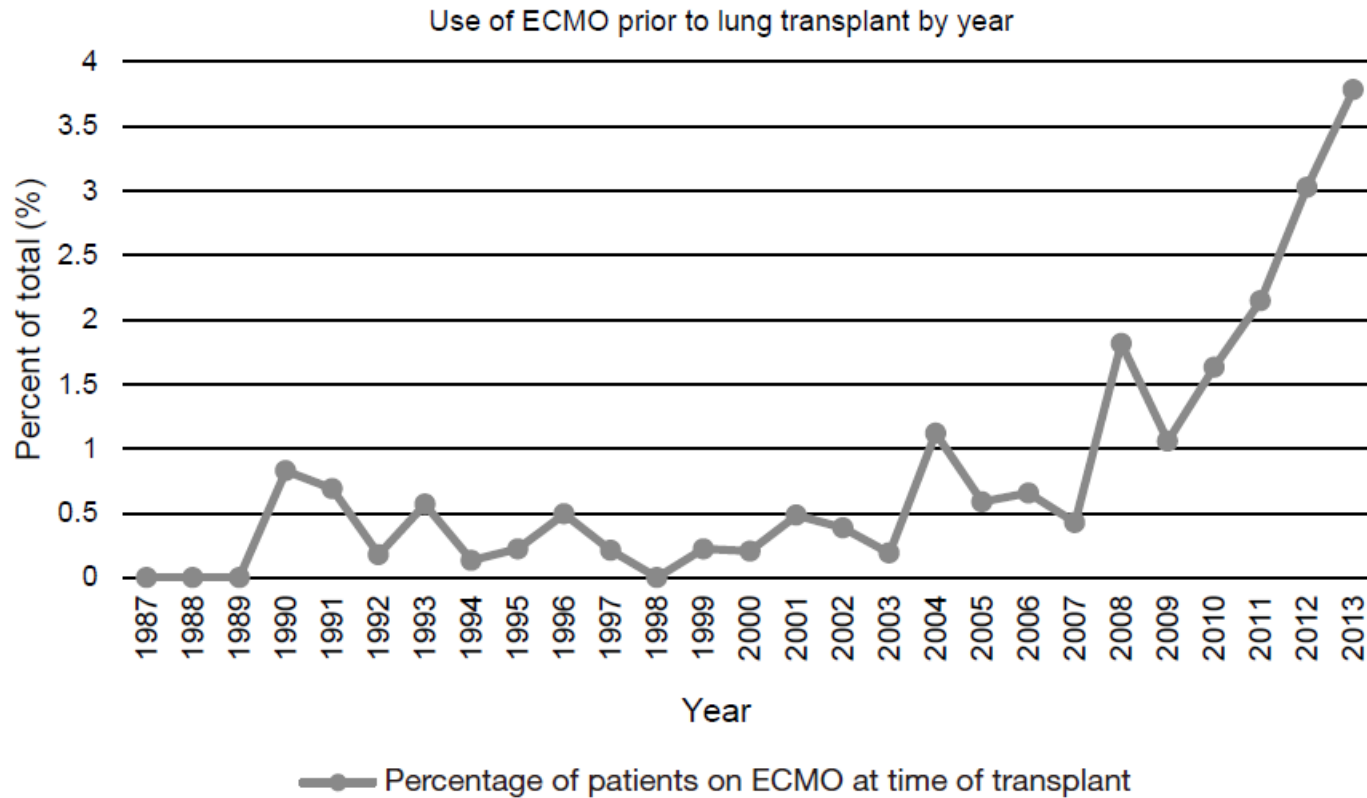
- profylakticky
- akutně (PGD)

- VA ECMO, VV ECMO, VAV ECMO

- centrální x periferní kanylace



ECMO U TX PLIC - BRIDGE



Extracorporeal Membrane Oxygenation in Awake Patients as Bridge to Lung Transplantation

Thomas Fuehner¹, Christian Kuehn², Johannes Hadem³, Olaf Wiesner¹, Jens Gottlieb¹, Igor Tudorache², Karen M. Olsson¹, Mark Greer¹, Wiebke Sommer², Tobias Welte¹, Axel Haverich², Marius M. Hoepfer¹, and Gregor Warnecke²

¹Department of Respiratory Medicine, ²Department of Cardiothoracic, Transplant and Vascular Surgery, and ³Department of Hepatology and Endocrinology, Hannover Medical School, Hannover, Germany

Rationale: The use of extracorporeal membrane oxygenation (ECMO) in patients who are awake and spontaneously breathing may represent a novel bridging strategy toward lung transplantation (LuTx).

Objectives: To evaluate the outcomes of patients treated with the "awake ECMO" concept as bridge to transplantation.

Methods: We performed a retrospective, single-center, intention-to-treat analysis of consecutive LuTx candidates with terminal respiratory or cardiopulmonary failure receiving awake ECMO support. The outcomes were compared with a historical control group of patients treated with conventional mechanical ventilation (MV group) as bridge to transplant.

Measurements and Main Results: Twenty-six patients (58% female; median age, 44 yr; range, 23–62) were included in the awake ECMO group and 34 patients (59% female; median age, 36 yr; range, 18–59) in the MV group. The duration of ECMO support or MV, respectively, was comparable in both groups (awake ECMO: median, 9 d; range, 1–45. MV: median, 15 d; range, 1–71; $P = 0.25$). Six (23%) of 26 patients in the awake ECMO group and 10 (29%) of 34 patients in the MV group died before a donor organ was available ($P = 0.20$). Survival at 6 months after LuTx was 80% in the awake ECMO group versus 50% in the MV group ($P = 0.02$). Patients in the awake ECMO group required shorter postoperative MV ($P = 0.04$) and showed a trend toward a shorter postoperative hospital stay ($P = 0.06$).

Conclusions: ECMO support in patients who are awake and nonintubated represents a promising bridging strategy, which should be further evaluated to determine its role in patients with end-stage lung disease awaiting LuTx.

AT A GLANCE COMMENTARY

Scientific Knowledge on the Subject

Waiting times for lung transplantation (LuTx) are increasing. Endotracheal intubation in patients with end-stage lung disease before LuTx is associated with increased mortality. New strategies of bridging critical candidates are of major interest.

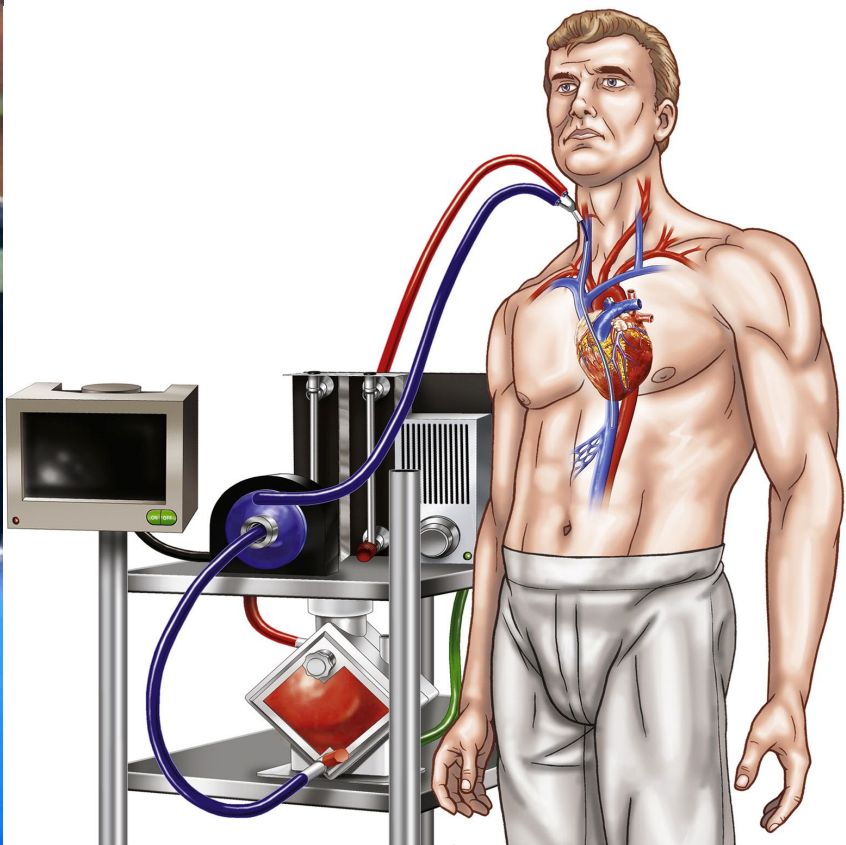
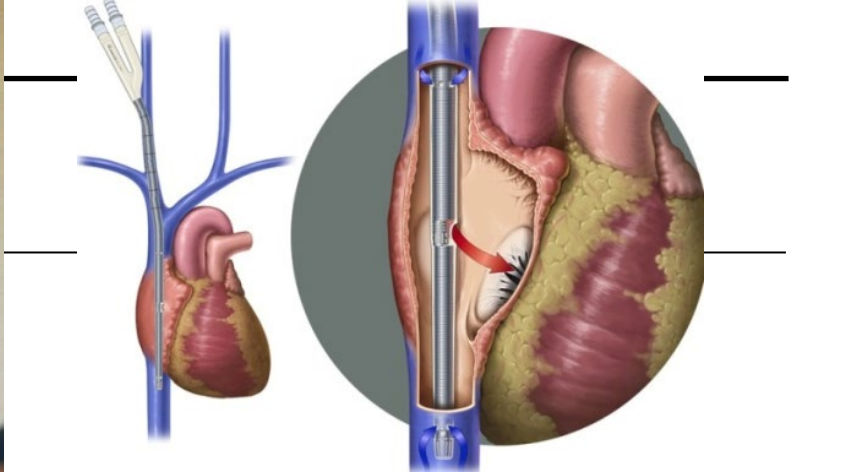
What This Study Adds to the Field

Extracorporeal membrane oxygenation support in patients who are awake and nonventilated is a new strategy for bridging patients to LuTx.

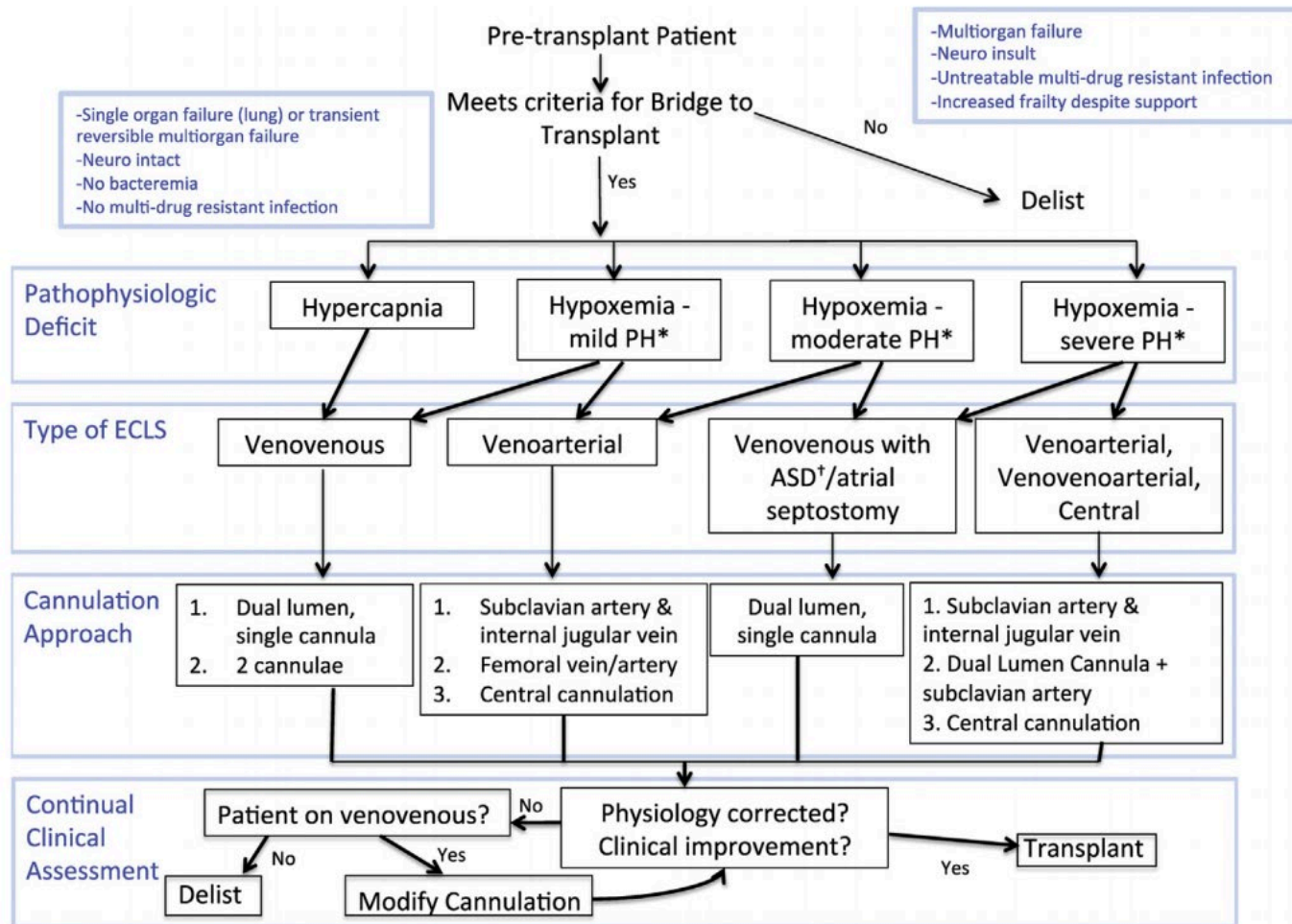
several weeks or even months until a suitable donor organ is available, resulting in considerable mortality on the waiting list.

These issues have led to renewed interest in alternative strategies for patients with end-stage lung disease. The use of awake ECMO, awake ECMO, and mechanical ventilation (MV) is a last resort because most patients who are intubated and mechanically ventilated do not survive to undergo transplantation, and those who do tend to have





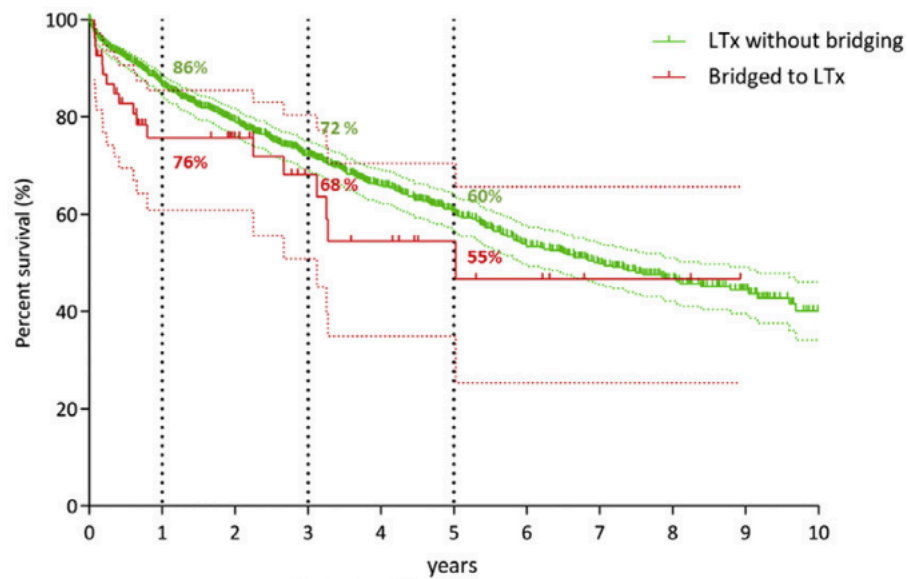
Absolutní kontraindikace ??: pacient není na čekací listině



TORONTO LUNG TRANSPLANT PROGRAM

2006-2016 1111 Tx

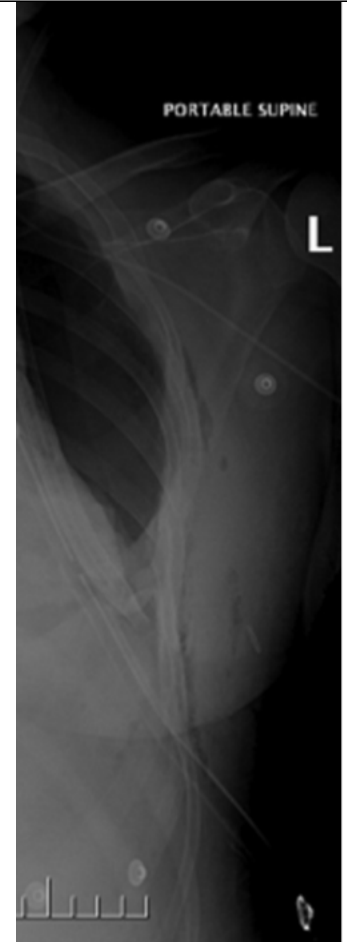
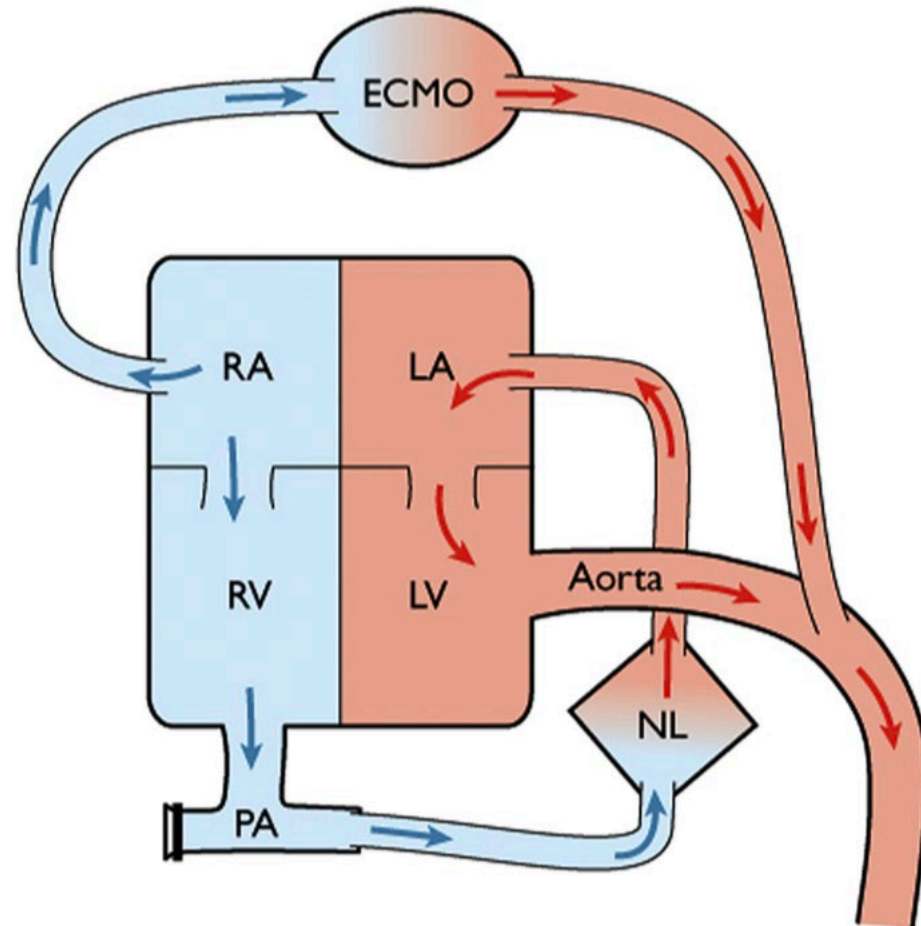
71/63 BRIDGE



	Patients at risk										
	0	1	2	3	4	5	6	7	8	9	10
LTx without bridging	1007	775	612	489	371	279	200	152	98	58	20
Bridged to LTx	54	28	23	15	11	7	5	2	2	0	0

▲

BILATERAL PNEUMONECTOMY TO TREAT UNCONTROLLED SEPSIS IN A PATIENT AWAITING LUNG TRANSPLANTATION



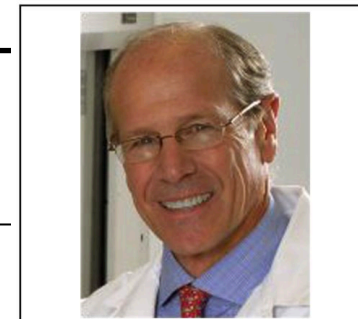
Cypel M. Bilateral pneumonectomy to treat uncontrolled sepsis in a patient awaiting lung transplantation
The Journal of Thoracic and Cardiovascular Surgery, 2017

Bilateral pneumonectomy to treat uncontrolled sepsis in a patient awaiting lung transplantation



Cypel M. Bilateral pneumonectomy to treat uncontrolled sepsis in a patient awaiting lung transplantation
The Journal of Thoracic and Cardiovascular Surgery, 2017

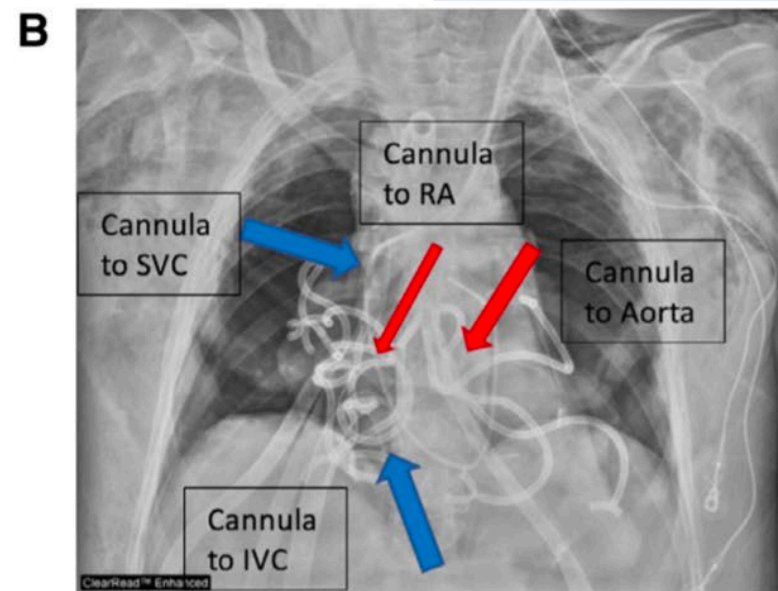
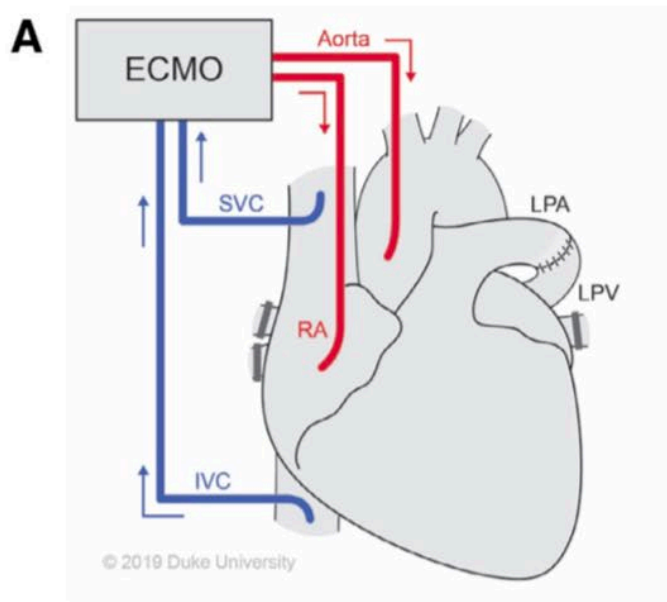
BILATERALNÍ PNEUMONEKTOMIE A VA ECMO MOST K TX PLIC



Bartley P. Griffith, MD, FACS, FRCS

Central Message

This case teaches us a lot about the effect of septic lungs on sepsis and about a creative use of dual extracorporeal membrane oxygenation systems, performed without complications. Bravo!



STATE OF ART

State of the Art: Bridging to lung transplantation using artificial organ support technologies



Keshava Rajagopal, MD, PhD,^a and Marius M. Hoeper, MD^b

From the ^aCenter for Advanced Heart Failure and Department of Cardiothoracic/Vascular Surgery, University of Texas-Houston and Memorial Hermann-Texas Medical Center, Houston, Texas; and the ^bDepartment of Respiratory Medicine, Hannover Medical School, and German Center for Lung Research (DZL), Hannover, Germany.

KEYWORDS:

lung transplantation;
extracorporeal mem-
brane oxygenation;
mechanical ventilation;
end-stage lung disease;
artificial organ support

Abstract

Lung transplantation increasingly is being performed in recipients of higher risk and acuity. A subset of these patients has severely abnormal gas exchange and/or right ventricular dysfunction, such that artificial organ support strategies are required to bridge patients to lung transplantation. We review the rationales and currently used and potential strategies for bridging to lung transplantation and characterize bridging outcomes. Based on physiologic reasoning and a study of the existing literature, we provide a working strategy for bridging to lung transplantation.

J Heart Lung Transplant 2016;35:1385–1398

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“BRIDGING TO Tx” ČR– VYSOKÁ URGENCE

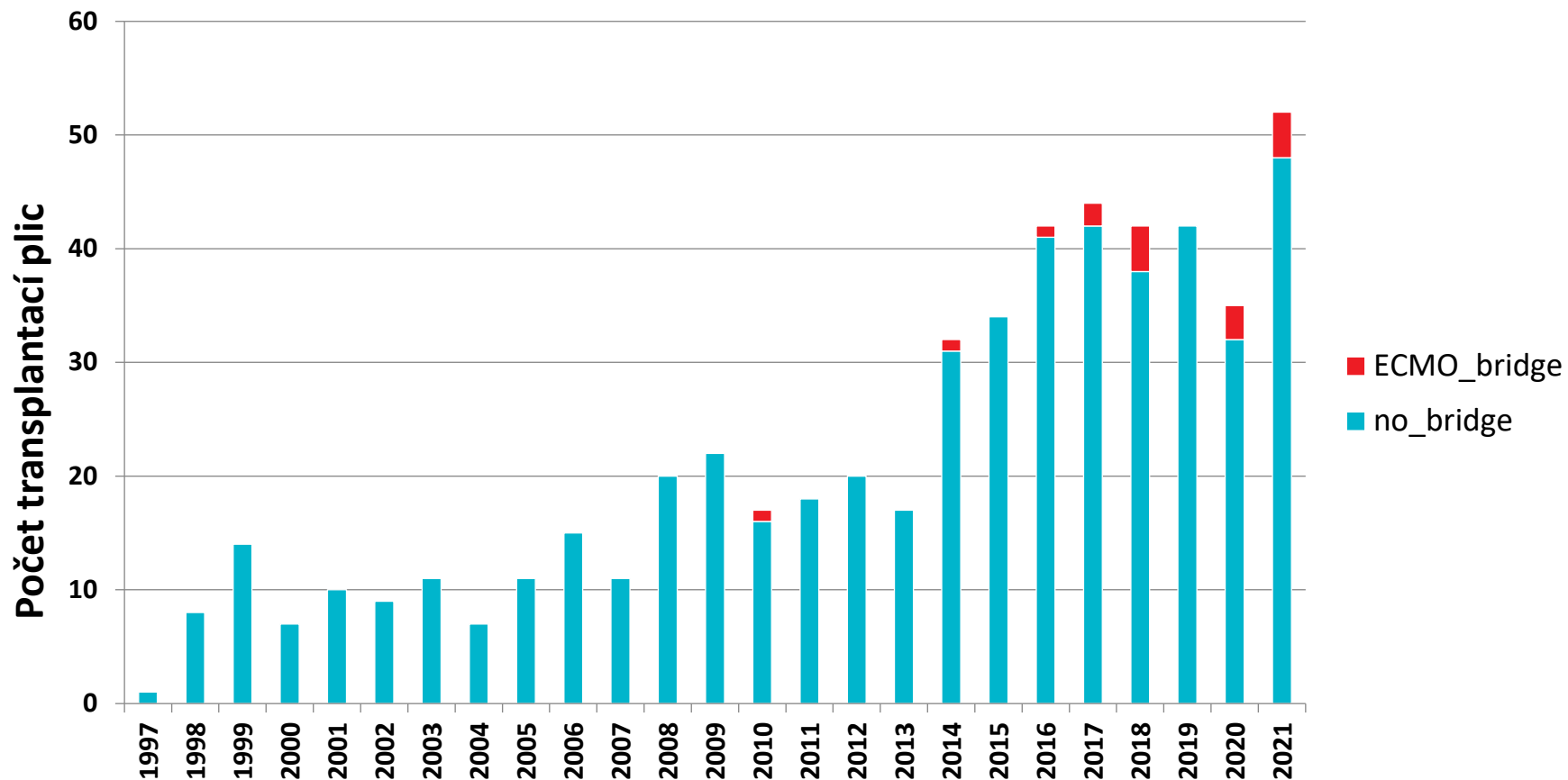
- Při zařazení pacienta nutno rozhodnout, zda bude indikován k “Bridge to Tx” nebo ne
 - věk, frailty, komorbidity atd.
- Zhoršení stavu
 - Ventilátor/ECMO
- Překlad do transplantačního centra FN Motol
 - Možnost každodenního vyhodnocování transplantability
- Urgentní transplantace x vyřazení z čekací listiny

“BRIDGING TO TX” ČR– VYSOKÁ URGENCE

Zásadní limit v ČR:

- *nedostatek vhodných dárců ?????? Spíše Relativní nedostatek*
- **nemožnost získání orgánu z nadnárodního systému**
- *Slovensko?*

ECMO bridge to Tx

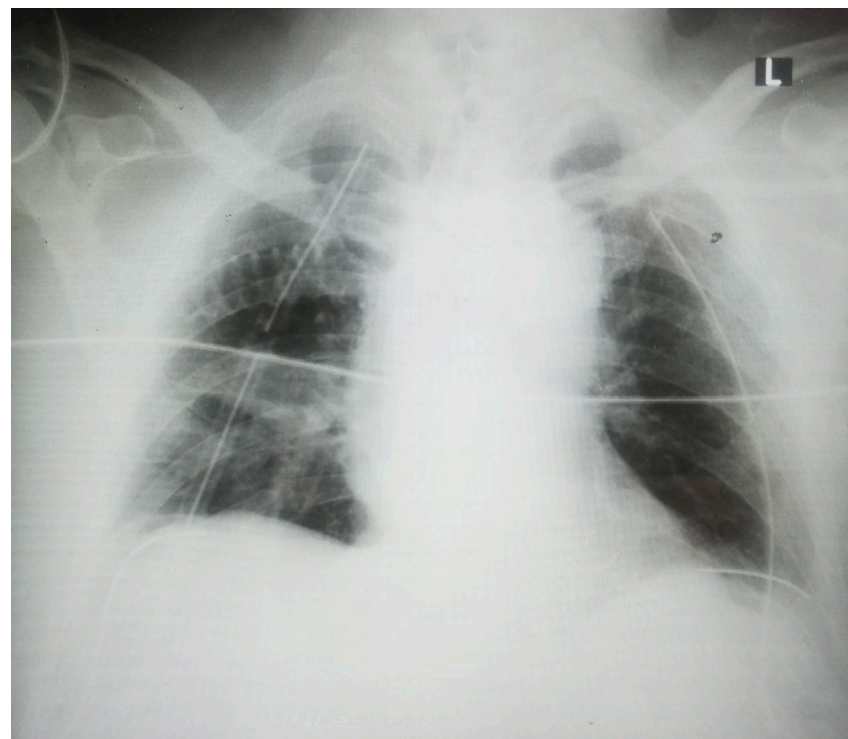
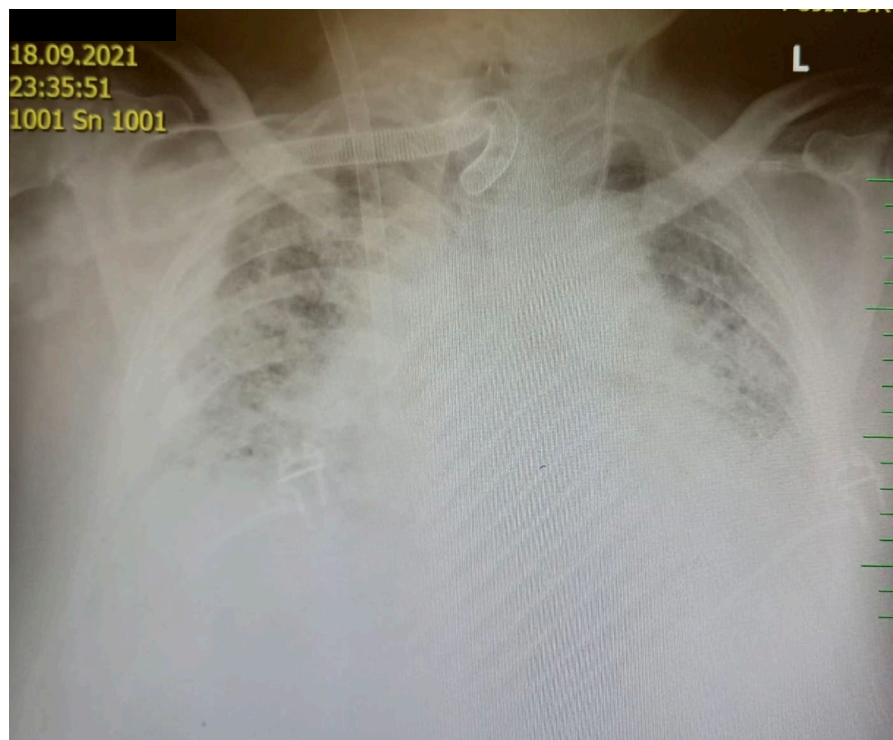


CASE REPORT

A patient with pulmonary hypertension waiting for donor lungs during the pandemic: 194 days on extracorporeal life support including 143 days on pulmonary artery to left atrium shunt

Martin Balik , Jan Rulisek, Marek Flaksa, Michal Porizka, Frantisek Mosna, Jaroslav Lindner, Samuel Heller, Jan Belohlavek, Theodor Adla, Christof Schmid, Alois Philipp, Jan Havlin, Jan Burkert, Robert Lischke ... [See fewer authors](#) ^

Transplantace plic pro COVID 19 ARDS – 19.9.2021, VA ECMO, prolongované – 5 dní
60 letý pacient – Bridge awake ECMO – 5 měsíců – 209 dní



První retransplantace plic s „ECMO bridge“ v České republice

KAZUISTIKA

Publikováno 2022-05-15

R. Novosedlák⁺ , J. Vachtenheim⁺ , Z. Střížová⁺ , J. Šimonek⁺ , M. Švorcová⁺ , J. Havlín⁺ , J. Pozniak⁺ , J. Kolařík⁺ , R. Lischke⁺ 

Abstrakt

Za 23 let trvání národního programu transplantace plic v České republice se uskutečnilo již přes 500 plicních transplantací, 4 retransplantace a jedna lobární retransplantace. Předmětem tohoto článku je kazuistika pacientky s cystickou fibrózou, která podstoupila první bilaterální transplantaci plic v lednu 2020. Z důvodu rozvoje chronické rejekce transplantovaného orgánu vyžadoval stav pacientky ECMO podporu a retransplantaci. Retransplantace proběhla v dubnu 2021 a vůbec poprvé tak byla v České republice provedena plicní retransplantace s „ECMO bridge to (re) transplantation“ podporou preoperačně z důvodu chronické dysfunkce plicního štěpu. Pacientka byla po 39 dnech od retransplantace ve stabilizovaném stavu dimitována. Při kontrole po 90 dnech od operace byla pacientka v celkově dobrém stavu a s uspokojivou funkcí plicního štěpu

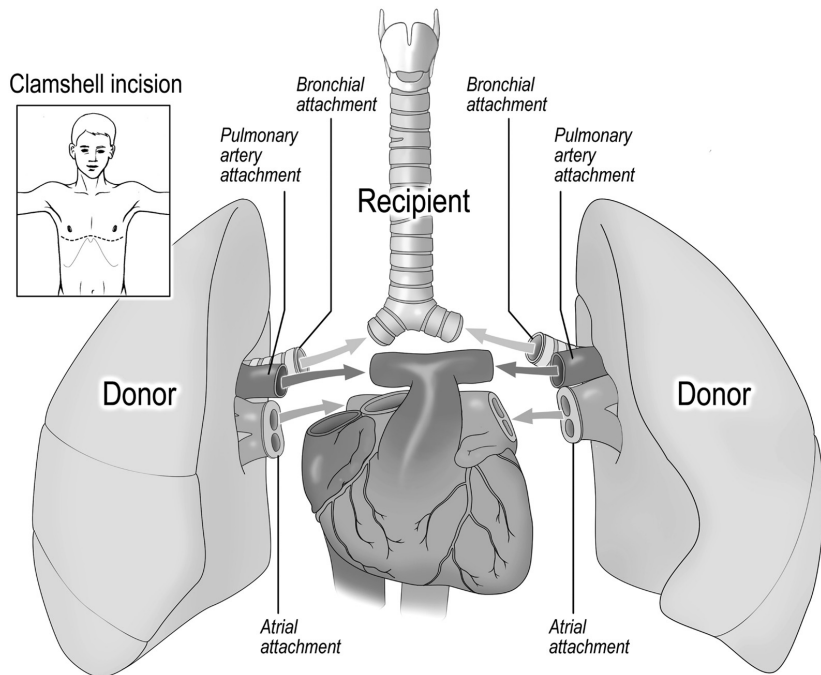


Klíčová slova

retransplantace plic
ECMO bridge
cystická fibróza
chronická dysfunkce
plicního štěpu
rejekce

Technika transplantace plic – FN Motol

Bilaterální sekvenční transplantace – VA ECMO



- Jednostranná transplantace
- **Oboustranná transplantace**
- Lobární transplantace
- Retransplantace
- Transplantace srdce a plic
- Bridge k transplantaci – ECMO
- Bridge k retransplantaci – ECMO
- Ex vivo perfúze a rekondice plic

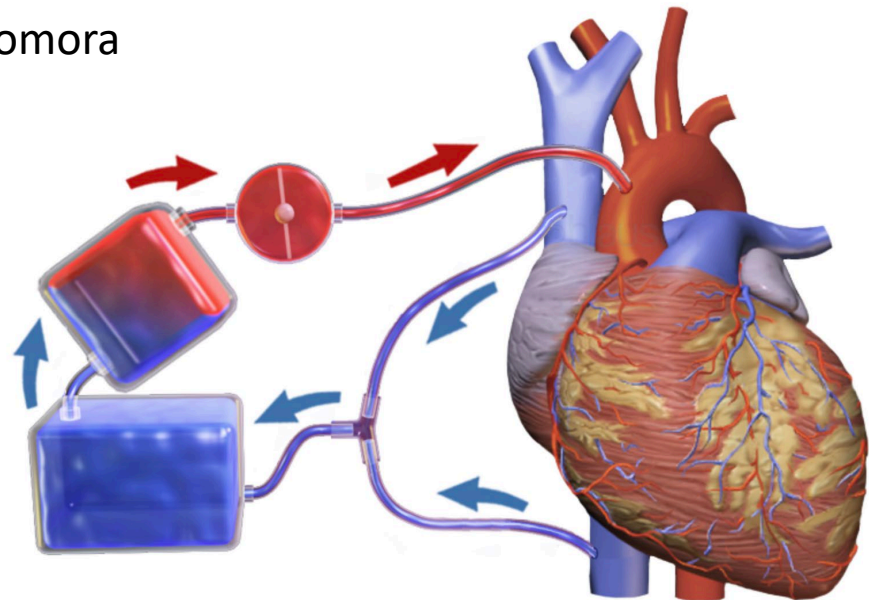
MIMOTĚLNÍ OBĚH U TX PLIC

- Vysoká plicní hypertenze
- Hypertrofická/dilatovaná pravá komora
- IPAH
- Nemožnost selektivní ventilace

CPB versus ECMO???

ECMO

- **Heparin 50j/kg**
ACT 160-180s – minimalizace krvácení
- **Možnost pokračovat po operaci při dysfunkci štěpu nebo srdce**



PERIOPERAČNÍ ROTEM A 5% ALBUMIN JAKO VOLUMEXPADÉR PŘI TRANSPLANTACI PLIC (PROSPEKTIVNÍ RANDOMIZOVANÁ STUDIE)



Rotational thromboelastometry reduces blood loss and blood product usage after lung transplantation



Miroslav Durila, MD, PhD,^a Jaromir Vajter, MD,^a Michal Garaj, MD,^a
Lukas Pollert, MD,^a Jan Berousek, MD,^a Jiri Vachtenheim, Jr, MD,^b
Tomas Vymazal, MD, PhD,^a and Robert Lischke, MD, PhD^b

From the ^aDepartment of Anesthesiology and Intensive Care Medicine, Second Faculty of Medicine, Charles University and Motol University Hospital, Prague, Czech Republic; and the ^bThird Department of Surgery, First Faculty of Medicine, Charles University and Motol University Hospital, Prague, Czech Republic.

KEYWORDS:

bleeding;
blood transfusion
products;
point of care;
ROTEM;
transplantation

BACKGROUND: The shortage of blood products has become a worldwide problem, especially during the COVID-19 Pandemic. Here, we investigated whether a point of care (POC) approach to perioperative bleeding and coagulopathy based on rotational thromboelastometry (ROTEM) results could decrease perioperative blood loss and the perioperative consumption of blood products during lung transplantation.

METHODS: Patients undergoing bilateral lung transplantation were randomized into two groups: In the first group, designated the “non POC” group, the management of perioperative bleeding and coagulopathy was based on the clinical experience of the anesthesiologist; in the second group, designated the “POC” group, the management of perioperative bleeding, and coagulopathy was based on the ROTEM results.

RESULTS: After performing an interim statistical analysis, the project was prematurely terminated as the results were significantly in favor of the POC approach. Data were analyzed for the period January 2018 until June 2020 when 67 patients were recruited into the study. There was significantly decreased perioperative blood loss in the POC group ($n = 31$ patients) with $p = 0.013$, decreased perioperative consumption of RBC with $p = 0.009$, and decreased perioperative consumption of fresh frozen plasma with $p < 0.0001$ (practically no fresh frozen plasma was used in the POC group) without deteriorating clot formation in secondary and primary hemostasis as compared to the non POC group ($n = 36$).

CONCLUSION: POC management of perioperative bleeding and coagulopathy based on ROTEM results is a promising strategy to decrease perioperative blood loss and the consumption of blood products in lung transplantation.

J Heart Lung Transplant 2021;40:631–641

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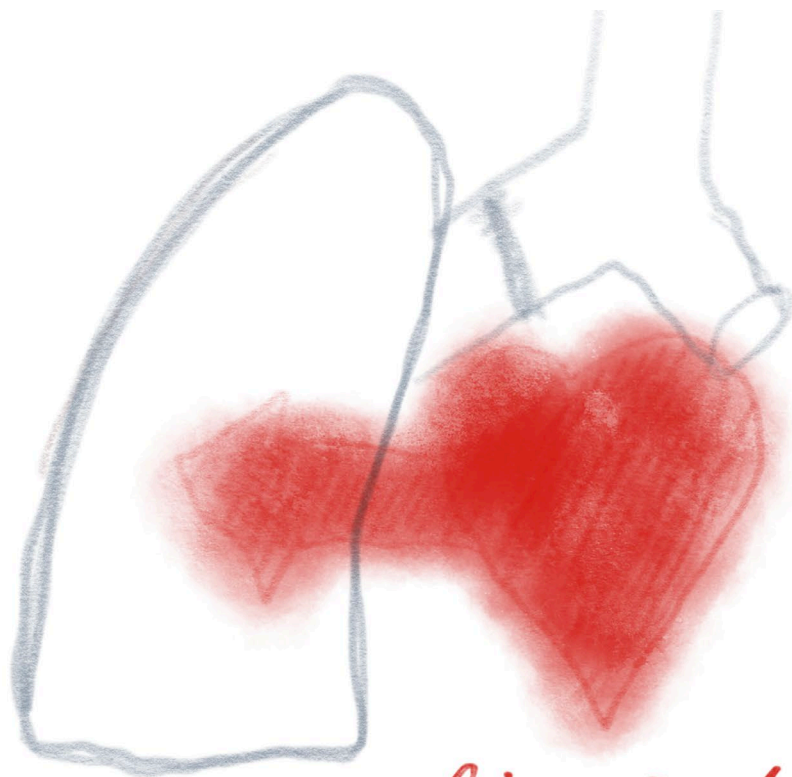
- Cílený management koagulopatie při Tx plic pomocí ROTEM signifikantně redukuje krevní ztrátu a nutnost podání krevních derivátů (ERY, PLT, FFP), publikováno v Journal of Heart and Lung Transplantation
- Cílený management koagulopatie a výhradní použití 5% albumin jako volumexpanderu při Tx plic signifikantně snižuje četnost primární dysfunkce štěpu, která se výraznou měrou podílí na časně morbiditě a mortalitě pacientů po Tx plic

ADULT-HEART LUNG TRANSPLANTS

CAUSE OF DEATH (DEATHS: JANUARY 1992 – JUNE 2016)

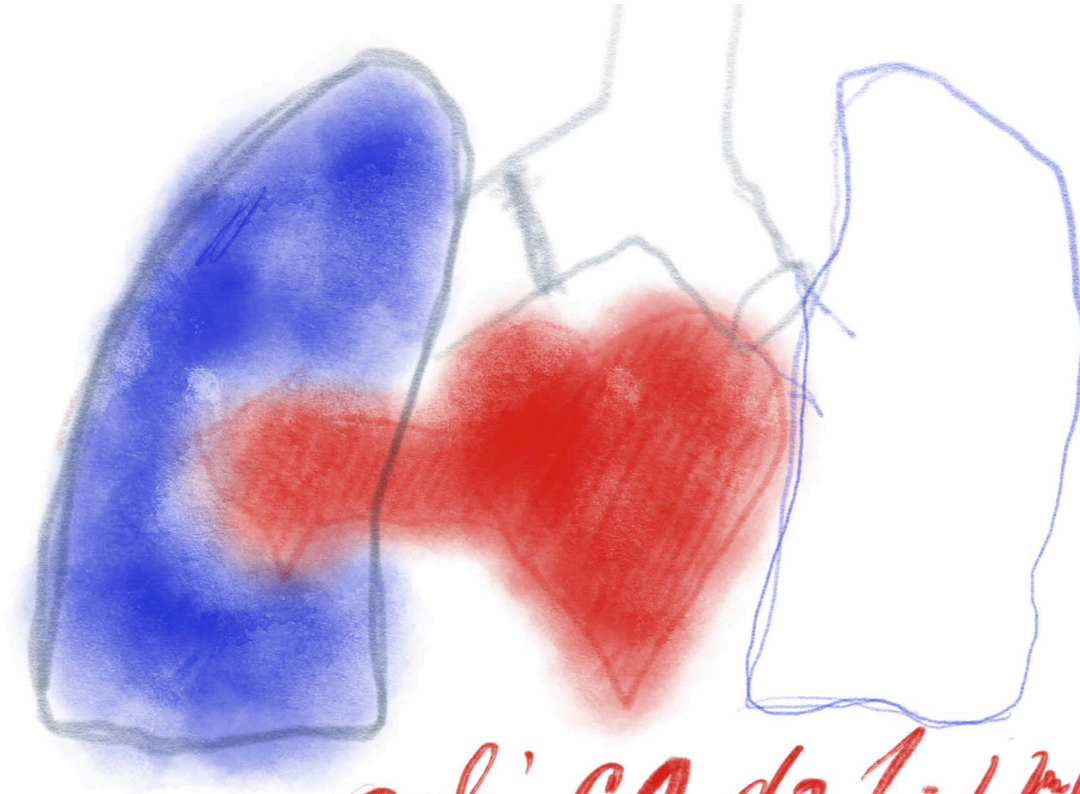
CAUSE OF DEATH	0-30 Days (N=472)	31 Days - 1 Year (N=360)	>1 Year - 3 Years (N=294)	>3 Years - 5 Years (N=175)	>5 Years (N=535)
OB/BOS	0	14 (3.9%)	69 (23.5%)	38 (21.7%)	110 (20.6%)
ACUTE REJECTION	7 (1.5%)	6 (1.7%)	5 (1.7%)	1 (0.6%)	3 (0.6%)
LYMPHOMA	0	7 (1.9%)	12 (4.1%)	8 (4.6%)	11 (2.1%)
MALIGNANCY, OTHER	1 (0.2%)	8 (2.2%)	13 (4.4%)	7 (4.0%)	43 (8.0%)
CMV	0	2 (0.6%)	2 (0.7%)	1 (0.6%)	1 (0.2%)
INFECTION, NON-CMV	80 (16.9%)	126 (35.0%)	84 (28.6%)	45 (25.7%)	115 (21.5%)
GRAFT FAILURE	127 (26.9%)	76 (21.1%)	44 (15.0%)	32 (18.3%)	78 (14.6%)
CARDIOVASCULAR	39 (8.3%)	15 (4.2%)	22 (7.5%)	18 (10.3%)	53 (9.9%)
TECHNICAL	110 (23.3%)	12 (3.3%)	3 (1.0%)	3 (1.7%)	7 (1.3%)
MULTIPLE ORGAN FAILURE	51 (10.8%)	54 (15.0%)	15 (5.1%)	7 (4.0%)	36 (6.7%)
OTHER	57 (12.1%)	40 (11.1%)	25 (8.5%)	15 (8.6%)	78 (14.6%)

SYNDROM 1. PLÍCE



*celý CO do 1. implantováno
plíce*

SYNDROM 1. PLÍCE



*celý CO do 1. implantované
plíce*

Controlled Reperfusion Protects Lung Grafts During a Transient Early Increase in Permeability

Moninder S. Bhabra, FRCS, David N. Hopkinson, MD, Trudi E. Shaw, Natasha Onwu, BSc, and Timothy L. Hooper, MD

Department of Cardiothoracic Surgery, Wythenshawe Hospital, Manchester, United Kingdom

Background. We have previously shown that an initial 10-minute period of low-pressure reperfusion prevents the lung graft dysfunction that follows physiologic-pressure reperfusion. Possible mechanisms were investigated in this study.

Methods. Rat lungs were reperfused ex vivo using a parabiotic animal after 0-hour (groups A through C) or 24-hour (groups D through G) storage. Reperfusion pressure was either physiologic (groups A through D) or reduced by 50% for a specified time (groups E through G). The duration of reperfusion was 5 minutes (groups A, D, and E), 10 minutes (groups B and F), or 30 minutes (groups C and G), at which time endothelial permeability was measured through iodine 125-labeled albumin leakage and neutrophil sequestration through tissue myeloperoxidase activity.

Results. Graft function in group D deteriorated rapidly, whereas groups E through G performed at control levels. Albumin leakage was significantly elevated in group D; with controlled reperfusion, it was elevated after 5 minutes (group E) but had returned to baseline at 10 minutes (group F) and 30 minutes (group G). Myeloperoxidase levels were not significantly different between groups.

Conclusions. Endothelial permeability is transiently elevated in the early phase of lung graft reperfusion. Initial low-pressure reperfusion may be protective by preventing irreversible edema formation during this period.

(Ann Thorac Surg 1998;65:187-92)

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Critical Importance of the First 10 Minutes of Lung Graft Reperfusion After Hypothermic Storage

Moninder S. Bhabra, FRCS, David N. Hopkinson, MD, Trudi E. Shaw, and Timothy L. Hooper, MD

Department of Cardiothoracic Surgery, Wythenshawe Hospital, Manchester, United Kingdom

Background. We have shown previously that lung graft function can be improved by achieving reperfusion with stepwise increments of perfusion pressure over 60 minutes. This study aimed to establish whether similar benefit could be achieved with a shorter, simpler protocol and different storage conditions.

Methods. Rat lungs were flushed with University of Wisconsin or modified Euro-Collins solution and reperfused for 1 hour with blood from a support animal. Grafts were reperfused immediately or after storage at 4°C for 24 hours (University of Wisconsin solution) or 6 hours (Euro-Collins solution). Stored-graft reperfusion was initiated with a 0-, 5-, or 10-minute period during which reperfusion pressure was reduced by 50%.

Results. Stored grafts receiving 0 or 5 minutes of initial low-pressure reperfusion performed poorly, with reduced oxygenation and blood flow and elevated pulmonary artery pressure, airway pressure, and wet/dry weight ratio. In contrast, 10 minutes of initial 50%-pressure reperfusion yielded function comparable with that in controls with both storage conditions.

Conclusions. An initial 10-minute period of 50%-pressure reperfusion improves the function of stored rat lung grafts, whereas 5 minutes is insufficient.

(*Ann Thorac Surg* 1996;61:1631–5)

Research article

Open Access

Length of pressure-controlled reperfusion is critical for reducing ischaemia-reperfusion injury in an isolated rabbit lung model

Stefan Guth*^{1,2}, Diethard Prüfer¹, Thorsten Kramm¹ and Eckhard Mayer¹

Address: ¹Department of Cardiothoracic and Vascular Surgery, Johannes Gutenberg – University, Langenbeckstr. 1, 55131 Mainz, Germany and ²Diakonie Hospital Rotenburg, Teaching Hospital of the University of Göttingen Elise-Averdieck, Str. 17, 27356 Rotenburg, Germany

Email: Stefan Guth* - guth@diako-online.de; Diethard Prüfer - pruefer@uni-mainz.de; Thorsten Kramm - dr.thorsten.kramm@uniklinikum-saarland.de; Eckhard Mayer - emayer@uni-mainz.de

* Corresponding author

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Abstract

Background: Ischaemia-reperfusion injury is still a major problem after lung transplantation. Several reports describe the benefits of controlled graft reperfusion. In this study the role of length of the initial pressure-controlled reperfusion (PCR) was evaluated in a model of isolated, buffer-perfused rabbit lungs.

Methods: Heart-lung blocks of 25 New Zealand white rabbits were used. After measurement of baseline values (haemodynamics and gas exchange) the lungs were exposed to 120 minutes of hypoxic warm ischaemia followed by repeated measurements during reperfusion. Group A was immediately reperfused using a flow of 100 ml/min whereas groups B, C and D were initially reperfused with a maximum pressure of 5 mmHg for 5, 15 or 30 minutes, respectively. The control group had no period of ischaemia or PCR.

Results: Uncontrolled reperfusion (group A) caused a significant pulmonary injury with increased pulmonary artery pressures (PAP) and pulmonary vascular resistance and a decrease in oxygen partial pressure (PO₂), tidal volume and in lung compliance. All groups with PCR had a significantly higher PO₂ for 5 to 90 min after start of reperfusion. At 120 min there was also a significant difference between group B (264 ± 91 mmHg) compared to groups C and D (436 ± 87 mmHg; 562 ± 20 mmHg, p < 0.01). All PCR groups showed a significant decrease of PAP compared to group A.

Conclusion: Uncontrolled reperfusion results in a severe lung injury with rapid oedema formation. PCR preserves pulmonary haemodynamics and gas exchange after ischaemia and might allow for recovery of the impaired endothelial function. 30 minutes of PCR provide superior results compared to 5 or 15 minutes of PCR.

DOBA KONTROLOVANÉ REPERFÚZE??



5, 10, 30, 45, 60 min????



Během celé implantace – intraOp VA ECMO

Intraoperative extracorporeal membrane oxygenation and the possibility of postoperative prolongation improve survival in bilateral lung transplantation

Read at the 97th Annual Meeting of The American Association for Thoracic Surgery, Boston, Massachusetts, April 29-May 3, 2017.

[Konrad Hoetzenecker](#), MD, PhD^a, [Stefan Schwarz](#), MD^a, [Moritz Muckenhuber](#), MD^a, [Alberto Benazzo](#), MD^a, [Florian Frommlet](#), PhD^b, [Thomas Schweiger](#), MD, PhD^a, [Orsolya Bata](#), MD^c, [Peter Jaksch](#), MD^a, [Negar Ahmadi](#), MD^d, [Gabriella Muraközy](#), MD^a, [Helmut Prosch](#), MD^e, [Helmut Hager](#), MD^f, [Georg Roth](#), MD^f, [György Lang](#), MD, PhD^{a,g}, [Shahrokh Taghavi](#), MD^a, [Walter Klepetko](#), MD^{a,*}  



DOI: <https://doi.org/10.1016/j.jtcvs.2017.10.144> |



 Article Info

Abstract | Full Text | Images | References | Supplemental Materials

Abstract

Objectives

The value of intraoperative extracorporeal membrane oxygenation (ECMO) in lung transplantation remains controversial. In our department, ECMO has been used routinely for intraoperatively unstable patients for more than 15 years. Recently, we have extended its indication to a preemptive application in almost all cases. In addition, we prolong ECMO into the early postoperative period whenever graft function does not meet certain quality criteria or in patients with primary pulmonary hypertension. The objective of this study was to review the results of this strategy.

Methods

All standard bilateral lung transplantations performed between January 2010 and June 2016 were included in this single-center, retrospective analysis. Patients were divided into 3 groups: group I—no ECMO (n = 116), group II—intraoperative ECMO (n = 343), and group III—intraoperative and prolonged postoperative ECMO (n = 123). The impact of different ECMO strategies on primary graft function, short-term outcomes, and patient survival were analyzed.

Results

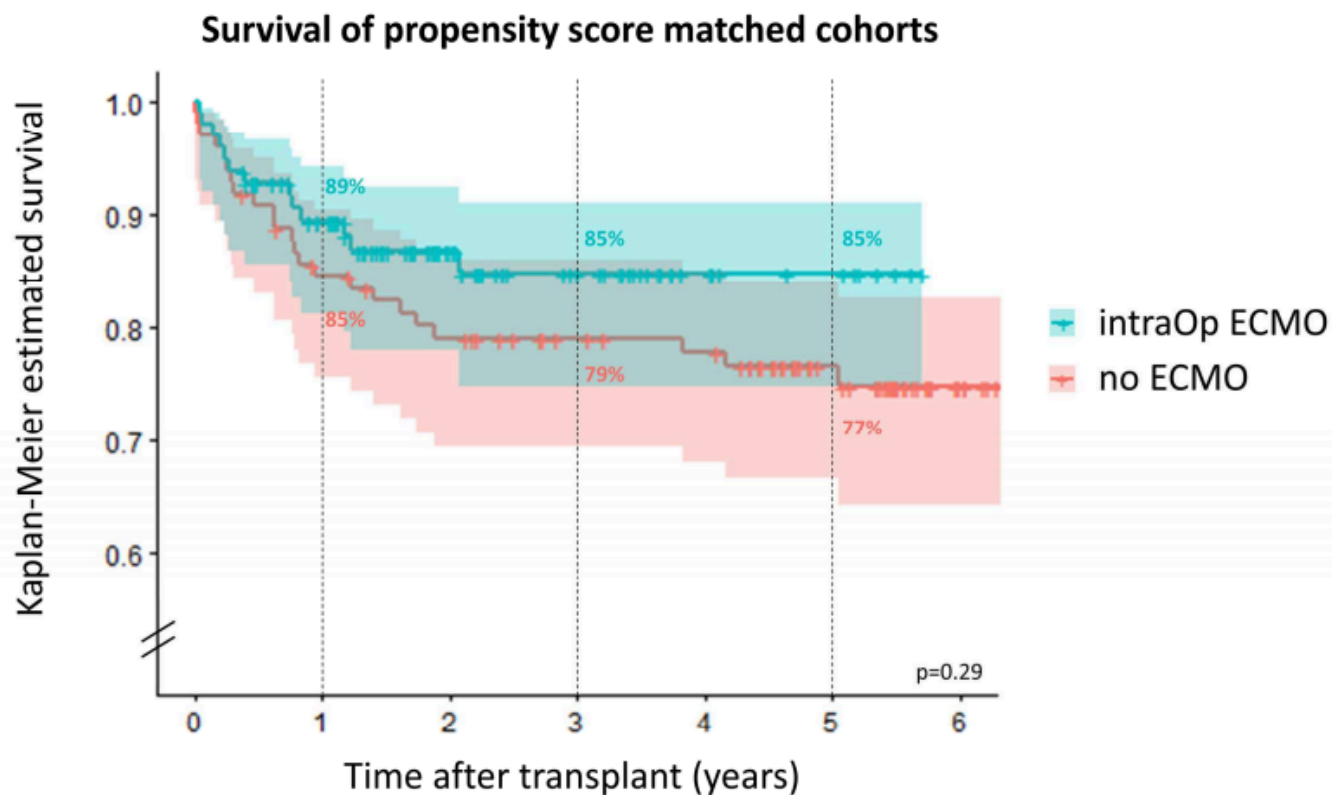
The use of intraoperative ECMO was associated with improved 1-, 3-, and 5-year survival compared with non-ECMO patients (91% vs 82%, 85% vs 76%, and 80% vs 74%; log-rank $P = .041$). This effect was still evident after propensity score matching of both cohorts. Despite the high number of complex patients in group III, outcome was excellent with higher survival rates than in the non-ECMO group at all time points.

Conclusions

Intraoperative ECMO results in superior survival when compared with transplantation without any extracorporeal support. The concept of prophylactic postoperative ECMO prolongation is associated with excellent outcomes in recipients with pulmonary hypertension and in patients with questionable graft function at the end of implantation.

Intraoperative ECMO and the possibility of postoperative prolongation improve survival in bilateral lung transplantation

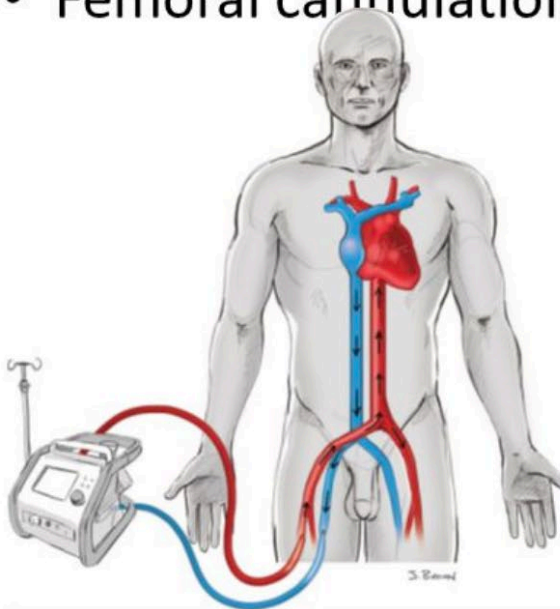
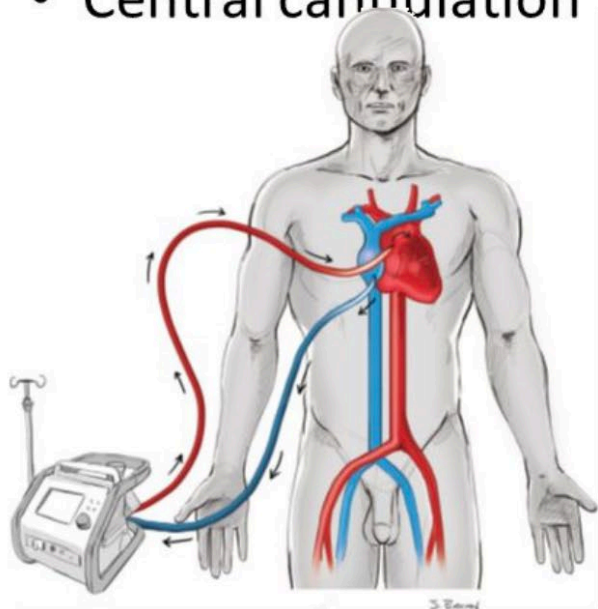
Figure 4



ECMO - KANYLACE U TX PLIC

V-A ECMO Cannulation Options

- Central cannulation
- Femoral cannulation



Problem with *peripheral* VA ECMO:

- Lower body receives better perfusion
 - Possible poor perfusion of coronary and cerebral vessels
- Oxygenated blood returned to aorta so lungs get little O₂ rich blood -> may exacerbate lung ischemia

CLINICAL LUNG AND HEART-LUNG TRANSPLANTATION

Trans Follow Trans Pulm Failure

Tudor Birsan
Omeros Arter
and Walter R

Background: pulmonary hypertension is a common complication of end-stage heart failure and may be associated with hemodynamic abnormalities.

Methods: We analyzed all echocardiographic and pulmonary artery catheterization data from 100 patients who underwent lung transplantation.

Results: Thirty-five percent of patients had pulmonary hypertension preoperatively. Hypertension was associated with right ventricular hypertrophy and dysfunction. Therapy with prostaglandins helped to establish the response to transplantation, but was very variable. The outcome of transplantation was significantly better in patients with preoperative pulmonary hypertension.

Conclusion: Echocardiography and pulmonary artery catheterism may be useful adjuvant diagnostic tools, beside routine physical examination, chest X-ray, and laboratory analysis. Therapy of this complication must be adapted individually and may be complex. J Heart Lung Transplant 1999;18:304-309.



ann, MD,^a

y for end-stage heart failure is associated with pulmonary hypertension. Echocardiography and pulmonary artery catheterism helped to establish the response to transplantation, but was very variable. The outcome of transplantation was significantly better in patients with preoperative pulmonary hypertension.



ents who underwent lung transplantation and echocardiographic findings of right ventricular hypertrophy and dysfunction.

monary hypertension was associated with right ventricular hypertrophy and dysfunction. Therapy with prostaglandins helped to establish the response to transplantation, but was very variable. The outcome of transplantation was significantly better in patients with preoperative pulmonary hypertension.

lung transplantation

The Problem after Lung Transplantation for Idiopathic Pulmonary Artery Hypertension Is not the Right Ventricle - Awake ECMO for LV Remodelling

Tudorache I.¹, Kuehn C.¹, Sommer W.¹, Avsar M.¹, Wiesner O.¹, Olsson K.¹, Hadem J.¹, Bara C.¹, Welte T.¹, Gottlieb J.¹, Hoepfer M.M.¹, Haverich A.¹, Warnecke G.¹

¹Hannover Medical School, Hannover, Germany

Background: Bilateral lung transplantation (LTx) for idiopathic pulmonary artery hypertension (IPAH) is an established treatment, but weaning off the respirator following surgery is more demanding as compared with LTx for other indications. This is widely attributed to a PAH-associated problem, impaired right heart function. We hypothesize that this assumption is wrong, but instead, impaired left heart function causes the problem and suggest an effective weaning strategy.

Methods: A novel surgical and intensive care approach was routinely assigned to all LTx for PAH (n=15) performed since 2010. Minimally invasive bilateral sequential lung transplantation was performed via anterolateral thoracotomies on extracorporeal circulation executed as veno-arterial ECMO. ECMO was left in place and maintained with 3-4 l/min flow after surgery. Early extubation on the first or second day after transplantation was achieved, but ECMO was not removed before postoperative day 6-10 routinely.

Results: The patients in this cohort had severely reduced CI of 1.5-2 l/min/m² before transplant. Early after transplant, left atrial pressures(LAP) were low and left ventricular ejection fraction (LVEF) satisfactorily under full ECMO support. Upon reduction of ECMO flow, LAP increased and LVEF decreased. Five - 10 days later, LAP and LVEF remained stable upon reduction of ECMO flow, thus, ECMO was removed. All patients survived and were eventually discharged from hospital.

Conclusion: Continuous v.-a. ECMO in spontaneously breathing patients enables LV-remodelling after LTx for IPAH. This strategy safes donor hearts and leads to superior early survival in this LTx recipient subgroup.

Lung Transplantation for Severe Pulmonary Hypertension—Awake Extracorporeal Membrane Oxygenation for Postoperative Left Ventricular Remodelling

Tudorache, Igor¹; Sommer, Wiebke¹; Kühn, Christian¹; Wiesner, Olaf²; Hadem, Johannes³; Fühner, Thomas²; Ius, Fabio¹; Avsar, Murat¹; Schwerk, Nicolaus⁴; Böthig, Dietmar¹; Gottlieb, Jens^{2,5}; Welte, Tobias^{2,5}; Bara, Christoph¹; Haverich, Axel^{1,5}; Hoeper, Marius M.^{2,5}; Warnecke, Gregor^{1,5}

Transplantation: February 2015 - Volume 99 - Issue 2 - p 451–458

doi: 10.1097/TP.0000000000000348

Original Clinical Science

FREE

Abstract

In Brief

Author Information

Article Outline

Article Metrics

Background Bilateral lung transplantation (BLTx) is an established treatment for end-stage pulmonary hypertension (PH). Ventilator weaning failure and death are more common as in BLTx for other indications. We hypothesized that left ventricular (LV) dysfunction is the main cause of early postoperative morbidity or mortality and investigated a weaning strategy using awake venoarterial extracorporeal membrane oxygenation (ECMO).

Methods In 23 BLTx for severe PH, ECMO used during BLTx was continued for a minimum of 5 days (BLTx-ECMO group). Echocardiography, left atrial (LA) and Swan-Ganz catheters were used for monitoring. Early extubation after transplantation was attempted under continued ECMO.

Results Preoperatively, all patients had severely reduced cardiac index (mean, 2.1 L/min/m²). On postoperative day 2, reduction of ECMO flow resulted in increasing LA and decreasing systemic blood pressures. On the day of ECMO explantation (median, postoperative day 8), LV diameter had increased; LA and blood pressures remained stable. Survival rates at 3 and 12 months were 100% and 96%, respectively. Data were compared to two historic control groups of BLTx without ECMO (BLTx ventilation) or combined heart-lung transplantation for severe PH.

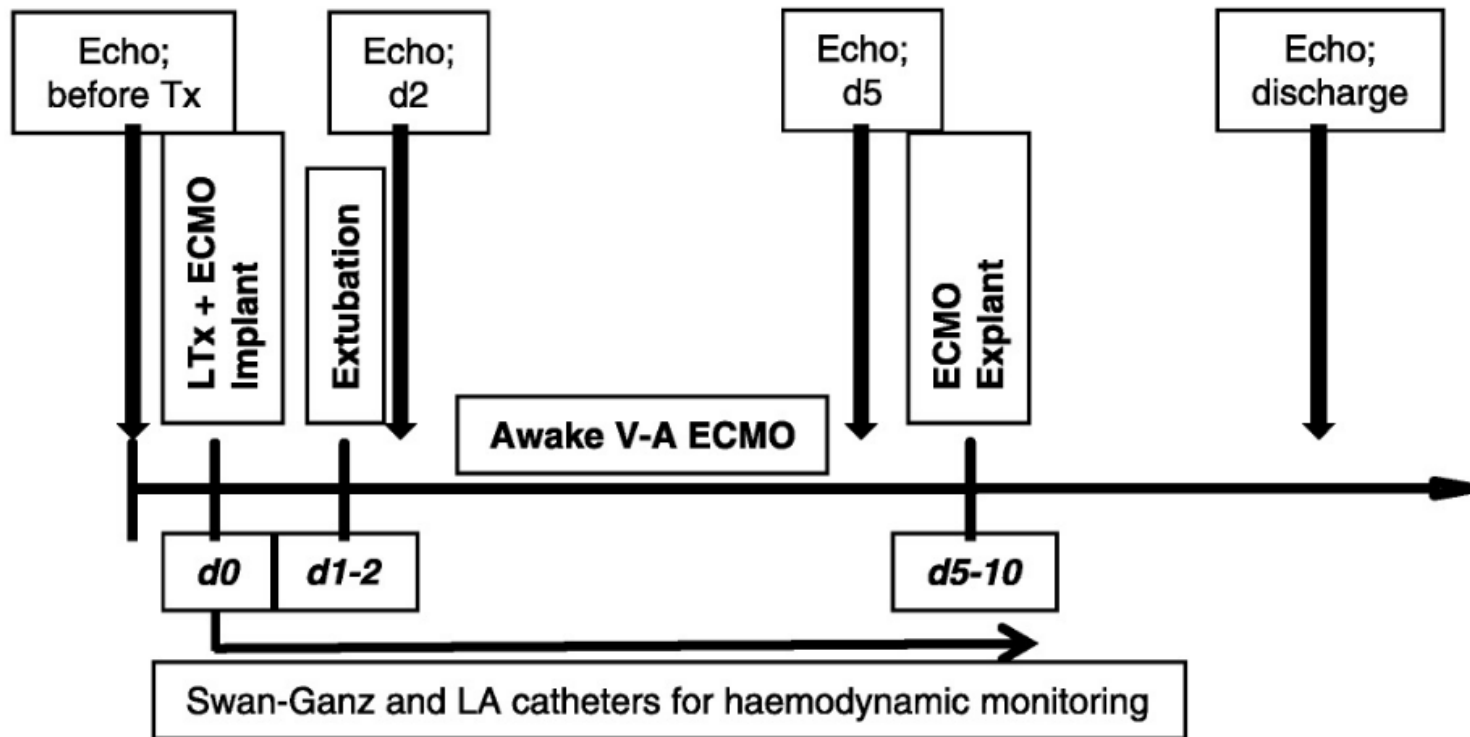
Conclusion Early after BLTx for severe PH, the LV may be unable to handle normalized LV preload. This can be effectively bridged with awake venoarterial ECMO.

Lung Transplantation for Severe Pulmonary Hypertension— Awake Extracorporeal Membrane Oxygenation for Postoperative Left Ventricular Remodelling

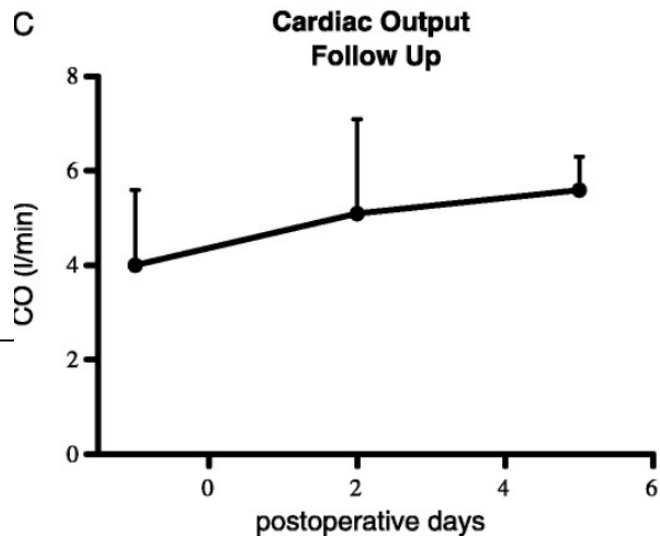
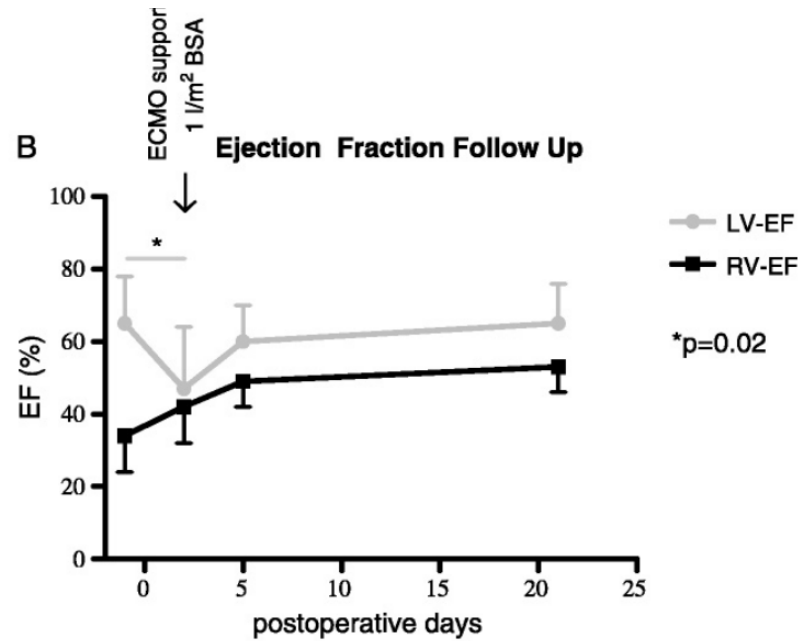
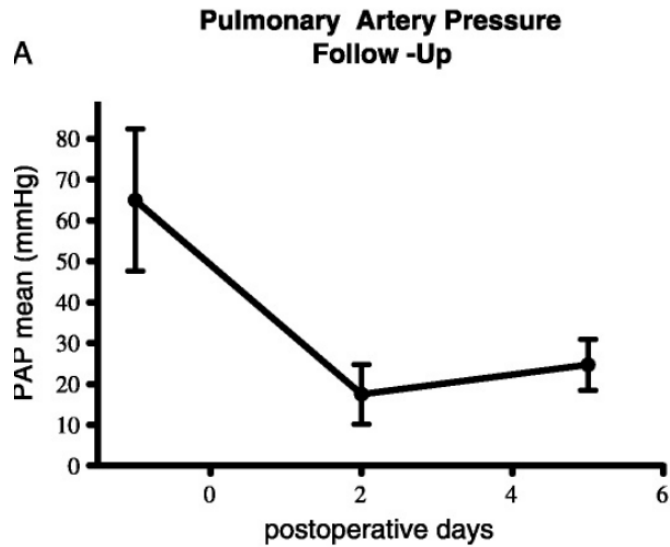
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Transplantation: February 2015 - Volume 99 - Issue 2 - p 451–458

A Protocol of BLTx for severe PAH

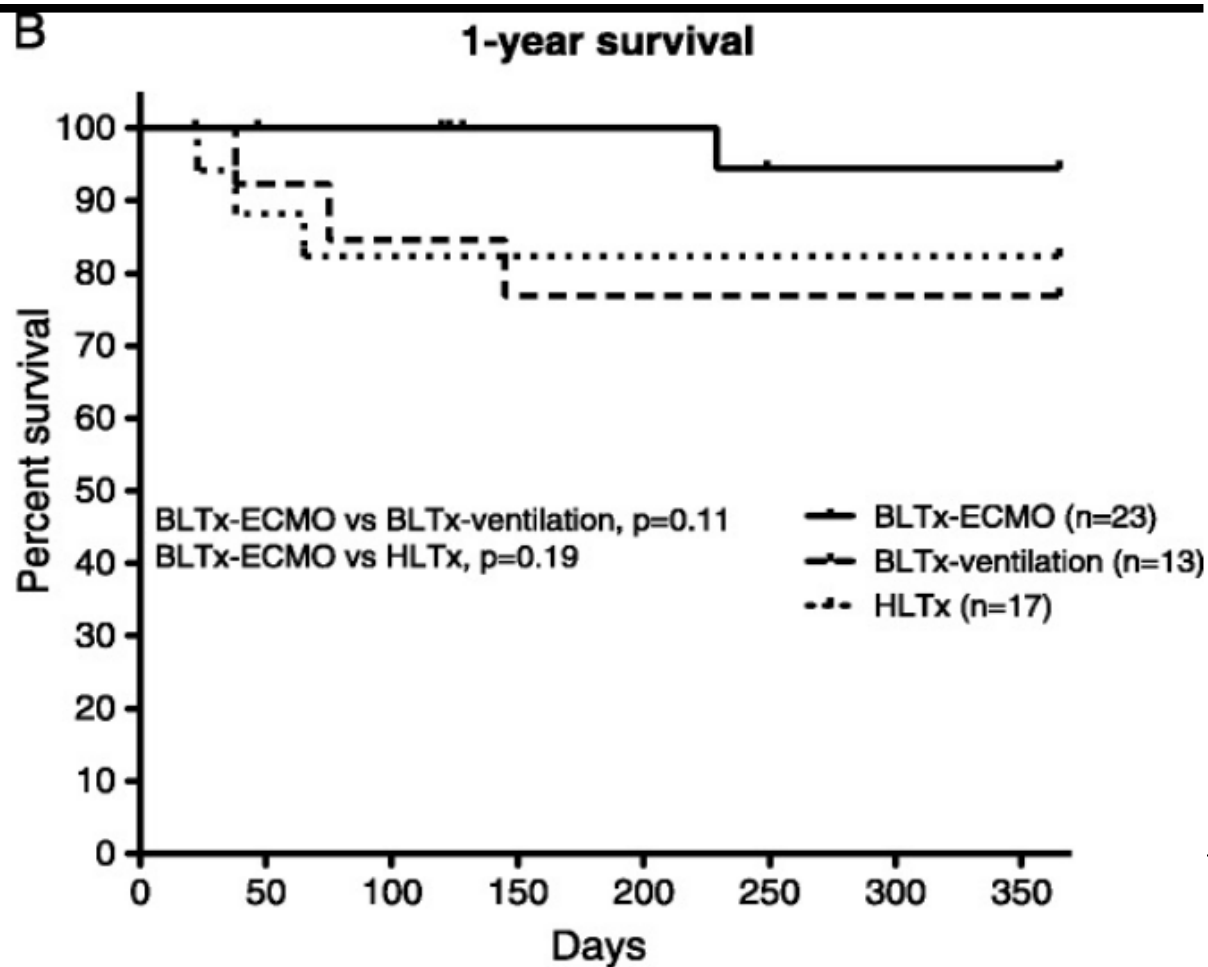


Lung Transplantation for Severe Pulmonary Hypertension— Awake Extracorporeal Membrane Oxygenation for Postoperative Left Ventricular Remodelling

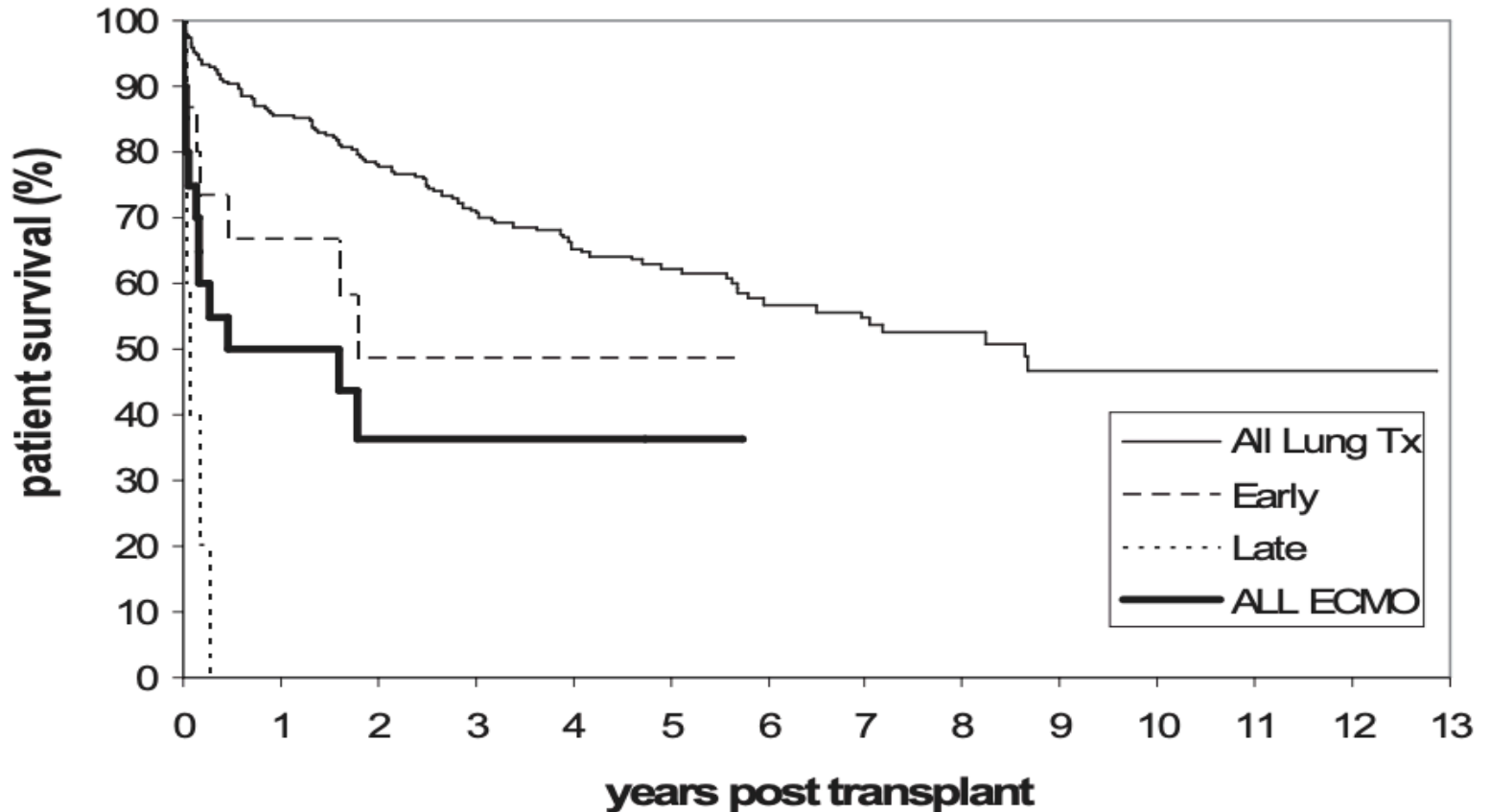


Lung Transplantation for Severe Pulmonary Hypertension— Awake Extracorporeal Membrane Oxygenation for Postoperative Left Ventricular Remodelling

Tudorache, Igor¹; Sommer, Wiebke¹; Kühn, Christian¹; Wiesner, Olaf²; Hadem, Johannes³; Fühner, Thomas²; Ius, Fabio¹; Avsar, Murat¹; Schwerk, Nicolaus⁴; Böthig, Dietmar¹; Gottlieb, Jens^{2,5}; Welte, Tobias^{2,5}; Bara, Christoph¹; Haverich, Axel^{1,5}; Hoeper, Marius M.^{2,5}; Warnecke, Gregor^{1,5}



— **Early Institution of Extracorporeal Membrane Oxygenation for Primary Graft Dysfunction After Lung Transplantation Improves Outcome**



— **Figure 1.** Kaplan–Meier survival curves. Extracorporeal membrane oxygenation support cohorts after lung transplantation with severe PGD compared with all lung transplant recipients without severe PGD.

IPAH

- Muž, 32 let, dekompenzované srdeční selhání s těžkou plicní hypertenzí
- Kachexie, ascites, anasarka
- Vstupní ECHO: PK 53mm x 91mm s EF 30%, Tri reg. 4/4, PASP 65, EDD LK 36mm s EF 40%

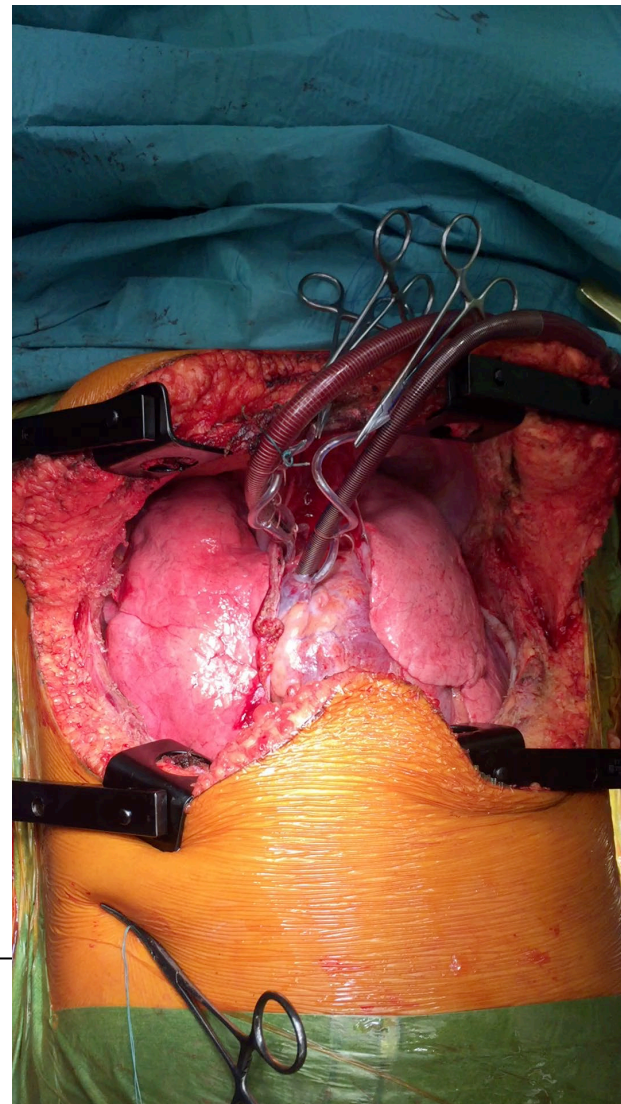
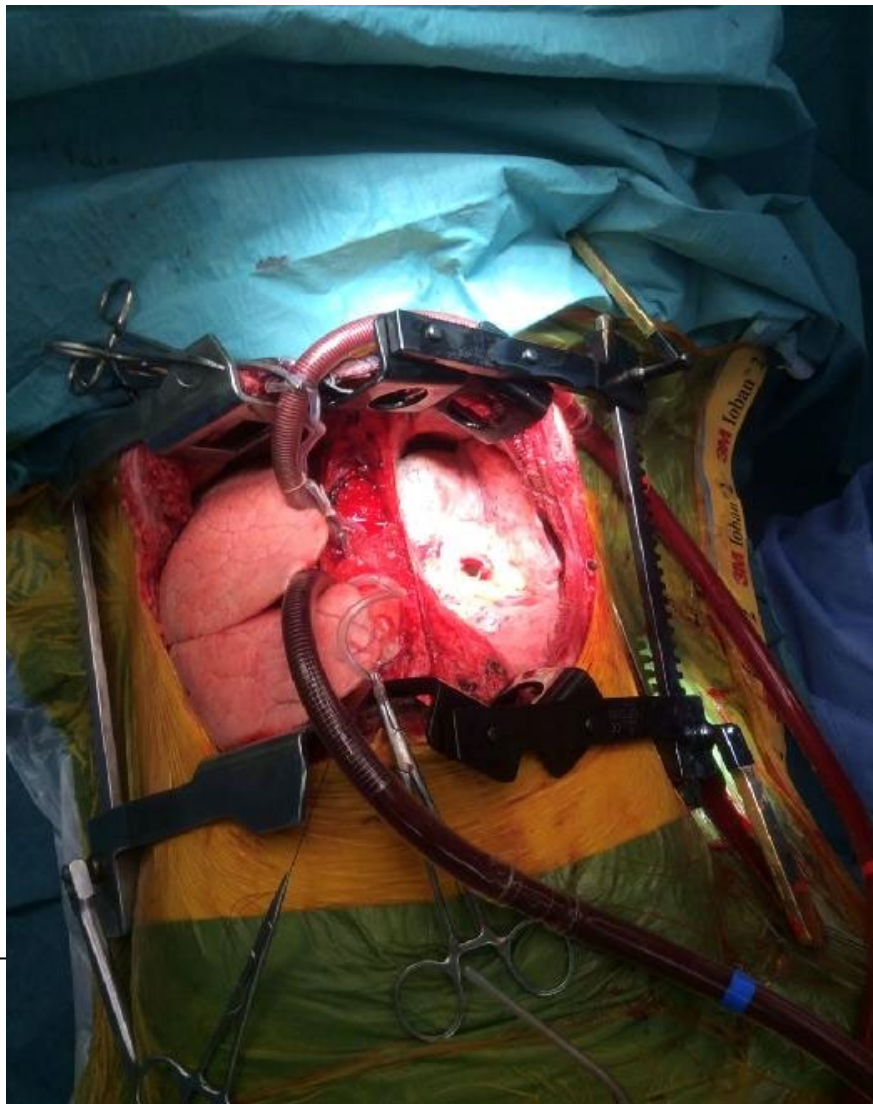


DLTx 2.9.2020, VA ECMO

- Prolongované awake ECMO 5 dní
- Extubace 1. pooperační den
- Dimise 60. den po Tx



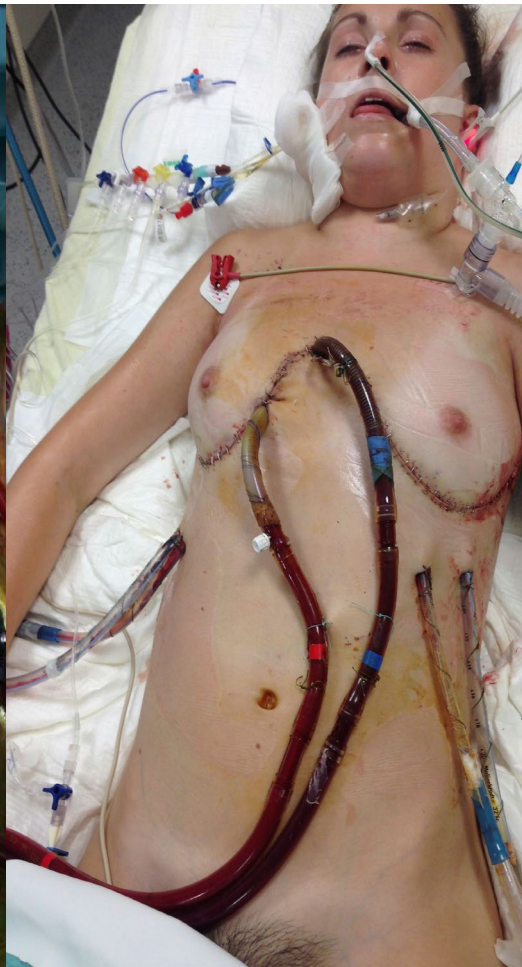
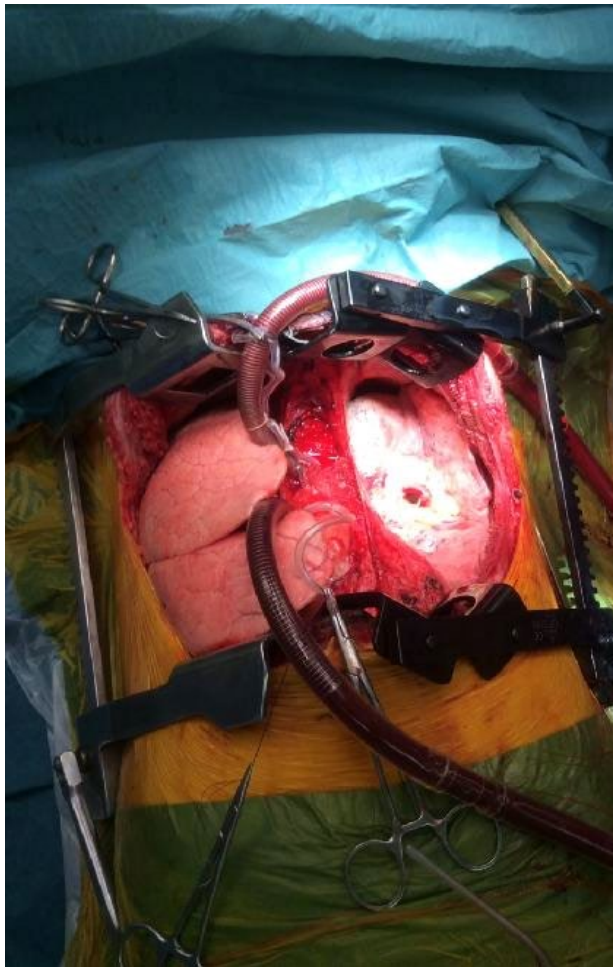
PROGRAM TX PLIC PRAHA



STANDARDIZACE JEDNOTLIVÝCH KROKŮ A PRIORI ECMO APPROACH

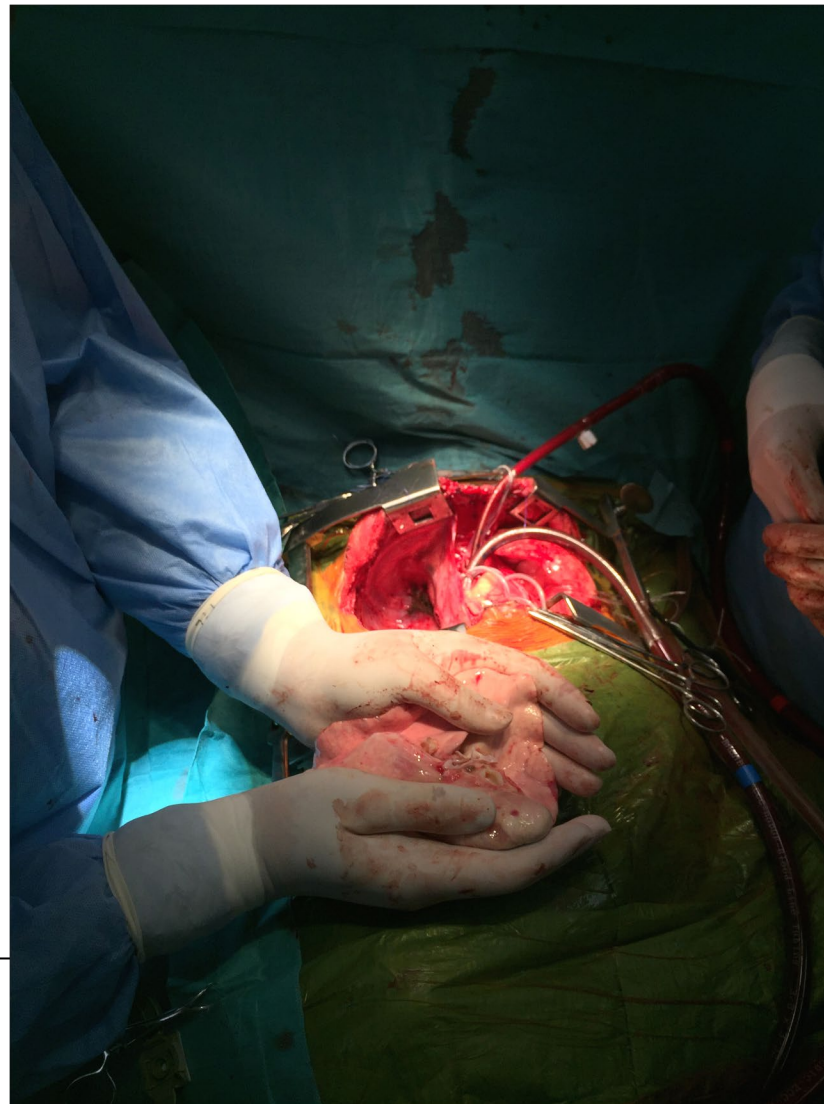
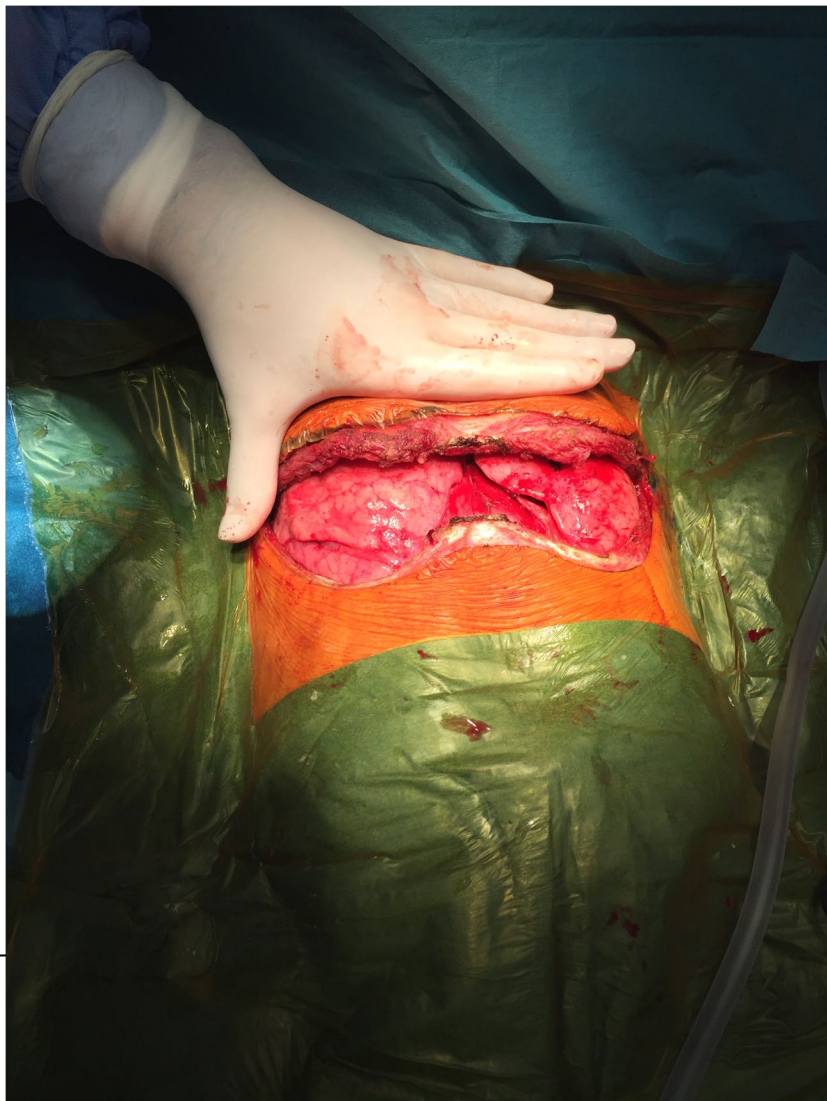
- Clamshell
- Jedna dávka 3000-5000 IE Heparinu
- Centrální VA kanylace
- ECMO flow 2-2,5l/min
- Sekvenční bilaterální transplantace
- Weaning

PROGRAM TX PLIC PRAHA





TX PLIC U DĚTÍ A LOBÁRNÍ TRANSPLANTACE



PROGRAM TRANSPLANTACE PLIC PRAHA

Strategické rozhodnutí v roce 2014:

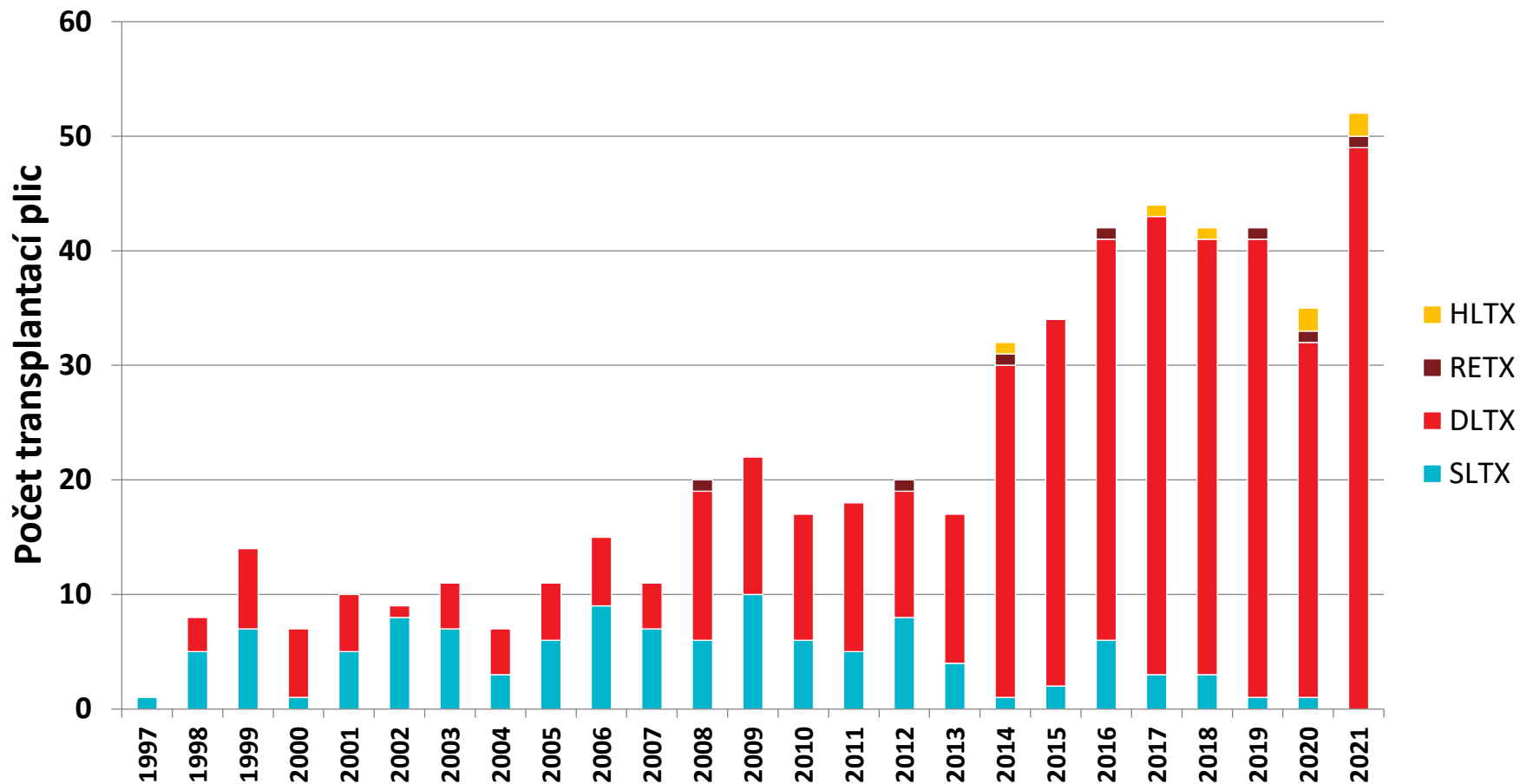
- Rutinní využití ECMO peroperačně
 - Bez ECMO pouze u pacientů bez PH a zdravým srdcem
 - Při náznaku oběhové nestability okamžitý přechod na ECMO

PROLONGOVANÉ/ZÁCHRANNÉ ECMO

VÍDEŇ, PRAHA

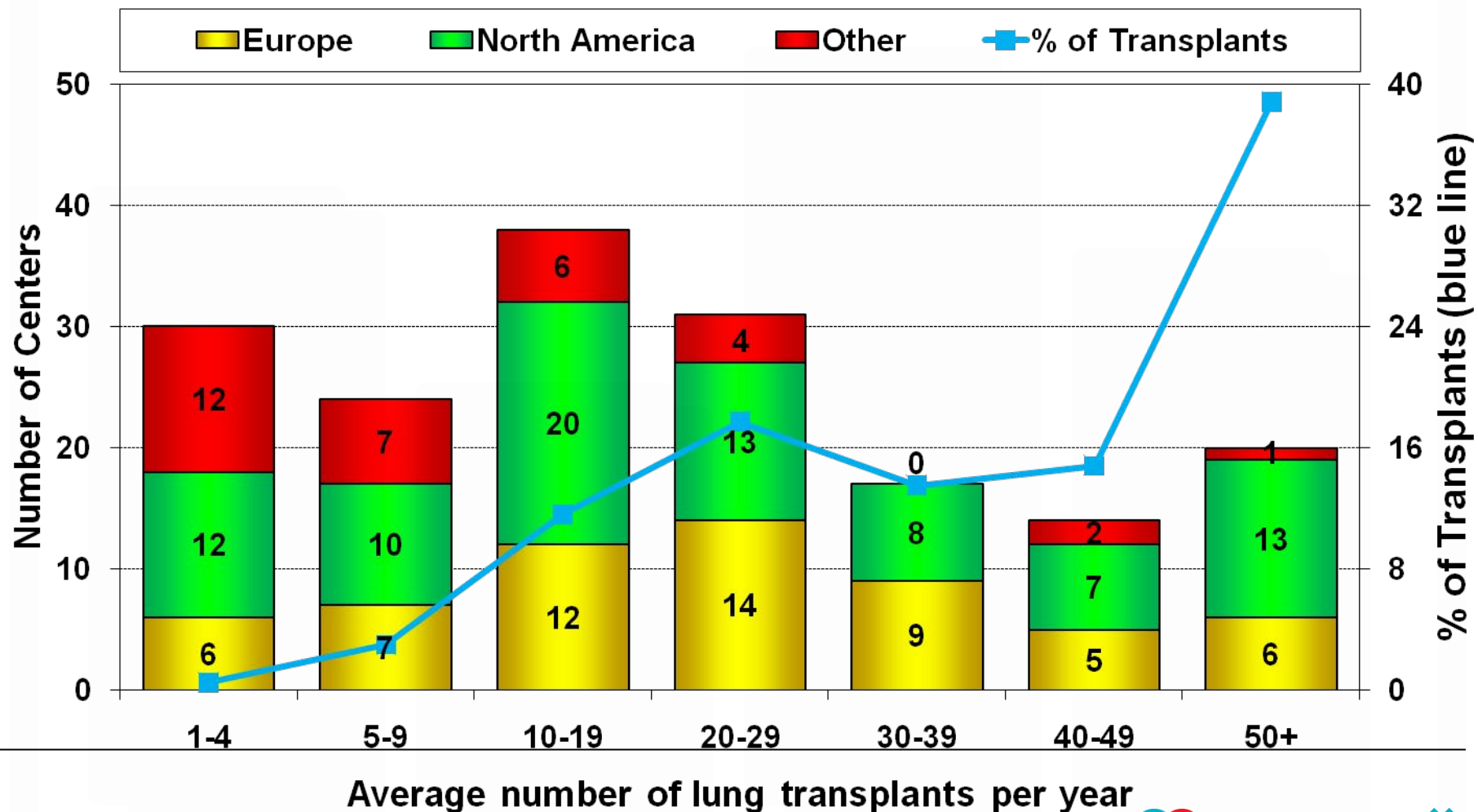
- **Prolongované elektivně** — IPAH, těžká sekundární PH, single lung
- **Na sále**
 - $PAP > 2/3 SAP$
 - $PO_2/FiO_2 < 100$
 - jasné zhoršení mezi dvěma měřeními
- **Na ARO**
 - lépe dříve než později
 - Rozvoj PGD
 - $P_{peak} \geq 35 \text{ cmH}_2\text{O}$, $FiO_2 > 0,6$

Transplantační aktivita

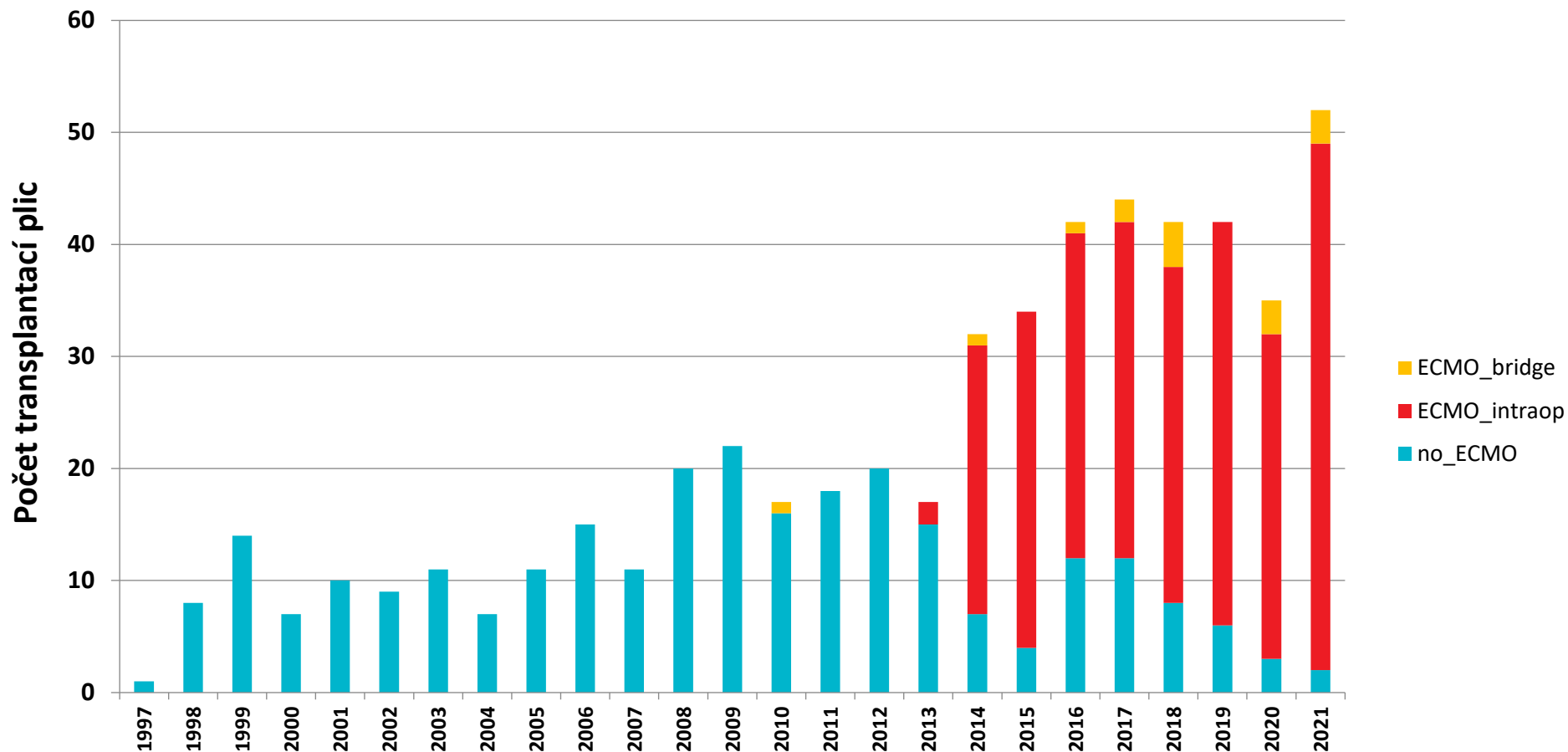


Adult Lung Transplants (Transplants: January 2010 – June 2018)

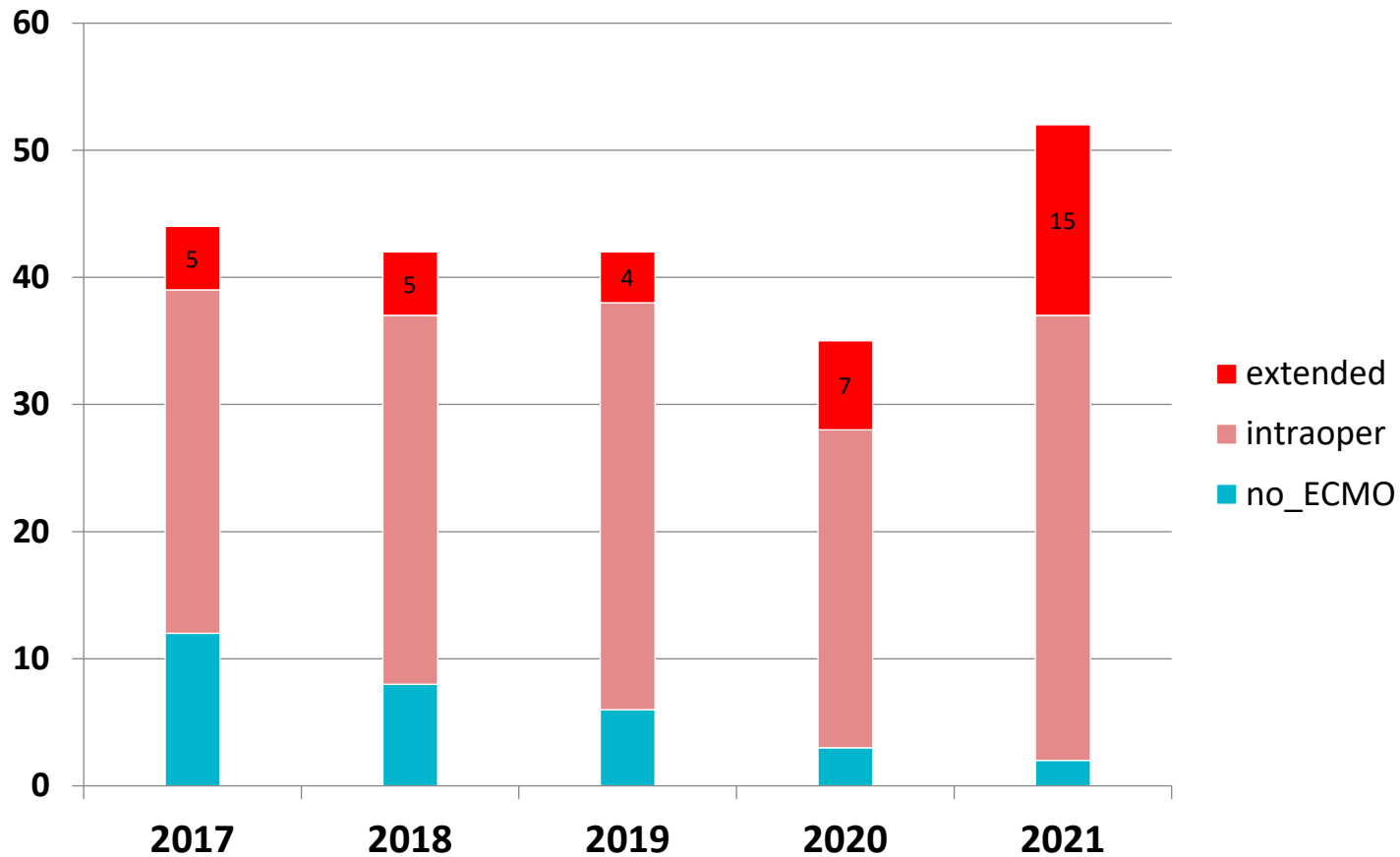
Average Center Volume by Location



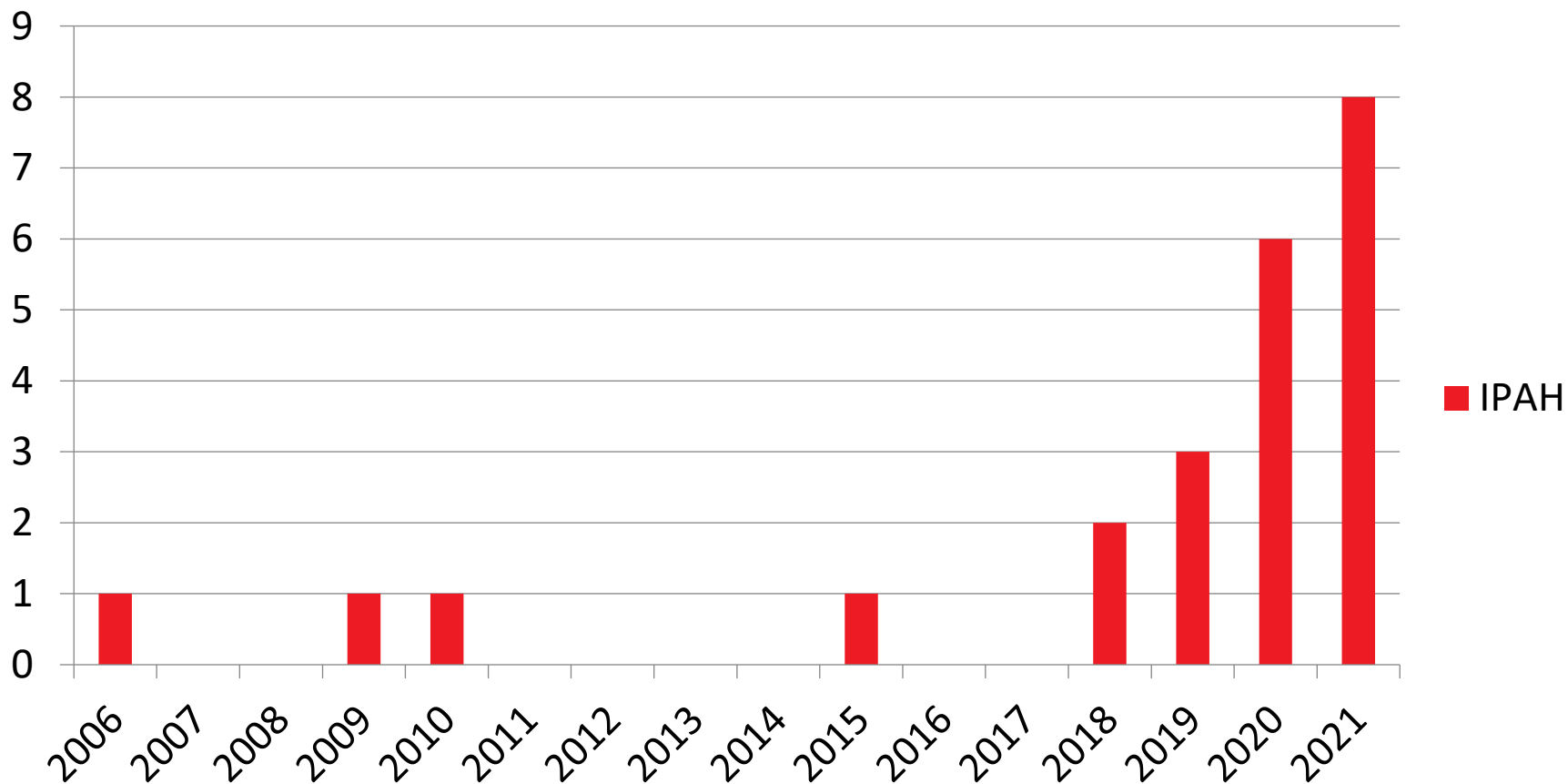
ECMO při LuTx



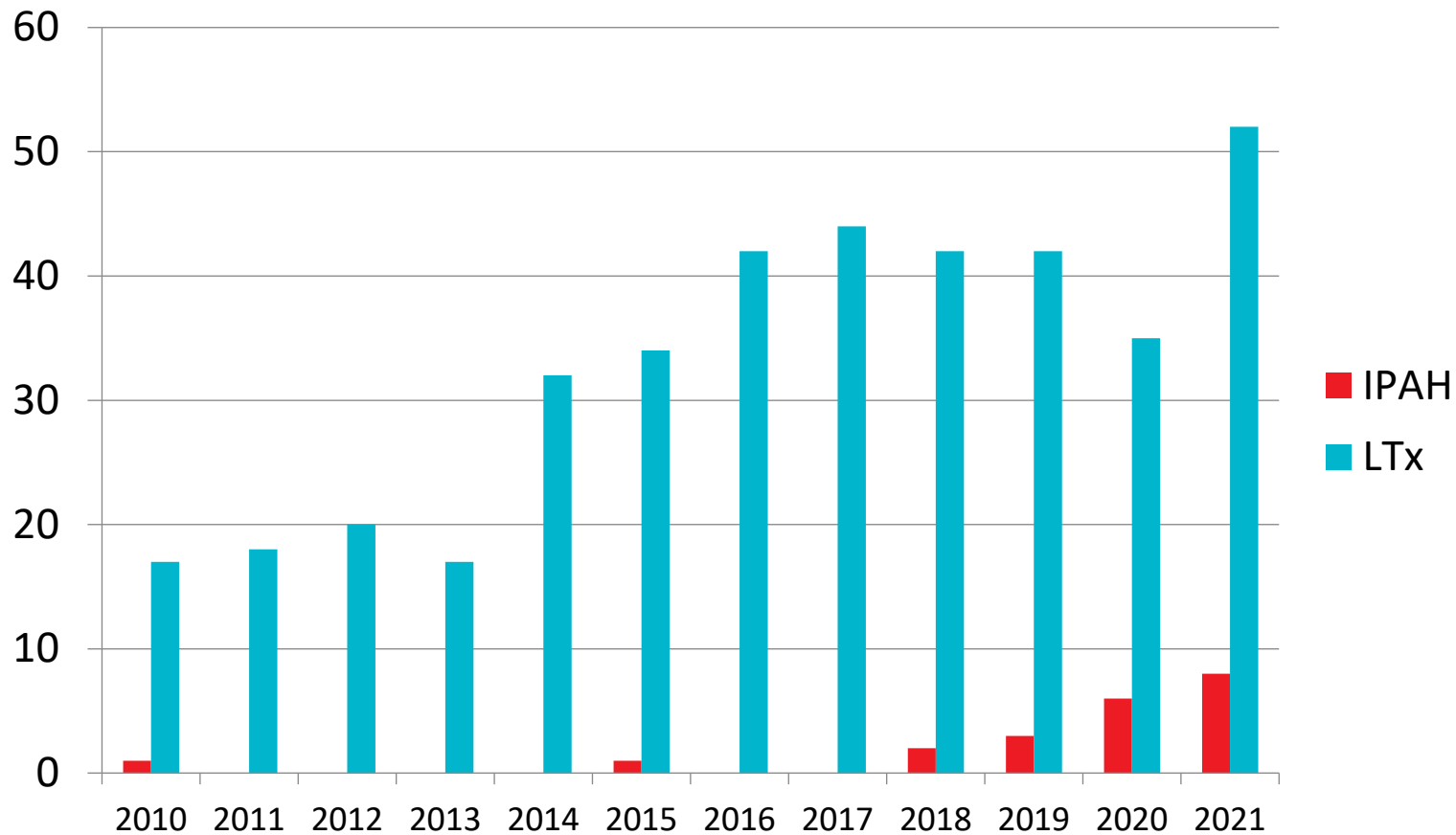
Využití ECMO při LuTx



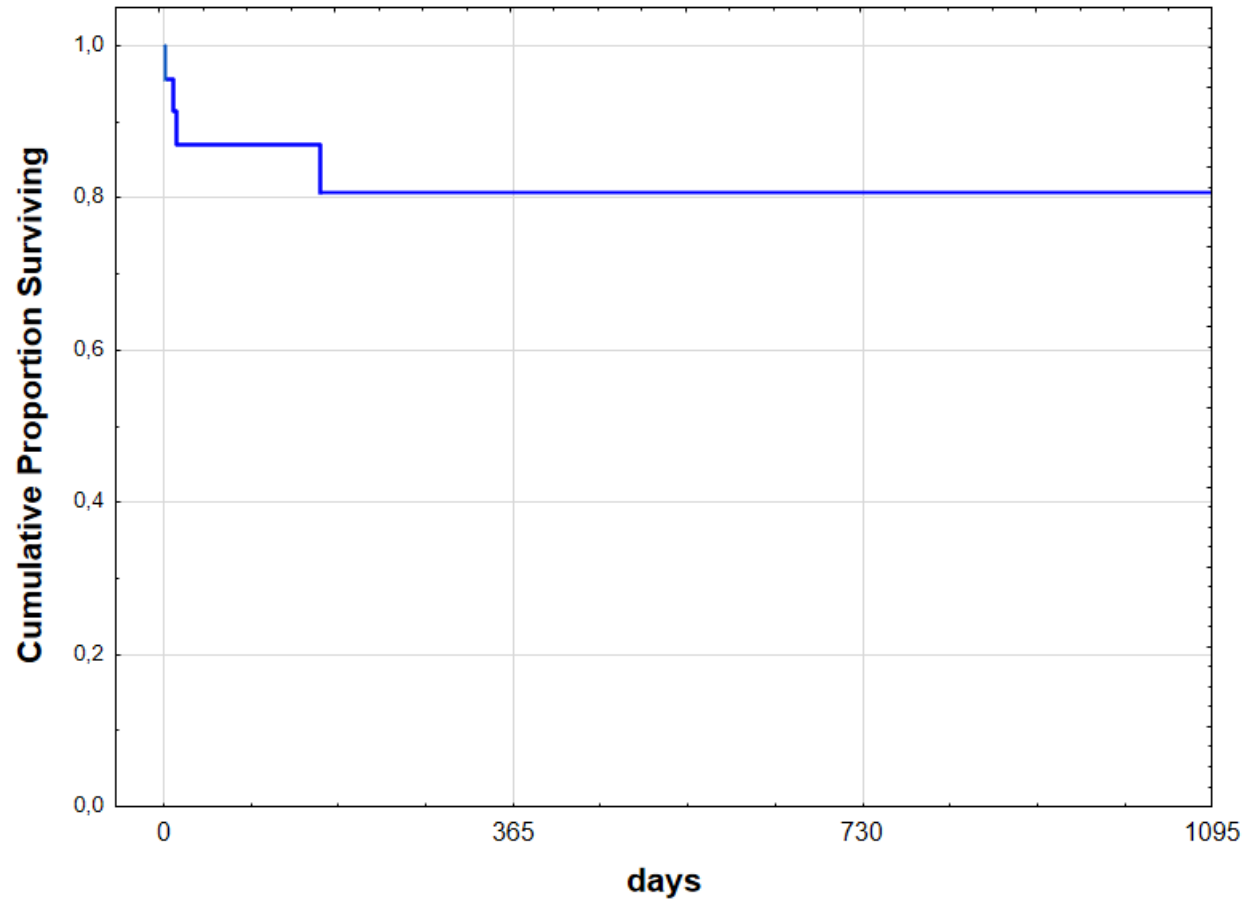
LTx pro IPAH 2006 - 2021



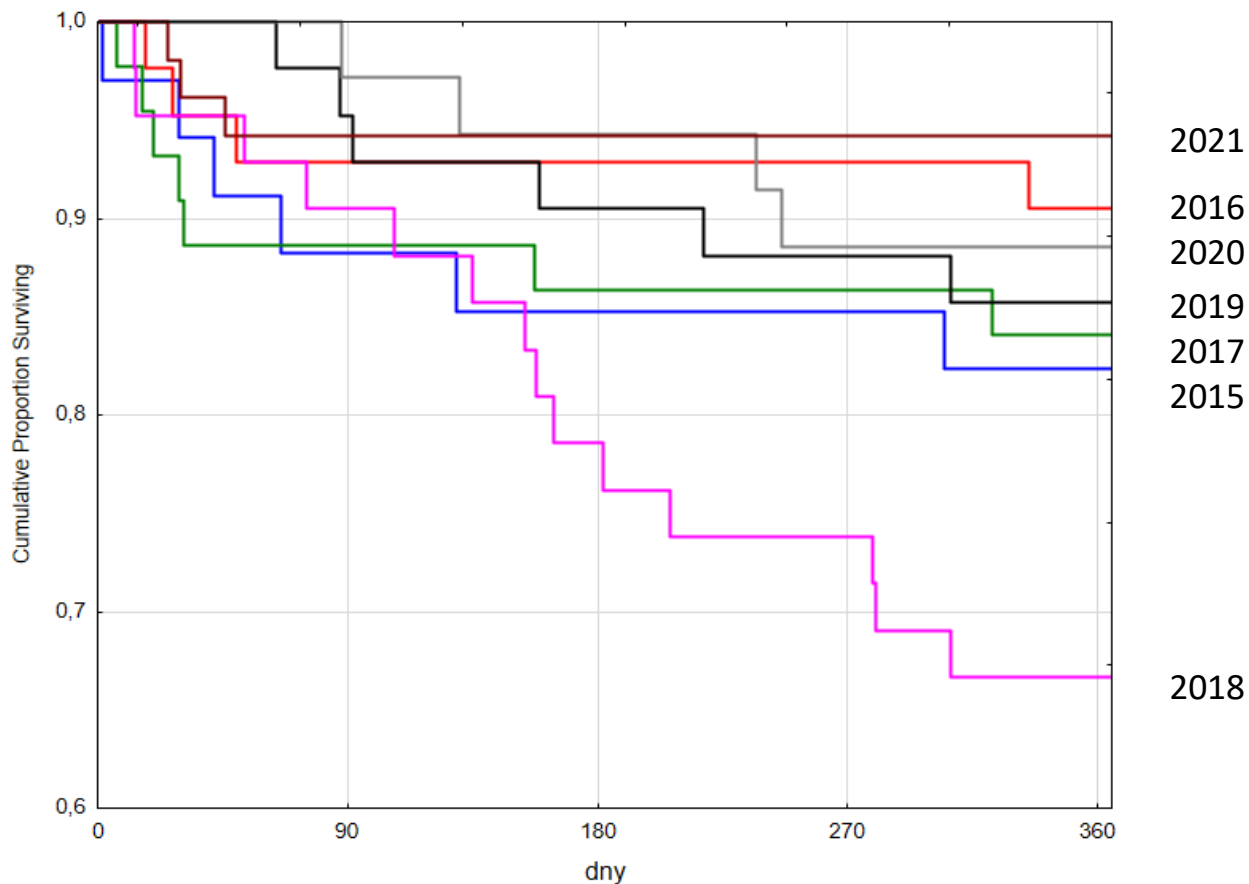
LTx pro IPAH 2010 - 2021



Přežití po LTx s primární dg. IPAH (2006 – 2021, n = 23)



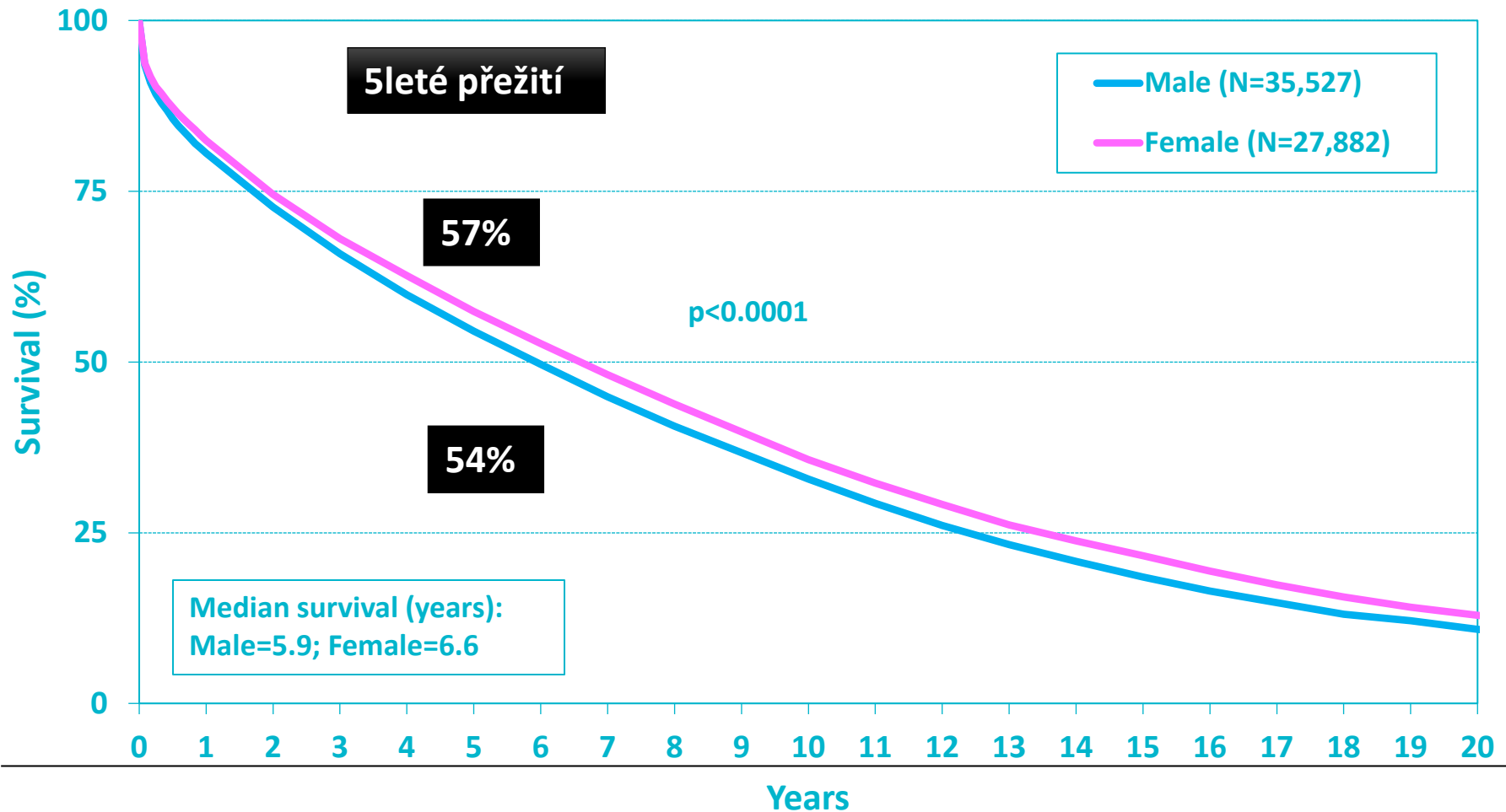
1leté přežití 2015 - 2021



Adult Lung Transplants

Kaplan-Meier Survival by Sex

(Transplants: January 1992 – June 2017)



Principles and indications of extracorporeal life support in general thoracic surgery

Karen McRae¹, Marc de Perrot²

¹Department of Anesthesia and Pain Management, ²Division of Thoracic Surgery, Toronto General Hospital, University Health Network, Toronto, Canada

Contributions: (I) Conception and design: All authors; (II) Administrative support: M de Perrot; (III) Provision of study materials or patients: All authors; (IV) Collection and assembly of data: All authors; (V) Data analysis and interpretation: All authors; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Marc de Perrot, MD, MSC. Division of Thoracic Surgery, Toronto General Hospital, 9N-961, 200 Elizabeth Street, Toronto, Ontario, Canada. Email: marc.deperrot@uhn.on.ca.

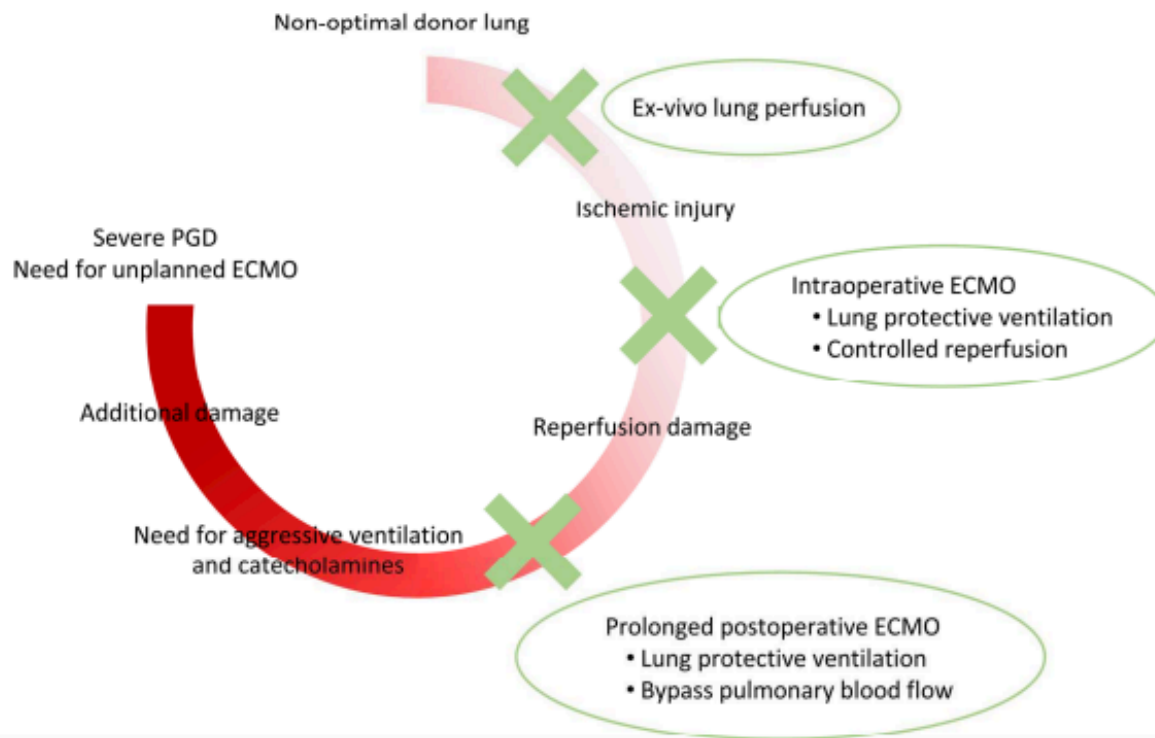
Abstract: The role of extracorporeal life support (ECLS) has expanded rapidly over the past 15 years to become an important tool in advanced general thoracic surgery practice. Intra-operative and in some cases continued post-operative ECLS is redefining the scope of complex surgical care. ECLS encompasses a spectrum of temporary mechanical support that may remove CO₂, oxygenate or provide hemodynamic support or a combination thereof. The most common modalities used in general thoracic surgery include extracorporeal membrane oxygenation (ECMO), interventional lung assist device (iLA[®] Novalung[®], Heilbronn, Germany), and extracorporeal CO₂ removal (ECCO₂R). The ECMO and Novalung[®] devices can be used in different modes for the short term or long-term support depending on the situation. In this review, the principles and current applications of ECLS in general thoracic surgery are presented.

Keywords: Mechanical support; respiratory failure; lung resection; tracheal resection; lung transplantation

ZÁVĚR

- ECMO je nepostradatelná metoda u transplantace plic
- Všeobecná shoda na využití v bridgingu k Tx a jako záchranná léčba při těžké primární dysfunkci štěpu – ischemicko-reperfúzní poškození
- Rutinní využití ECMO v naší zkušenosti – lepší výsledky a vyšší objem
- Využití ECMO u Tx plic vede k liberálnějšímu využití v hrudní chirurgii

ECMO u Tx PLIC A PRIMÁRNÍ SELHÁNÍ ŠTĚPU

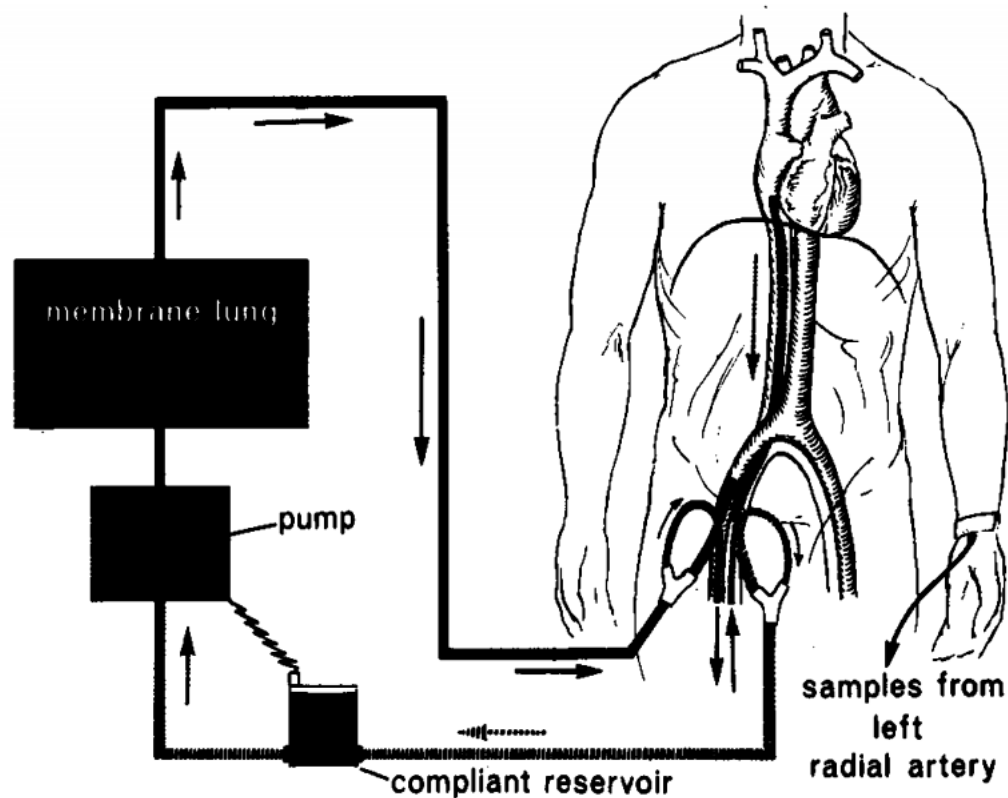




PROLONGED

J. DONALD HILL, M.D.
M

Abstract A 24-year-old patient with a traumatic transection of the thoracic aorta and multiple orthopedic injuries required emergency surgery. Aortic injury was repaired, and a bypass was established. Perfusion occurred for four days. Maximal conventional venoarterial perfusion with use of the ILLUMINATOR machine, was initiated. At a by-pass flow of



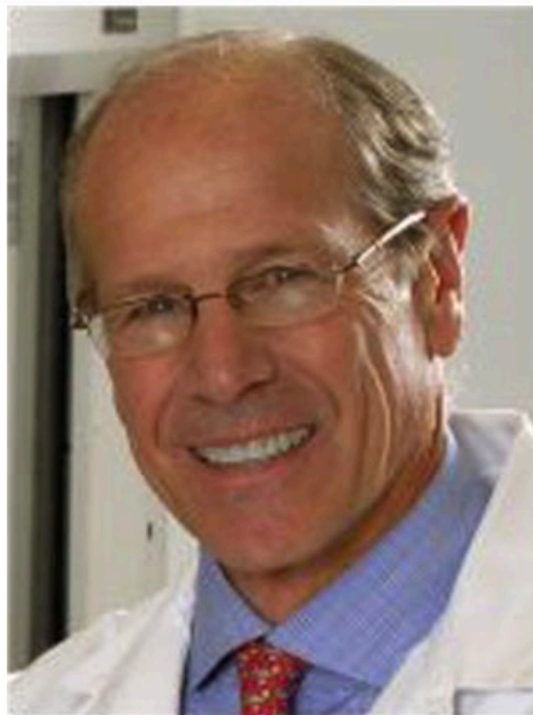
TRAUMATIC

DONTIGNY, M.D.,
)

38 to 75 mm of
tration was reduced
ak airway pressure
water. The shock-
and the patient

reversible if the
exchange through
with an appropri-

Figure 3. Cannulation System Used during the Perfusion.

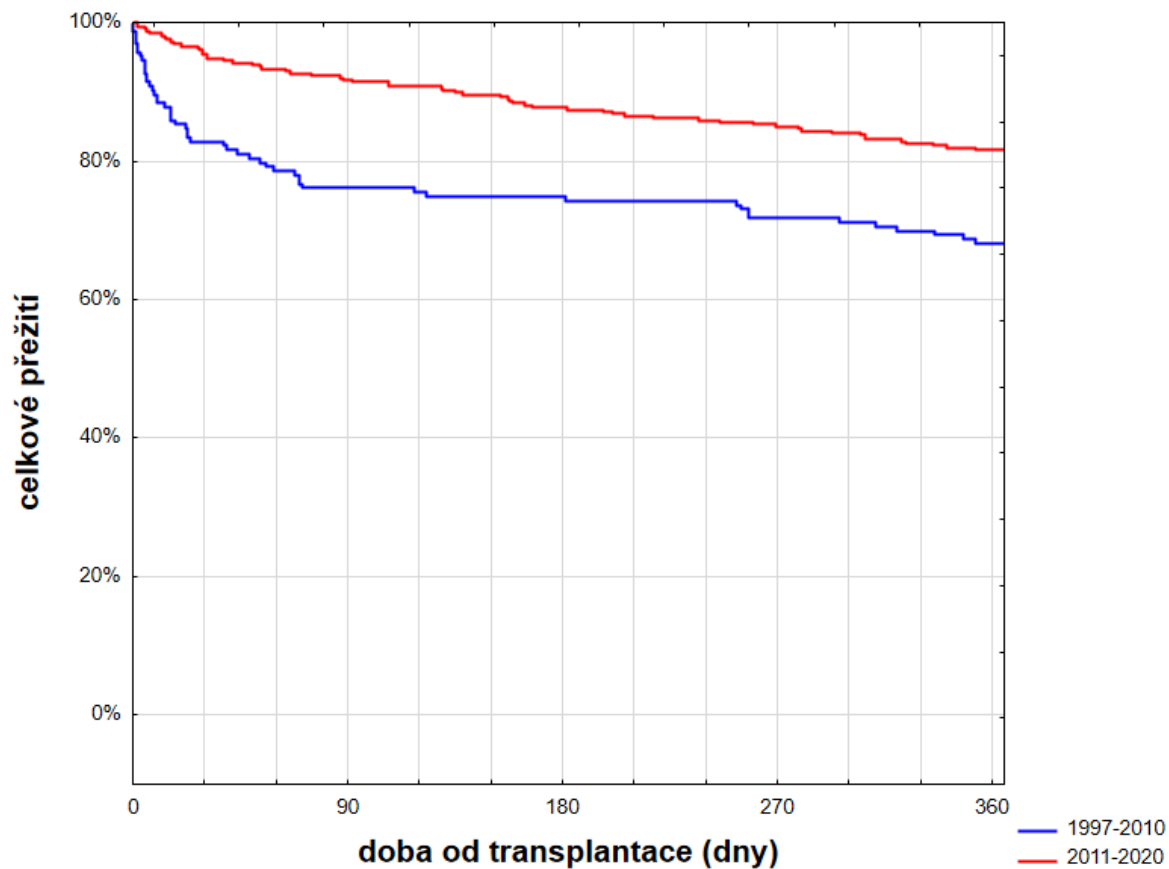


Bartley P. Griffith, MD, FACS, FRCS

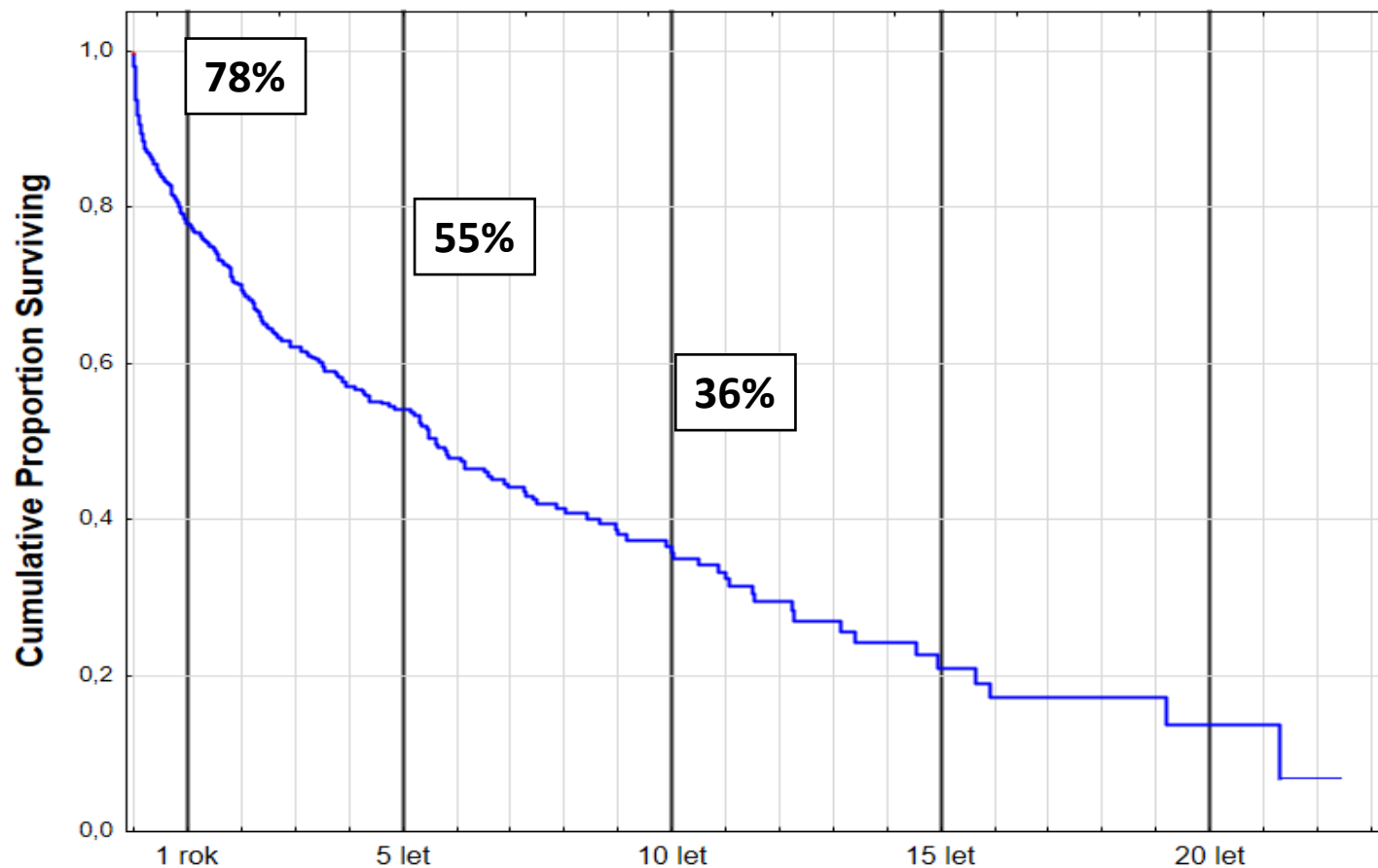
Central Message

This case teaches us a lot about the effect of septic lungs on sepsis and about a creative use of dual extracorporeal membrane oxygenation systems, performed without complications. Bravo!

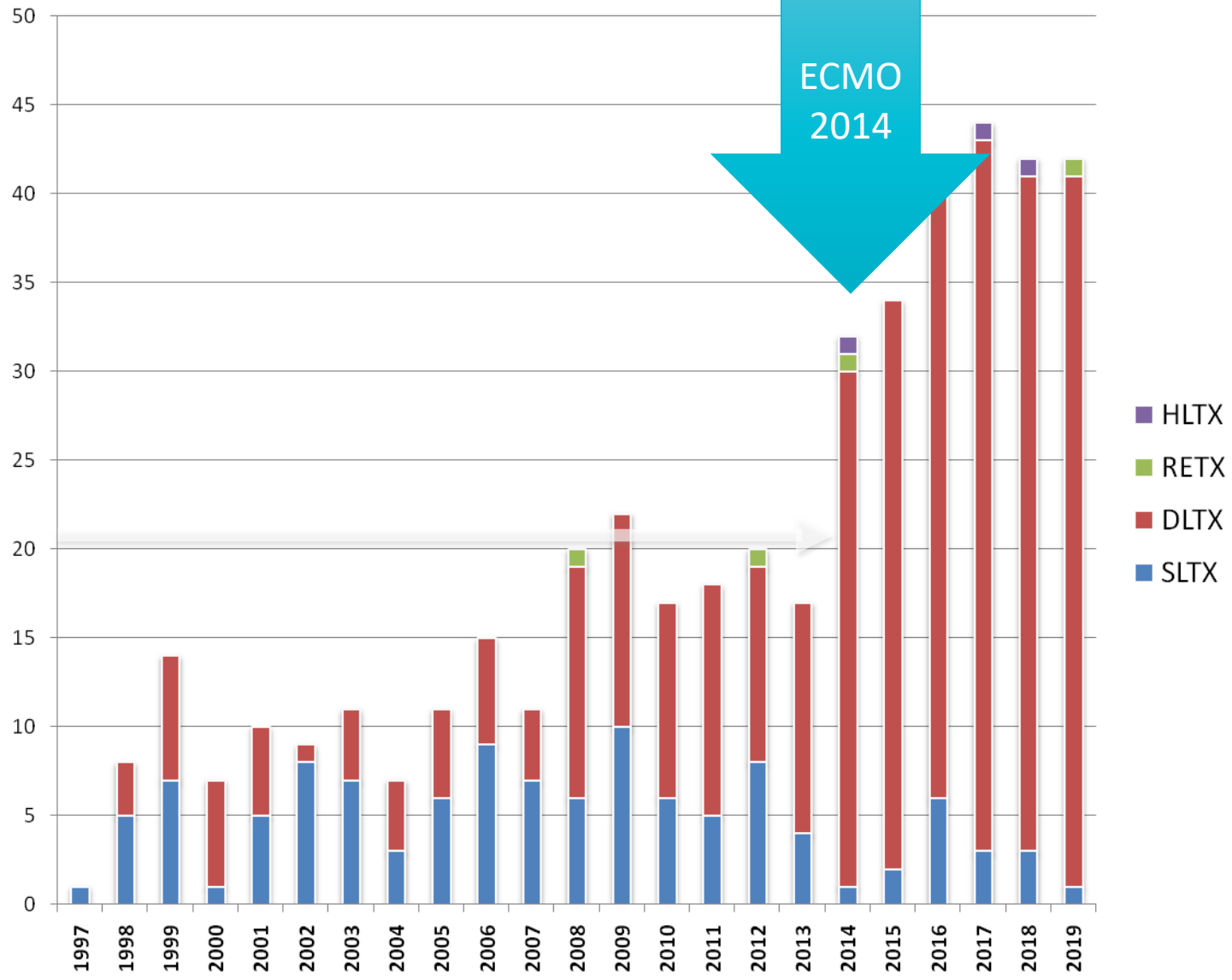
1leté přežití po LuTx 1997-2010 versus 2011-2020



Přežití LuTx v ČR 1997-2020



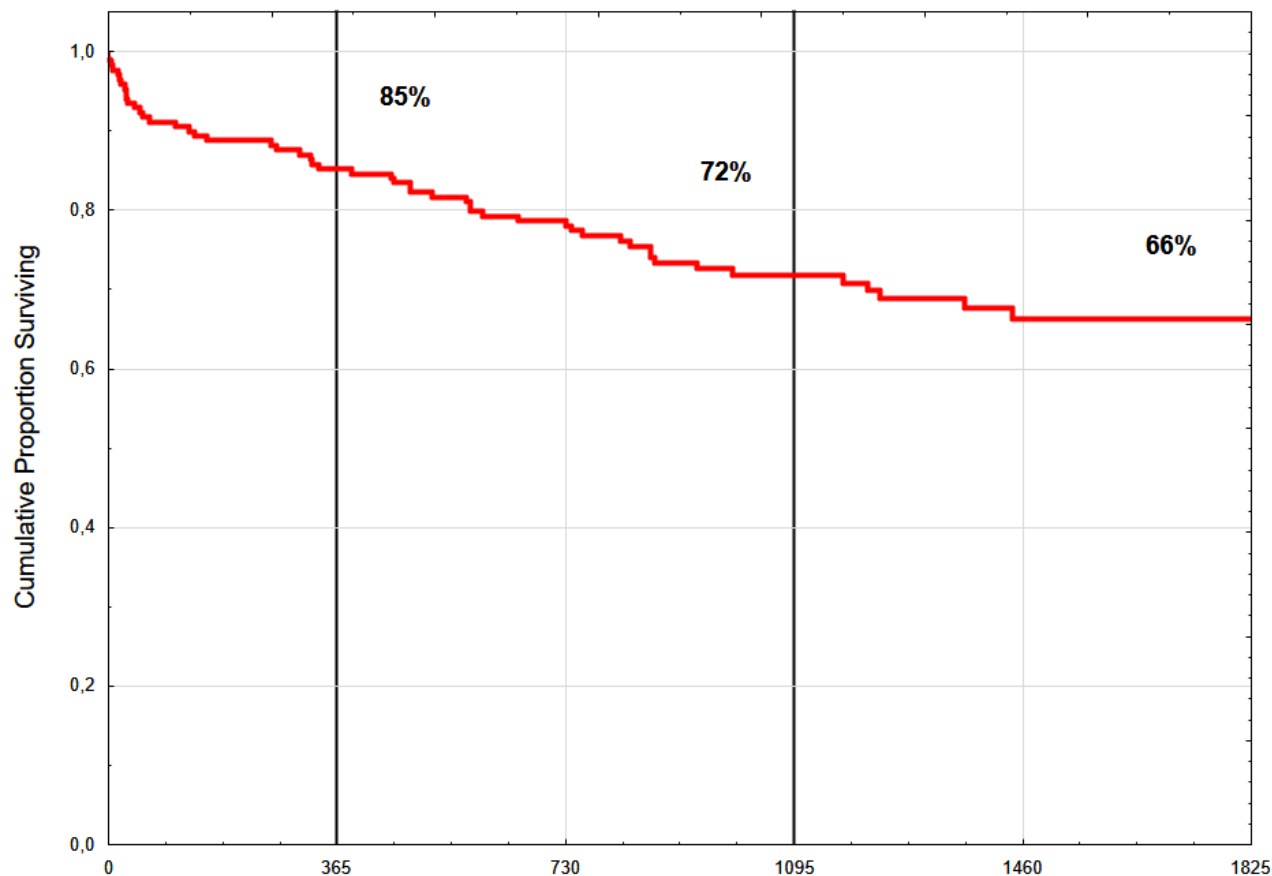
Počet transplantací plic



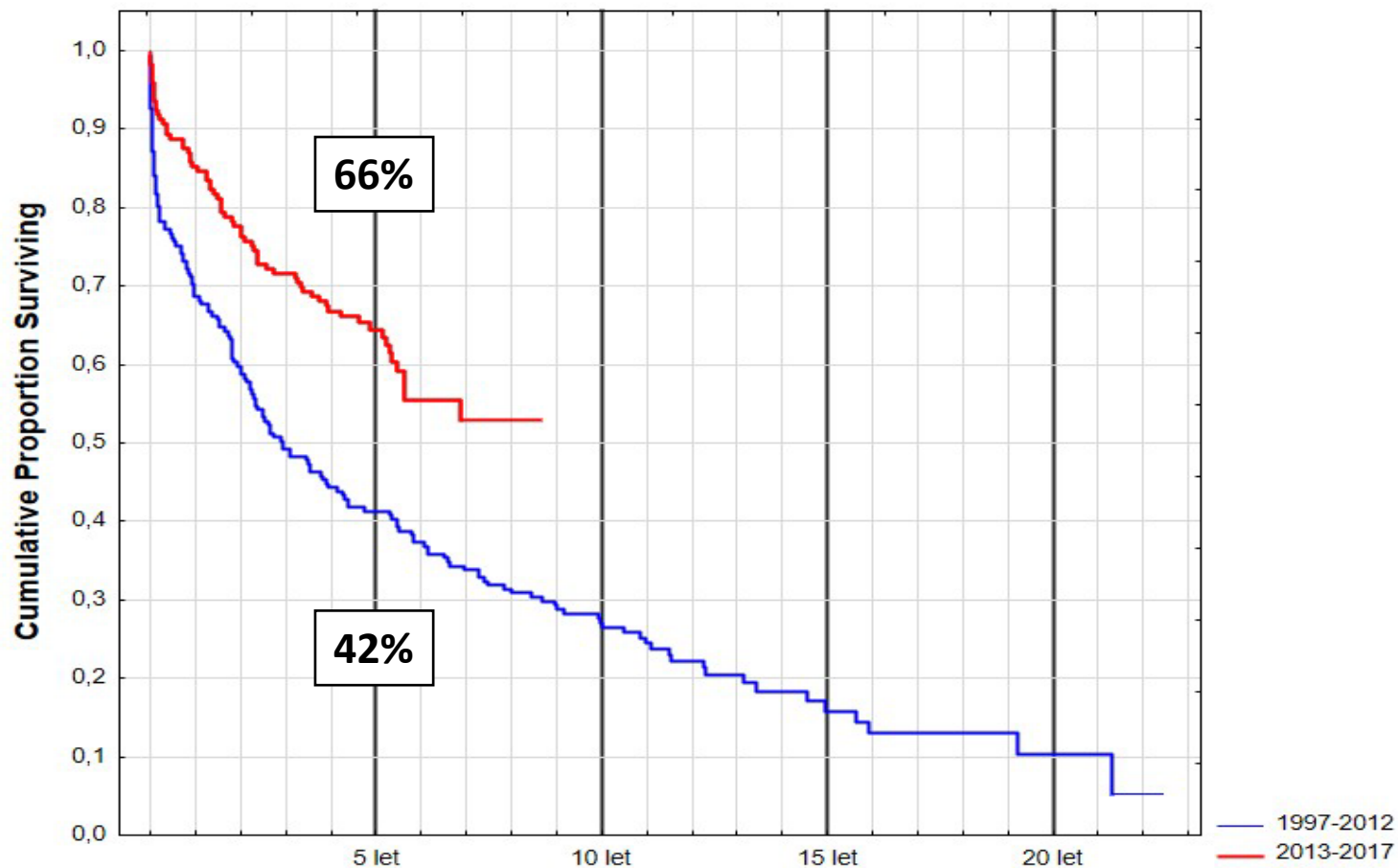
ECMO
2014

- HLTX
- RETX
- DLTX
- SLTX

Přežití LuTx v ČR 2013 - 2017



Přežití LuTx v ČR 1997-2012 versus 2013-2017



METODIKA

retrospektivní analýza 232 pacientů po LuTx
období 01/2008 - 02/2017

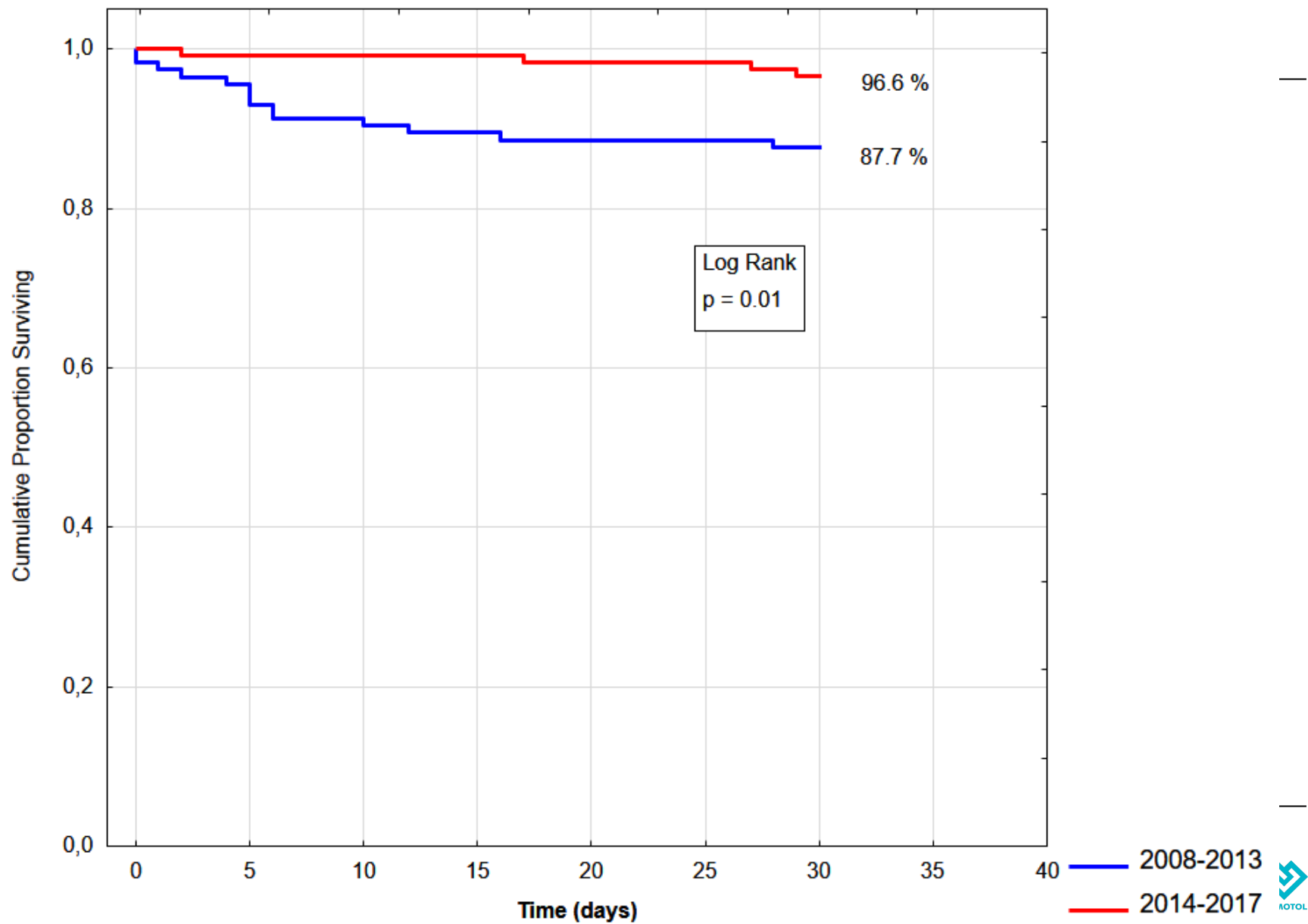
01/2008 – 12/2013
(n = 114)

01/2014 – 02/2017
(n = 118)

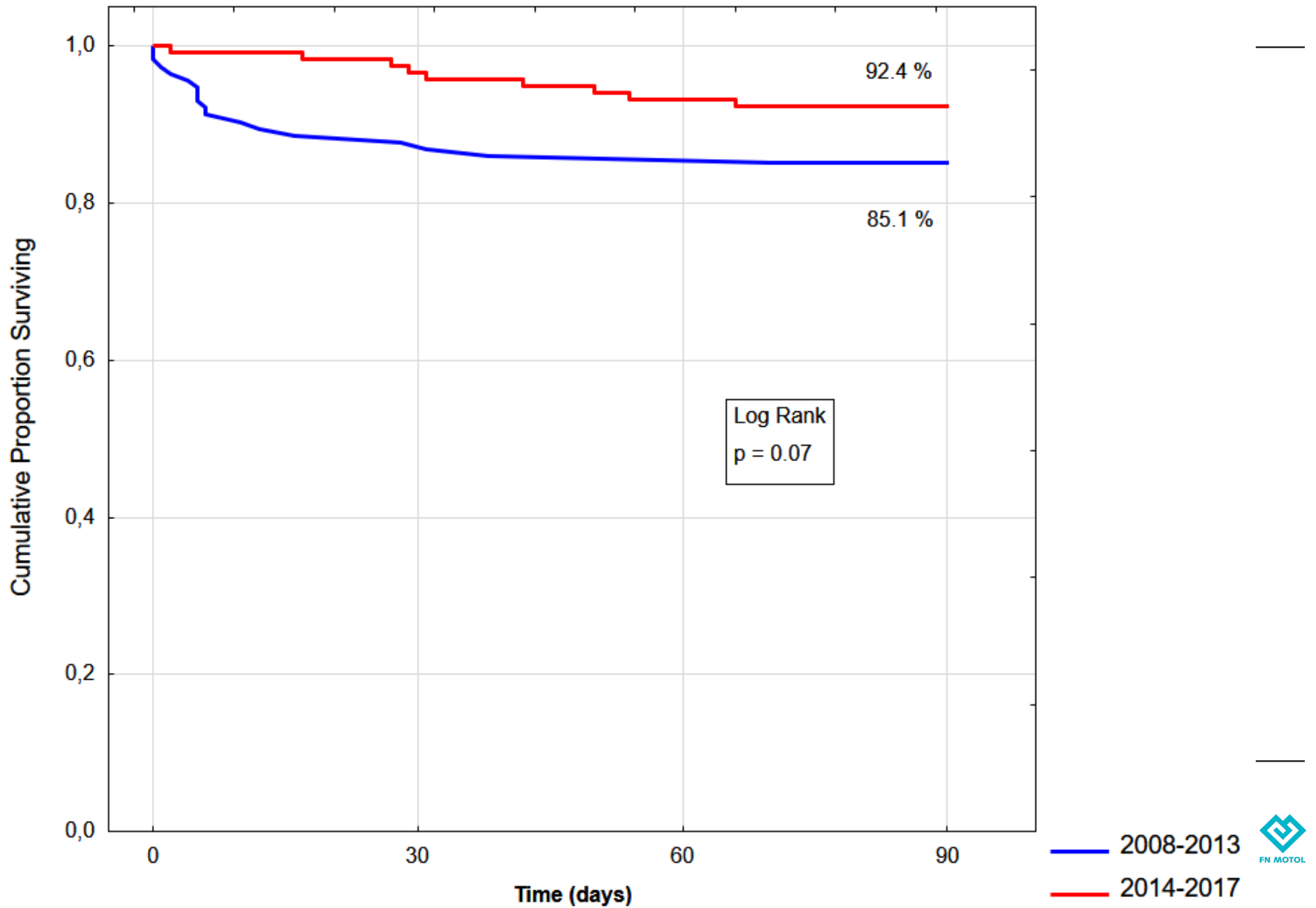
ZÁKLADNÍ CHARAKTERISTIKA SOUBORU

	01/2008-12/2013 N = 114	01/2014-02/2017 N = 118	P value
Age (years, mean ±SD)			
Recipient	50.6 (± 13.5)	47.4 (± 15.9)	NS
Donor	40.3 (± 13.8)	43.6 (± 14.4)	NS
Gender male, n (%)	72 (63%)	60 (51%)	NS
DLTx, n (%)	75 (66%)	107 (91%)	< 0.001
Diagnosis, n (%)			
COPD	58 (51%)	42 (36%)	0.02
IPF	27 (24%)	42 (36%)	0.047
CF	17 (15%)	27 (23%)	NS
Other	12 (10%)	7 (6%)	NS
CMV match, n (%)			
Donor + / Recipient -	31 (27%)	36 (31%)	NS
Cold Ischemia (min, mean ±SD)			
First Lung	296 (± 78)	261 (± 58)	< 0.001
Second Lung	425 (± 70)	358 (± 58)	< 0.001
Intraoperative ECMO, n (%)	2 (1.8 %)	90 (76.2 %)	< 0.001

1-MĚSÍČNÍ PŘEŽITÍ



3-MĚSÍČNÍ PŘEŽITÍ



1-LETÉ PŘEŽITÍ

