Use of extended criteria donors in liver transplant

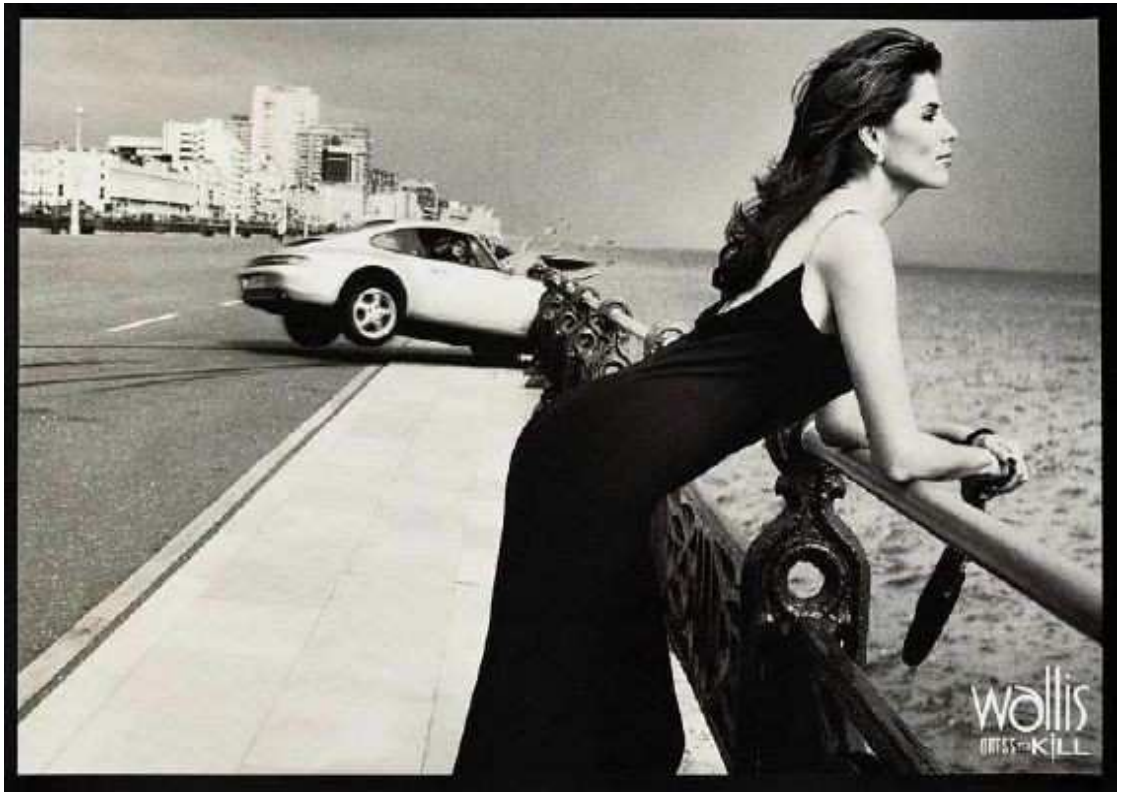
Matteo Cescon

General Surgery and Transplantation Unit

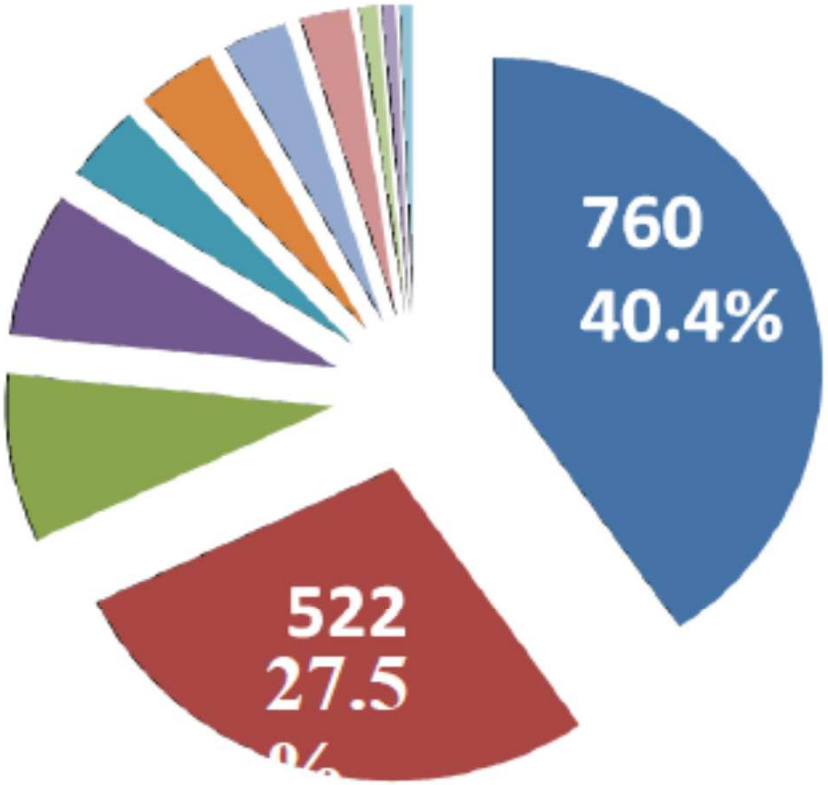
Policlinico Sant'Orsola-Malpighi

University of Bologna, Italy

Liver transplantation as a trip for patients…



1900 Liver transplantations at University of Bologna (1986-2016)



- Viral cirrhosis
- HCC on cirrhosis
- Retransplantations
- Alcholic cirrhosis
- Primary biliary cirrhosis
- Fulminant hepatatis
- Sclerosant colangitis
- Amiloidosis
- Wilson disease
- Metabolic disease
- Others

Problems: to many passengers…

Extended criteria donors

Graft with an increased risk of early failure or inferior graft and patient survival resulting from per-transplant factors

Extended Criteria Donor/Graft = ECD

Extended criteria donors

- ✓ Older donors
- ✓ Steatotic grafts
- ✓ Seropositive Donors
- ✓ Split Grafts
- ✓ Living Donors

Extended criteria donors

- ✓ Older donors
- ✓ Steatotic grafts
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- ✓ Split Grafts
- ✓ Living Donors

“Liberal” allocation of older donors under a low liver damage strategy (2003 – ongoing)

- Routine graft biopsy before donor aorta cross-clamping in donors ≥ 60 years
- Histology available before donor aorta cross-clamping
- Recipient entering OT after donor histology evaluation

- Absolute contraindications:

- Cirrhosis, steatohepatitis

- Fibrosis stage >2 ± severe portal inflammation

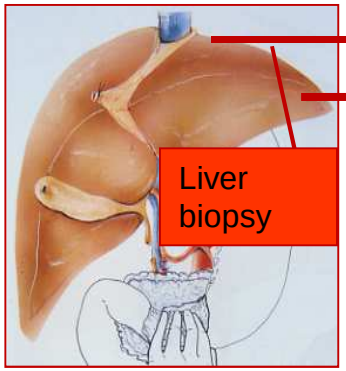
- Necrosis

- Relative contraindications:

- Macrosteatosis > 30%

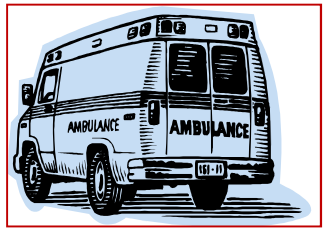
Ravaioli et al, Transpl Int 2008

“Liberal” allocation of older donors under a low liver damage strategy (2003 – ongoing)



Liver biopsy

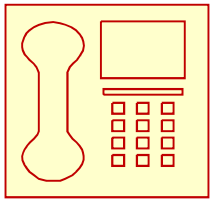
1-3 hours



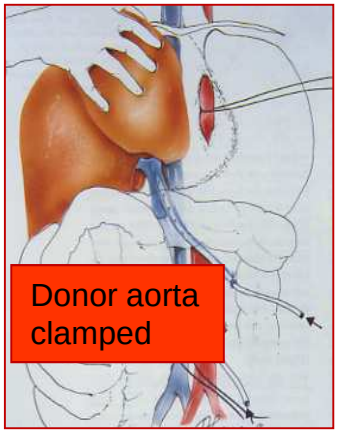
Expert pathologists on liver disease available 24 hours per day at our hospital

30 minutes

Histo-pathological report by telephone



Decision to accept the liver:
senior surgeons considers the histological assessment and the macroscopic aspect as depicted by the harvesting surgeon

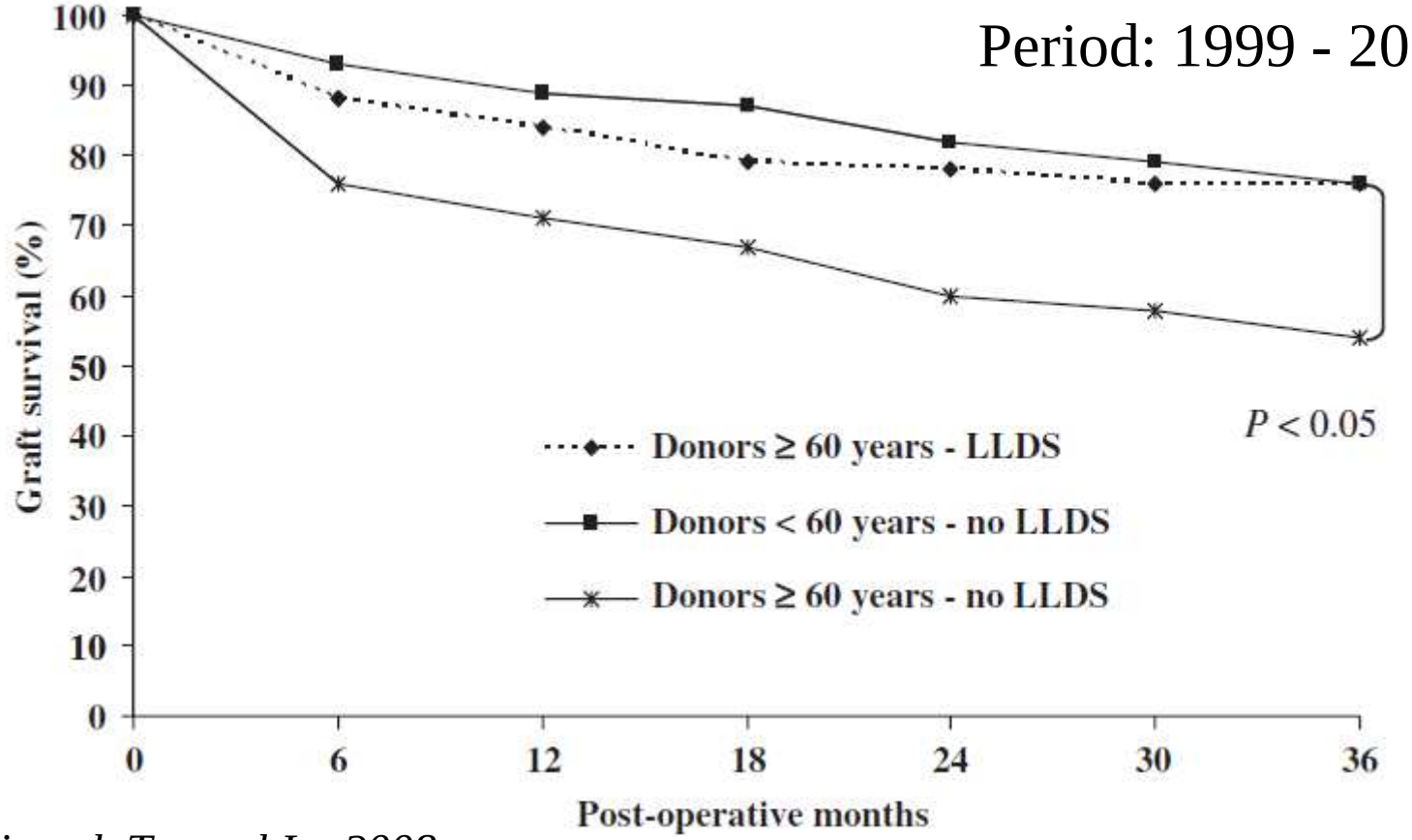


Donor aorta clamped

Recipient on the operating room

“Liberal” allocation of older donors under a low liver damage strategy (2003 – ongoing)

Period: 1999 - 2005



Ravaioli et al, Transpl Int 2008

935 liver transplants in Bologna (1998-2008) Donors characteristics

	Donor < 70 y (N=713)	Donor ≥ 70 y (N=222)	p
Donor gender (M/F)	**408/286**	**101/114**	**0.002**
Donor anti-HCV positivity	20 (2.8%)	11 (5.0%)	0.092
Donor anti-HBc positivity	**104 (14.6%)**	**45 (20.3%)**	**0.030**
Donor HBsAg positivity	6 (0.8%)	2 (0.9%)	0.933
Donor cause of death			
Cerebral stroke	**406 (56.9%)**	**178 (80.2%)**	**< 0.001**
Trauma	**254 (35.6%)**	**37 (12.7%)**	**< 0.001**
Post-anoxic encephalopathy	19 (2.7%)	2 (2.3%)	0.478

Median follow-up = 96 months

Bertuzzo et al, Ann Surg 2017

935 liver transplants in Bologna (1998-2008) Patients characteristics

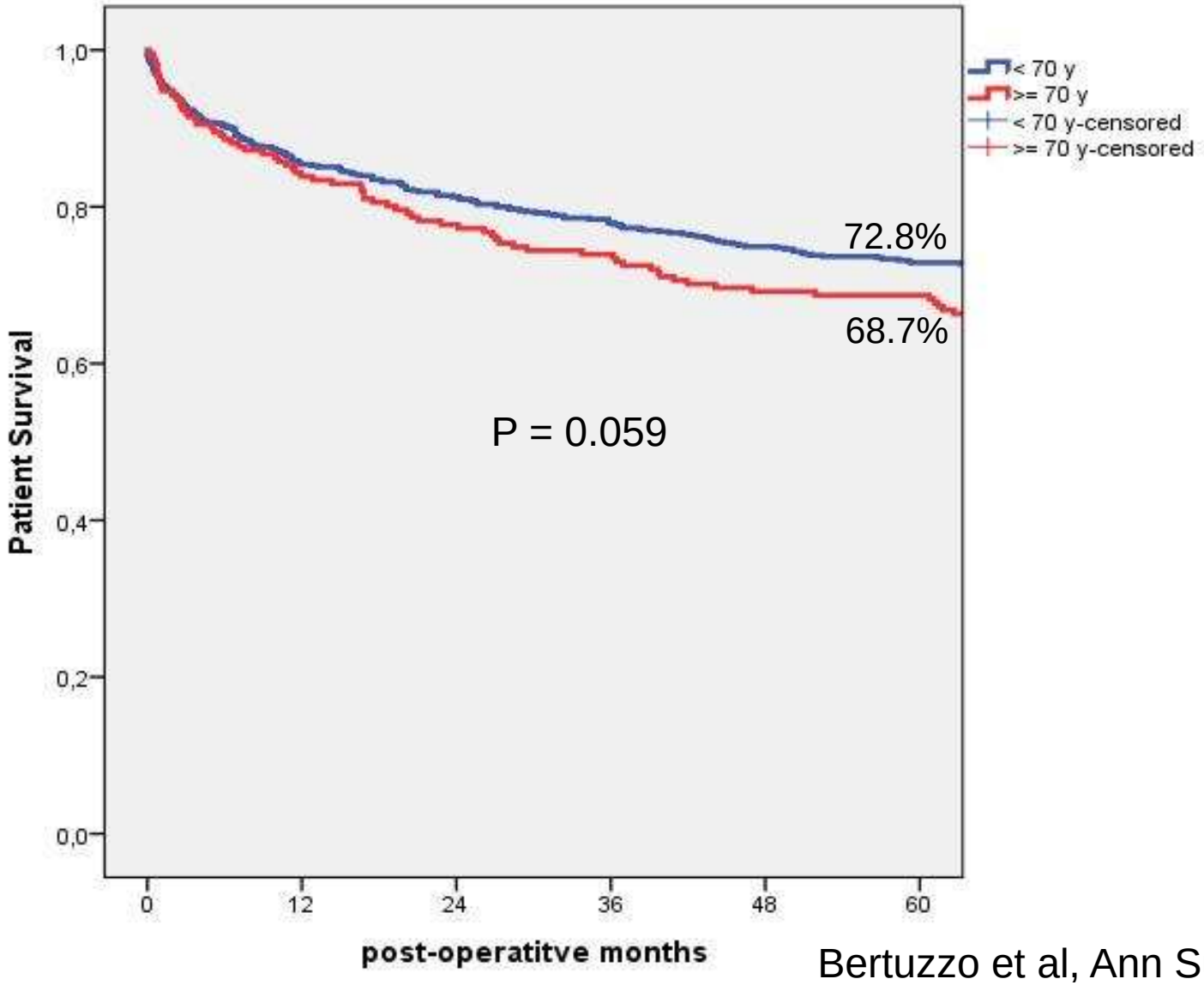
	Donor < 70 y (N=713)	Donor ≥ 70 y (N=222)	p
Recipient gender (M/F)	523/190	159/63	0.335
Recipient age ≥ 60 years	153 (21.5%)	60 (27.0%)	0.052
Recipient BMI ≥ 25 kg/m²	**293 (42.5%)**	**107 (49.3%)**	**0.047**
Combined transplant	**37 (5.2%)**	**1 (0.5%)**	**0.001**
Recipient HCV infection	368 (51.6%)	114 (51.4 %)	0.503
Recipient HBV infection	160 (22.4%)	51 (23.0%)	0.467
Recipient HIV positivity	14 (2.0%)	5 (2.3%)	0.484
HCC on cirrhosis	**162 (22.7%)**	**68 (30.6%)**	**0.012**
Alcoholic cirrhosis	56 (7.9%)	17 (7.7%)	0.528
PSC	19 (2.7%)	7 (3.2%)	0.424
PBC	**14 (2.0%)**	**11 (5.0%)**	**0.019**
Acute liver failure	16 (2.2%)	2 (0.9%)	0.203
Re-OLT	65 (9.1%)	26 (11.7%)	0.104
Median natural MELD score	**18 (6 - 48)**	**20 (6 - 45)**	**0.014**
Median D-MELD	**832 (104 – 2640)**	**1445 (444 - 3420)**	**< 0.001**

935 liver transplants in Bologna (1998-2008) Results

Causes of death	Donor < 70 y (N=713)	Donor ≥ 70 y (N=222)	p
HCV recurrence	55 (8.7%)	25 (11.8%)	0.116
Infection	42 (5.9%)	17 (7.7%)	0.213
Multi-organ failure	31 (4.9%)	9 (4.3%)	0.432
HCC recurrence	25 (3.5%)	9 (4.1%)	0.418
De-novo tumour	17 (2.4%)	11 (5.0%)	0.066

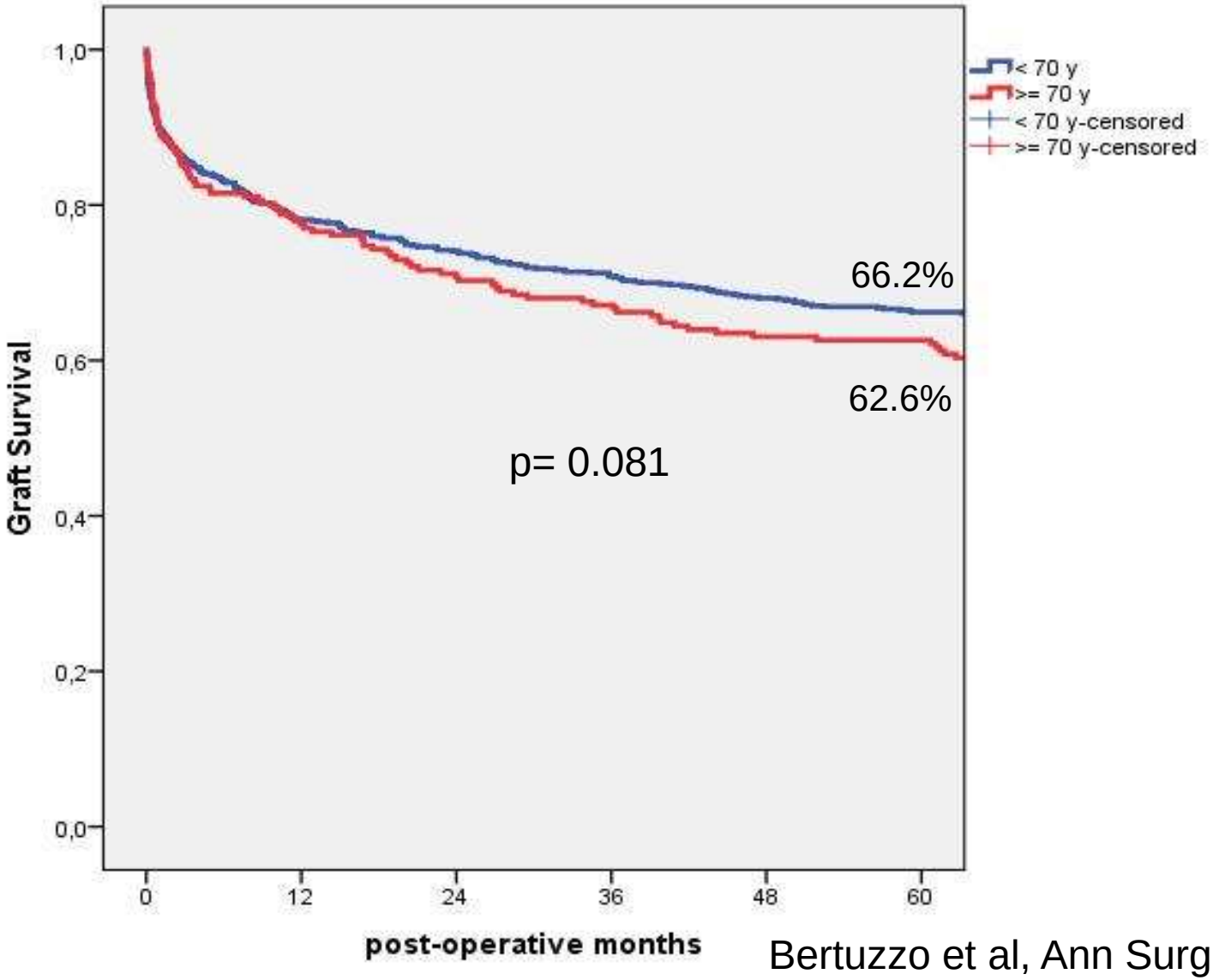
Bertuzzo et al, Ann Surg 2017

935 liver transplants in Bologna (1998-2008) Results



Bertuzzo et al, Ann Surg 2017

935 liver transplants in Bologna (1998-2008) Results



Bertuzzo et al, Ann Surg 2017

946 liver transplants in Bologna (1998-2008) Comparison between periods - Donors

	1998-2003 (N=494)	2004-2008 (N=452)	p
Donor gender (M/F)	274/208	236/192	0.326
Donor age	**55 (8-87)**	**60 (19-95)**	**< 0.001**
Donor anti-HCV positivity	8 (1.6%)	23 (5.1%)	0.002
Donor anti-HBc positivity	**57 (11.5%)**	**92 (20.4%)**	**< 0.001**
Donor HBsAg positivity	**0**	**8 (1.8%)**	**0.003**
Donor cause of death			
Cerebral stroke	300 (60.7%)	291 (64.4%)	0.138
Trauma	**176 (35.6%)**	**119 (26.3%)**	**0.001**
Post-anoxic encephalopathy	13 (2.6%)	11 (2.4%)	0.507

Bertuzzo et al, Ann Surg 2017

946 liver transplants in Bologna (1998-2008) Comparison between periods – Recipients (1)

	1998-2003 (N=494)	2004-2008 (N=452)	p
Recipient gender (M/F)	354/140	336/116	0.197
Recipient age ≥ 60 years	**78 (15.8%)**	**138 (30.5%)**	**< 0.001**
Recipient BMI < 25 kg/m^2	265 (56.1%)	244 (54.8%)	0.369
Combined transplant	**7 (1.4%)**	**34 (7.5%)**	**< 0.001**
Recipient HCV infection	260 (52.6%)	232 (51.3%)	0.368
Recipient HBV infection	**129 (26.1%)**	**83 (18.4%)**	**0.003**
Recipient HIV positivity	**0**	**19 (4.2%)**	**< 0.001**
HCC on cirrhosis	**76 (15.4%)**	**154 (34.1%)**	**< 0.001**
Alcoholic cirrhosis	41 (8.3%)	33 (7.3%)	0.532
PSC	9 (1.8%)	17 (3.8%)	0.052
PBC	13 (2.6%)	12 (2.7%)	0.570
Acute liver failure	13 (2.6%)	5 (1.1%)	0.068
Pre-OLT MELD score ≥ 25	**36 (10.3%)**	**101 (31.0%)**	**< 0.001**
D-MELD ≥ 1628	**28 (8.0%)**	**80 (24.5%)**	**< 0.001**
Pre-OLT MELD-score	**17 (6 - 40)**	**20 (6 - 48)**	**< 0.001**
D-MELD	**880 (104 – 2442)**	**1080 (108 - 3420)**	**< 0.001**

946 liver transplants in Bologna (1998-2008) Comparison between periods – Recipients (2)

	1998-2003 (N=494)	2004-2008 (N=452)	p
Re-OLT	**35 (36.8%)**	**60 (12.1%)**	**0.016**
PGNF	20 (4.0%)	17 (3.8%)	0.477
Vascular complications	**27 (5.5%)**	**12 (2.7%)**	**0.021**
HCV recurrence	**10 (2.0%)**	**1 (0.2%)**	**0.010**
Chronic rejection	3 (0.6%)	1 (0.2%)	0.361
PSC recurrence	1 (0.2%)	0	0.522

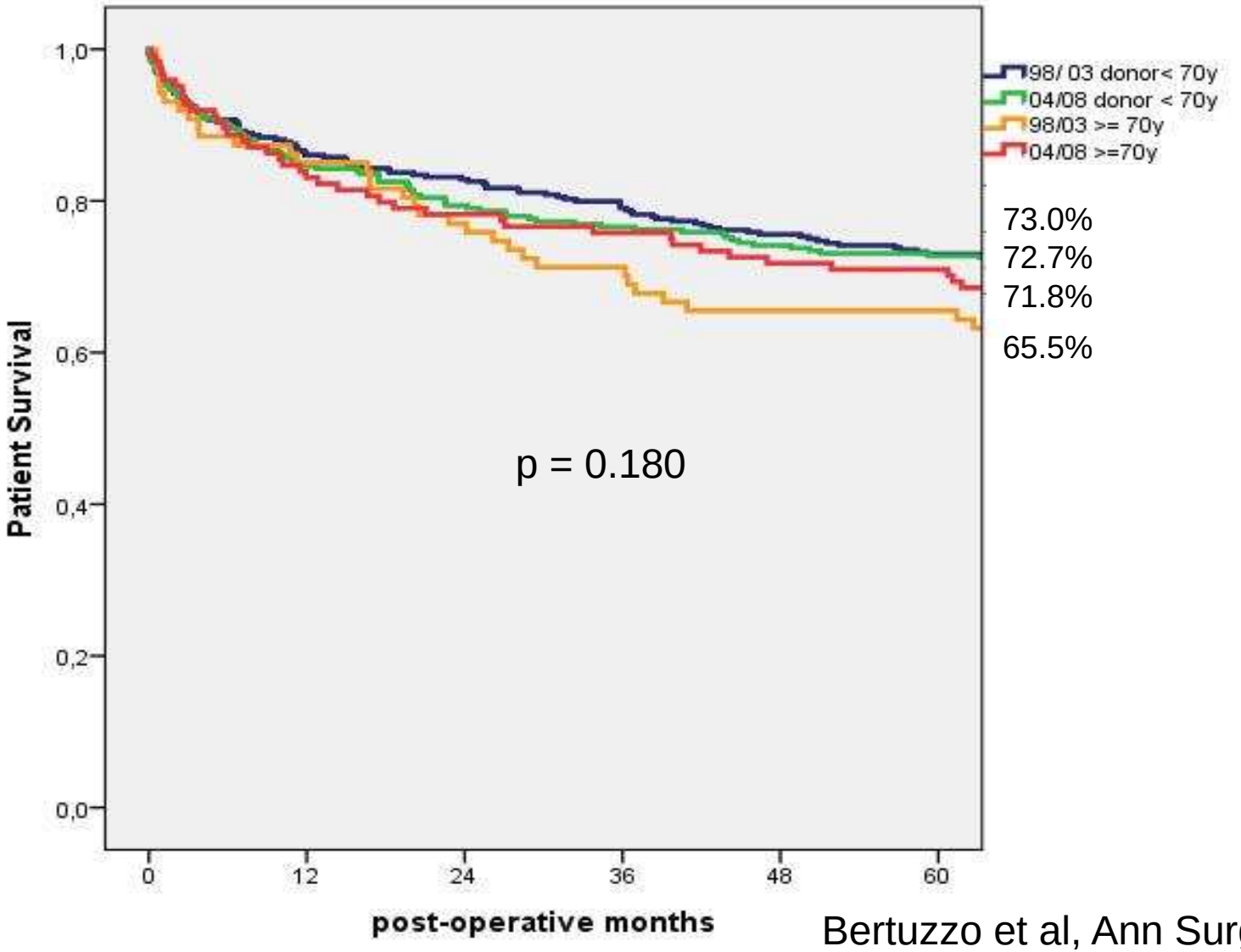
Bertuzzo et al, Ann Surg 2017

946 liver transplants in Bologna (1998-2008) Comparison between periods - Results

Causes of death	1998-2003 (N=494)	2004-2008 (N=452)	p
HCV recurrence	**53 (12.2%)**	**27 (6.5%)**	**0.003**
Infection	27 (6.2%)	24 (5.8%)	0.444
Multi-organ failure	25 (5.8%)	15 (3.6%)	0.092
HCC recurrence	**8 (1.8%)**	**25 (6.0%)**	**0.001**
De-novo tumour	10 (2.3%)	18 (4.3%)	0.073
Follow-up (mo)	**138 (0 - 198)**	**82 (0 - 125)**	**< 0.001**

Bertuzzo et al, Ann Surg 2017

946 liver transplants in Bologna (1998-2008) Results



Bertuzzo et al, Ann Surg 2017

946 liver transplants in Bologna (1998-2008) Results

Factors affecting survival

- **LT performed before 2004** (CI=1.164–1.743; Exp[B]=1.424; P=0.001)
- **Recipient HCV-positive serology** (CI=0.554–0.848; Exp[B]=0.686; P=0.001)
- **BAR score >18** (CI=0.140–0.670; Exp[B]=0.306; P=0.003)
- **Pre-LT need for CVVH/HD** (CI=0.351–0.921; Exp[B]=0.568; P=0.022)

Bertuzzo et al, Ann Surg 2017

Inflow problems: hepatic artery and old donors

Increased Risk of Graft Loss from Hepatic Artery Thrombosis After Liver Transplantation with Older Donors

Zoe A. Stewart, Jayme E. Locke, Dorry L. Segev, Nabil N. Dagher, Andrew L. Singer, Robert A. Montgomery, and Andrew M. Cameron
Department of Surgery, Johns Hopkins University School of Medicine, Baltimore, MD

Donor Age (years)	Relative Risk	95% Confidence Interval	*P* Value
<40	Reference		
40-49	1.07	0.92, 1.25	0.37
50-59	1.35	1.17, 1.57	<0.001
60-69	1.52	1.28, 1.82	<0.001
≥70	1.61	1.26, 2.06	<0.001

LIVER TRANSPLANTATION 15:1688-1695, 2009

Inflow problems: hepatic artery and old donors

Impact of Very Advanced Donor Age on Hepatic Artery Thrombosis After Liver Transplantation

Matteo Cescon, Matteo Zanello, Gian Luca Grazi, Alessandro Cucchetti, Matteo Ravaioli, Giorgio Ercolani, Massimo Del Gaudio, Augusto Lauro, Maria Cristina Morelli, and Antonio Daniele Pinna

	P	Exp (B)	95% confidence interval
Hepatic artery anatomical variations	0.005	9.40	1.94–45.59
Jumping graft	0.004	12.36	2.21–68.96
Complex reconstruction(s)	0.63	1.95	0.11–32.09
Study group (A vs. B)	0.01	9.20	1.59–53.21

Reduced incidence of HAT in the period 2003-2008 (B) (1.5%) compared to 1998-2002 (A) (8.8%) mainly related to a more appropriate technical management

TRANSPLANTATION 2011

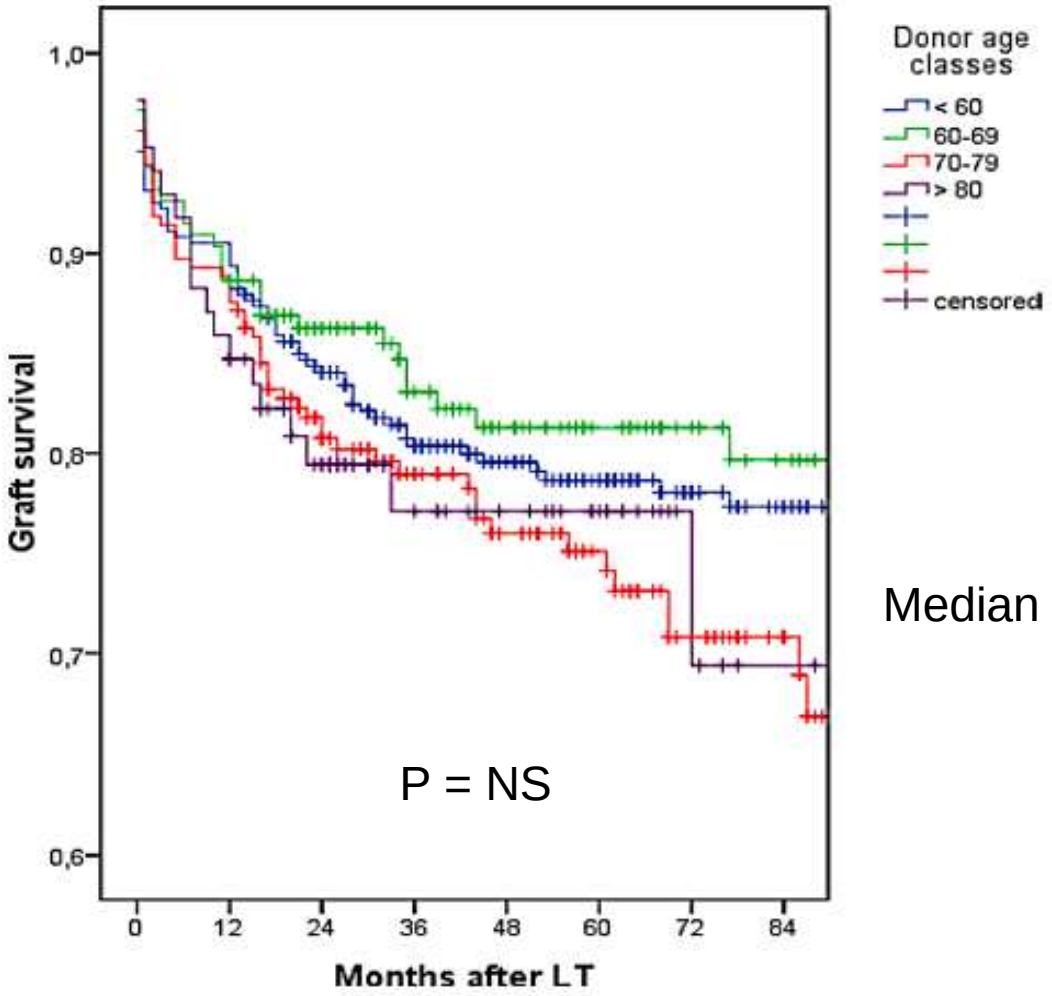
Use of octogenarian donors for liver transplantation - Recipients

Ghinolfi et al, AJT 2014

	<60 years (n = 348)	60–69 years (n = 176)	70–79 years (n = 233)	≥80 years (n = 85)	p
Gender M/F (n, %)	253/95 (73/27)	145/31 (82/18)	180/53 (77/23)	67/18 (79/21)	0.09
Age years, mean ± SD	47.3 ± 0.6	52.7 ± 0.6	54.7 ± 0.4	56.3 ± 0.8	<0.001
Primary indication to OLT (n, %)					<0.001
HCV	147 (42.2)	75 (42.6)	107 (45.9)	31 (36.5)	
HBV	78 (22.4)	32 (18.2)	52 (22.3)	19 (22.4)	
Alcoholic (ALD)	24 (6.9)	37 (21.0)	24 (10.3)	10 (11.8)	
Autoimmune	6 (1.7)	2 (1.1)	3 (1.3)	1 (1.2)	
Cholestatic	35 (10.0)	3 (1.7)	7 (3.0)	4 (4.7)	
Other	58 (16.7)	27 (15.3)	40 (17.2)	20 (23.5)	
HCC (n, %)	91 (26.1)	77 (43.8)	120 (51.5)	47 (55.3)	<0.001
HCV (n, %)	160 (46.0)	84 (47.7)	122 (52.4)	36 (42.4)	0.33
Pre-LT calculated MELD (mean ± SD)	13.9 ± 0.3	13.0 ± 0.4	12.3 ± 0.3	12.2 ± 0.5	0.001
Non-HCC patients pre-LT calculated MELD (mean ± SD)	14.6 ± 5.6	14.4 ± 5.7	13.8 ± 4.2	13.5 ± 5.0	0.38
D-MELD (mean ± SD)	560 ± 16	838 ± 27	911 ± 20	1000 ± 45	<0.001
Platelets ($n \times 10^3/mm^3$) (median, range)	71 (10–621)	77 (17–408)	73 (20–572)	85 (25–247)	0.84
Creatinine serum level (mg/dL) (mean ± SD)	0.8 ± 0.5	0.82 ± 0.2	0.79 ± 0.2	0.83 ± 0.3	0.803
Albumin serum level (g/L) (mean ± SD)	3.5 ± 0.1	3.7 ± 0.1	3.6 ± 0.1	3.6 ± 0.1	0.13
Post-LT hospital stay (days) (mean ± SD)	22.3 ± 0.9	22.1 ± 1.6	23.7 ± 1.6	20.7 ± 1.9	0.65

Use of octogenarian donors for liver transplantation - Survivals

Ghinolfi et al, AJT 2014



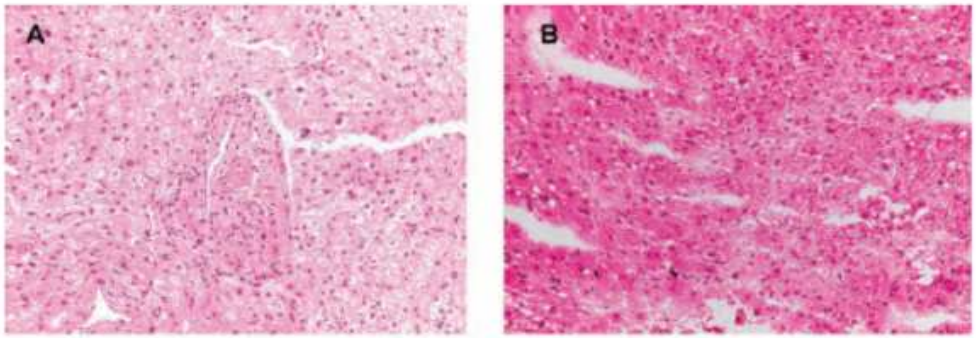
Median follow-up = 4.5 yrs

American Journal of Transplantation 2008; 8: 725–726
Blackwell Munksgaard

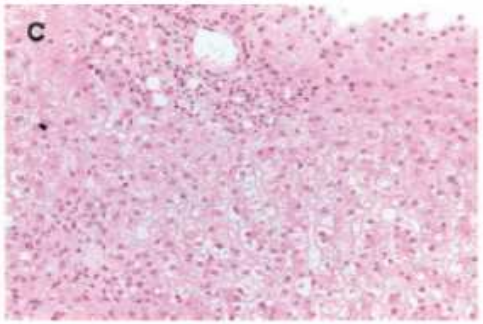
doi: 10.1111/j.1600-6143.2007.02114.x

Letter to the Editor

Successful Liver Transplantation from a 95-Year-Old Donor to a Patient with MELD Score 36 and Delayed Graft Arterialization



Donor Liver
biopsy
at the harvesting



14days after liver transplantation

Grazi GL. et al, Am J Transpl 2008

Extended criteria donors

- ✓ Older donors
- ✓ Steatotic grafts
- ✓ Seropositive Donors
- ✓ Split Grafts
- ✓ Living Donors

Extended criteria donors

Retrospective, single center study:

- Considered only biopsy proven macrovescicular fat (120 donors, 27% of total)

S0 = no fat	N = 323
S1 = mild < 30%	N = 72
S2 = mod 30-60%	N = 25
S3 = severe > 60%	N = 23

Findings:

- Increased graft loss with mod and severe macro steatosis
- Higher recurrence in HCV patients with mod and severe macro steatosis
- Graft loss at 6 months due to HCV 17% vs. 2% ($p<0.058$)

Verran D et al, Liver Transplantation 2003

Extended criteria donors

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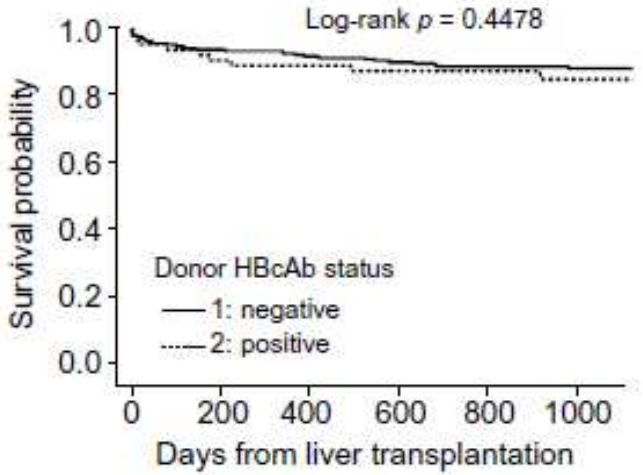
- ✓ Living Donors

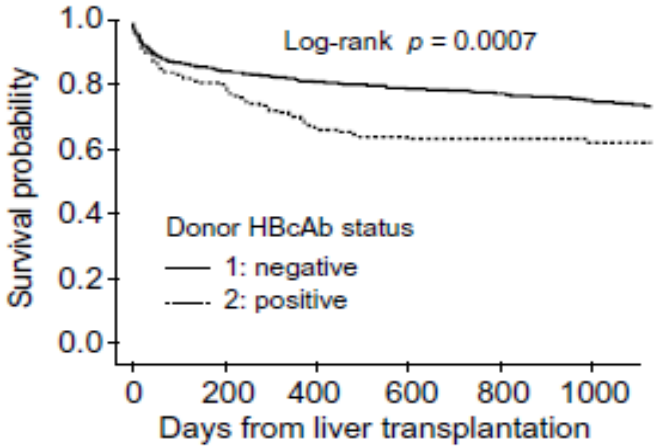
Hepatitis B-core antibody positive donors

Angelico et al, J Hepatol 2013

Variable	Hazard Ratio	95% CI		*p* value
MELD at LT	1.300 (per 10 units)	1.134	1.491	0.0002
Recipient HBsAg status (positive *vs.* negative)	0.426	0.304	0.597	<0.0001
Portal vein thrombosis (yes *vs.* no)	1.988	1.139	3.496	0.0156
Donor HBcAb status (positive *vs.* negative)	1.555	1.184	2.042	0.0015
DRI	1.406 (per unit)	1.029	1.921	0.0325



HBsAg-pos recipients

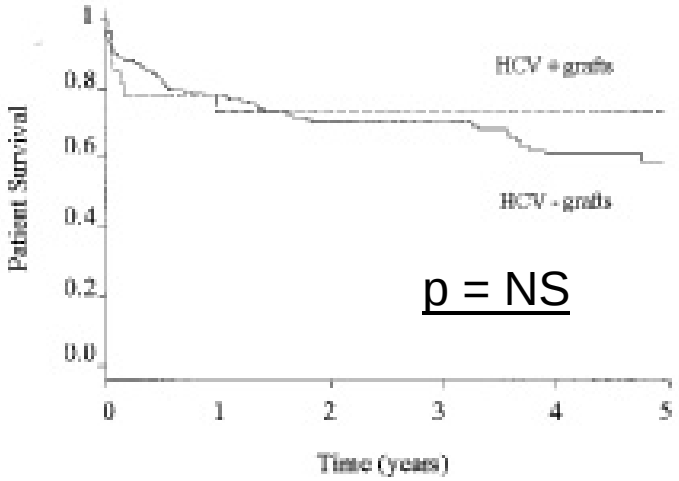


HBsAg-neg recipients

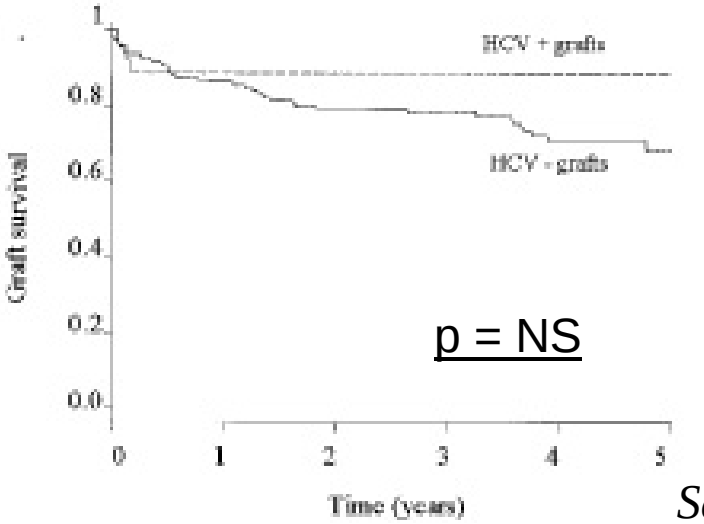
Bologna experience of LT with MELD >30 (93 cases)
HBcAb related to 90 days mortality

Variables				90d-M
Pre-OLT creatinine (mg/dL)			< 1.22	2.6%
Donor HBcAb			neg	
Pre-OLT creatinine (mg/dL)	< 1.22		≥ 1.22	21.3%
		or		
Donor HBcAb	pos		no	
Pre-OLT creatinine (mg/dL)			≥ 1.22	44.4%
Donor HBcAb			yes	

HCV positive donors



p = NS



p = NS

Saab S, Liver Transplantation2003

Liver grafts from hepatitis B surface antigen-positive donors: A review of the literature

Elisabetta Loggi, Fabio Conti, Alessandro Cucchetti, Giorgio Ercolani, Antonio Daniele Pinna, Pietro Andreone

Table 1 Published studies with liver transplantation using hepatitis B surface antigen (+) positive donors in hepatitis B surface antigen (+) recipients

Ref.	Patient No.	Prophylaxis		Outcome at the last FU			Median FU (mo)
		Nucleos(t)ide Analogue	HBIg	HBV disease	HBsAg	HBV-DNA	
Franchello *et al*[13]	3	LMV LMV + ADV (n = 1)	Yes	No (n = 1) Yes (HDV =2)	Persistence	Negative HDVRNA +	19
Ho *et al*[17]	1	LMV + ADV	No	No	Persistence	Negative	24
Hwang *et al*[16]	1	LMV + ADV	Yes	Mild	Persistence	Negative	64
Soejima *et al*[15]	1	LMV	Yes	No	Persistence	Negative	48
Jiao *et al*[24]	2	LMV	Yes	Mild	Persistence	Negative	48
Jang *et al*[25]	6	LMV + ADV	Yes	No	Persistence	Negative	22.5
Bahde *et al*[14]	1	LMV + ADV	Yes	HDV cirrhosi	Persistence	Negative	50
Loggi *et al*[25]	6	LMV + ADV LMV + TDF	Yes	No	Persistence	HDVRNA + Negative	42
Choi *et al*[26]	8	LMV (n = 2) ETV (n = 6)	Yes	No	Persistence (n = 6) Loss (n = 2)	Negative	25.5
Ju *et al*[27]	23	ETV	Yes	No	Persistence (n = 17) Loss (n = 1)	Negative	NA
Saidi *et al*[28]	68	NA	NA	NA	NA	NA	NA
Li *et al*[29]	15	NA	NA	NA	NA	NA	NA
Yu *et al*[31]	38	Not specified	Yes	No	Persistence	Negative	NA
Jeng *et al*[32]	13	ETV	No	No	Persistence	Negative	46

Loggi E. et al, World J Gastr 2016

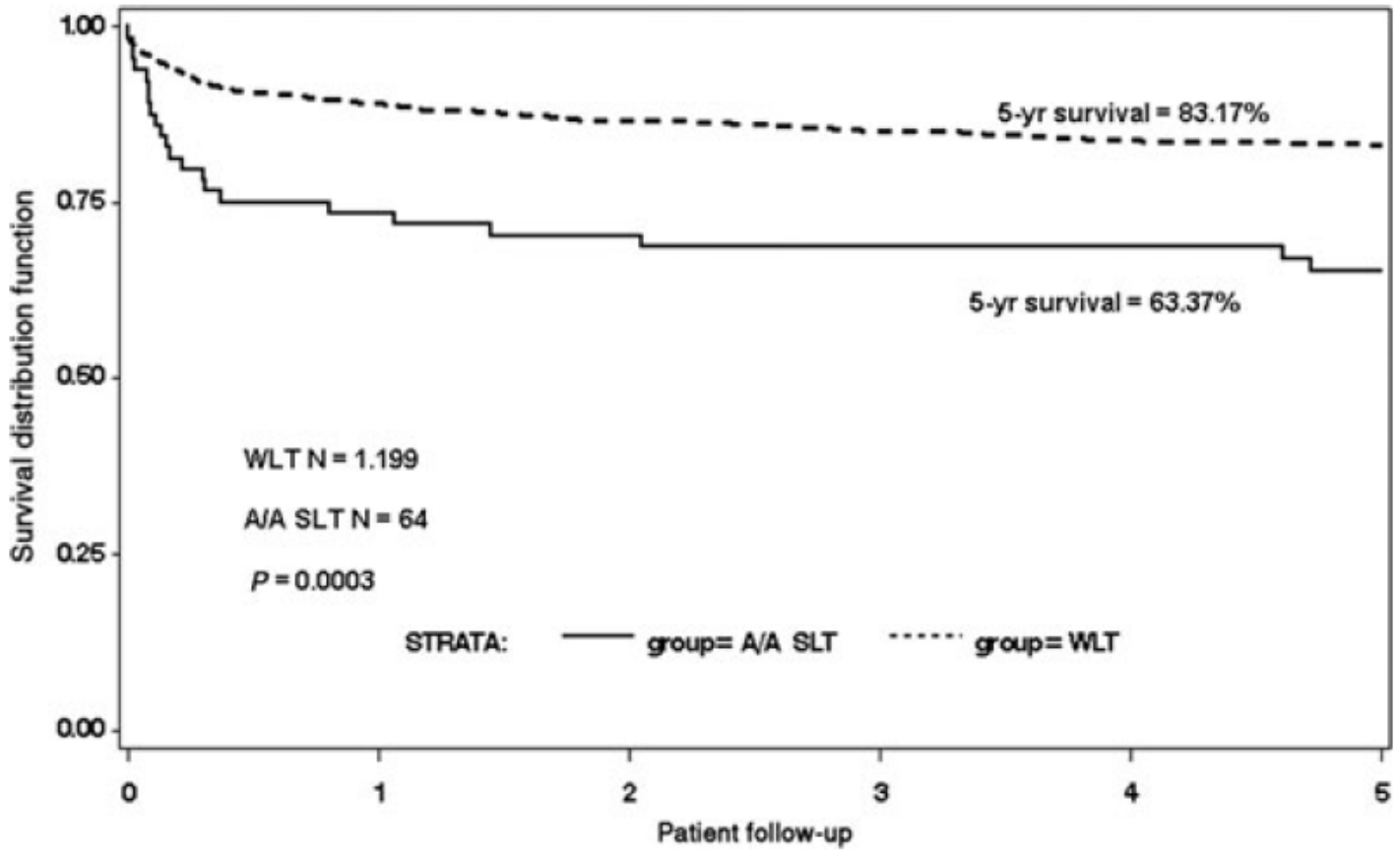
Extended criteria donors

- ✓ Older donors
- ✓ Steatotic grafts
- ✓ Seropositive Donors
- ✓ Split Grafts
- ✓ Living Donors

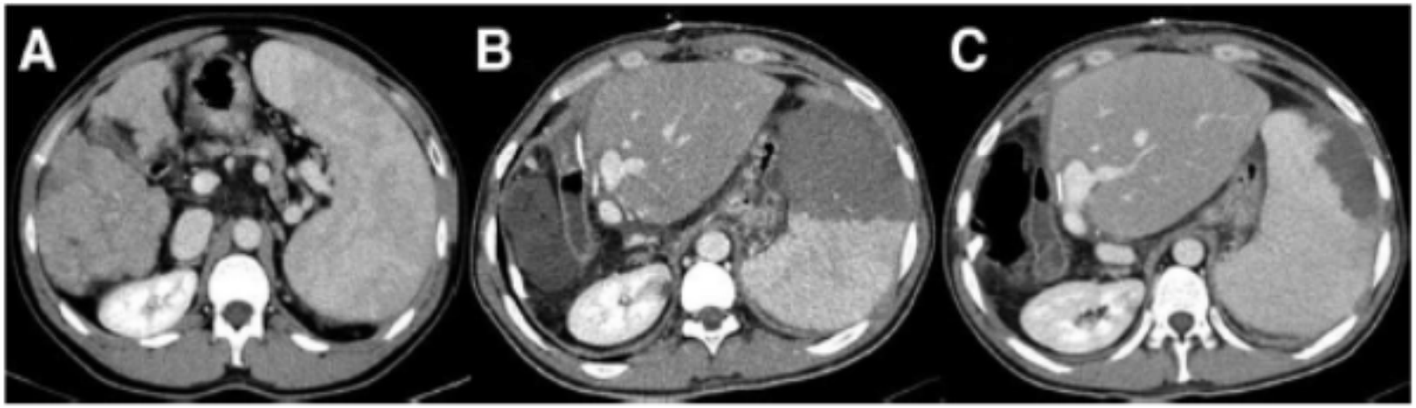
A Prospective Policy Development to Increase Split-Liver Transplantation for 2 Adult Recipients

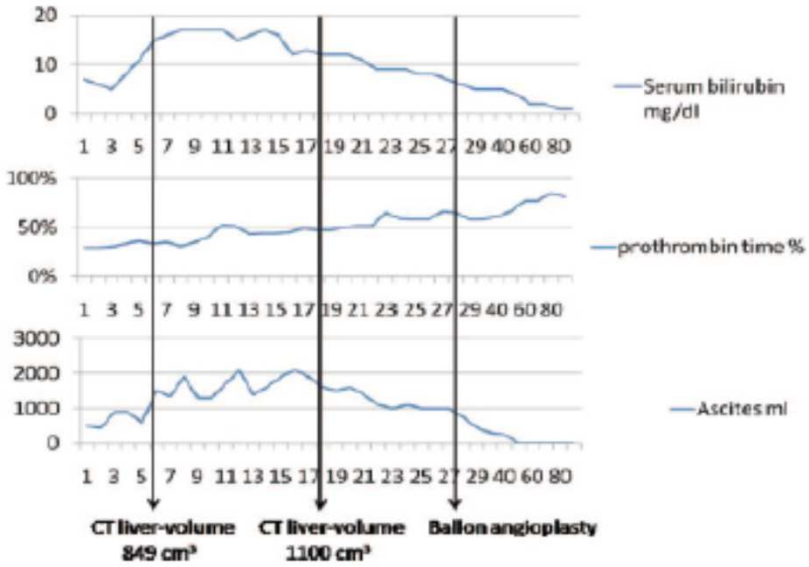
Results of a 12-Year Multicenter Collaborative Study

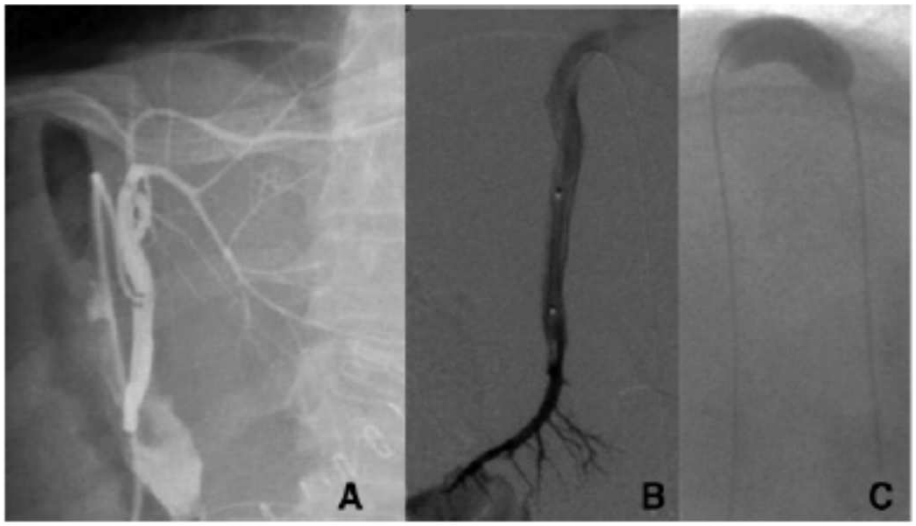
(*Ann Surg* 2014;259:157–165)



Liver Transplantation With Left Lateral Segments in Adults: A Risk or a Possibility?







Ravaioli M. et al., Transplantation 2009

Estimates of Early Death, Acute Liver Failure, and Long-term Mortality Among Live Liver Donors

4111 live liver donors in the United States between April 1994 and March 2011 for a mean of 7.6 years

Seven donors had early deaths

risk of death did not vary with age of the liver recipient or portion of liver donated

Long-term mortality of live liver donors was comparable to that of live kidney donors and NHANES participants (1.2%, 1.2%, and 1.4% at 11 years, respectively; *P* = .9).

The risk of early death among live liver donors in the United States is 1.7 per 1000 donors. Mortality of live liver donors does not differ from that of healthy, matched individuals over a mean of 7.6 years.

Gastroenterology 2012

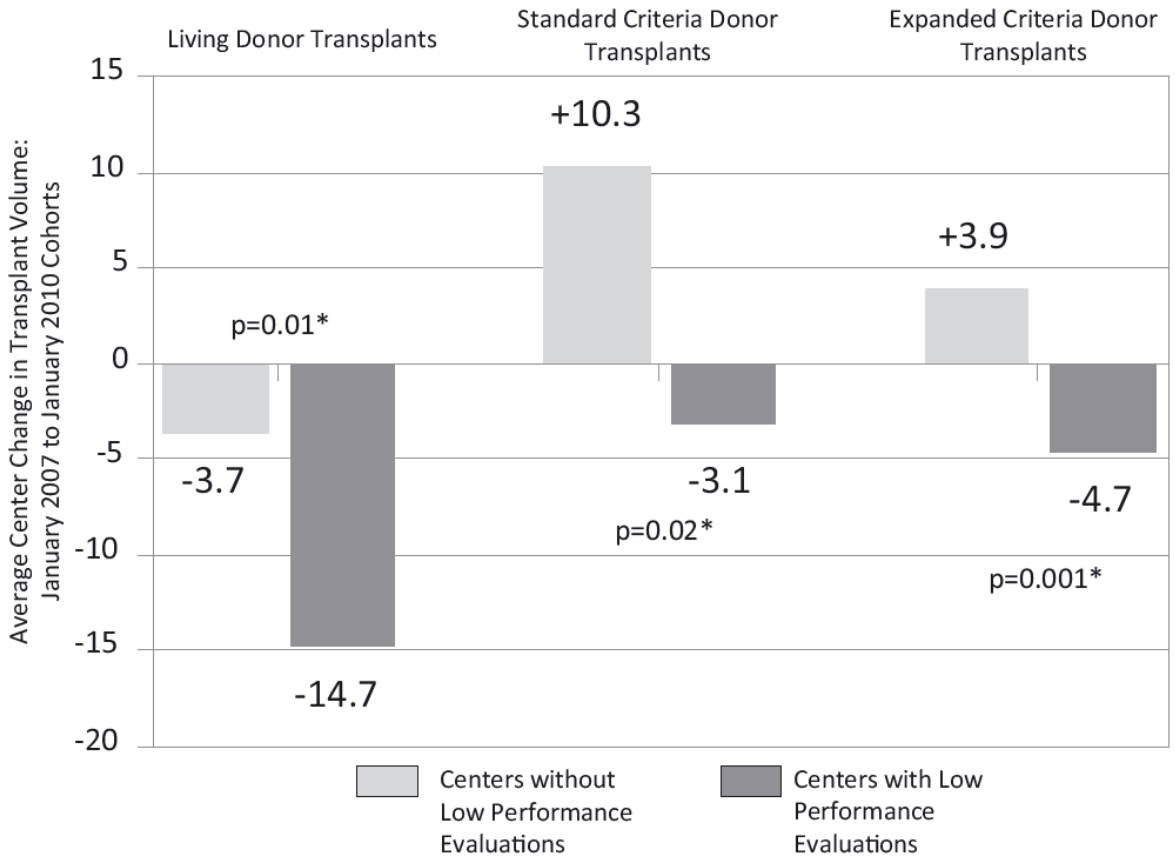
What happen without risks in liver transplantation

Centers that received low performance evaluations (LP) had an average decrease of 39.9 transplants (p<0.01) and 67.3 candidates (p<0.01). ***LP centers reduced the use of older donors, donations with longer cold ischemia, and donations after cardiac death*** (p-values<0.01).

Transplant characteristics	Low performing centers (n = 15 478)	Average or high performing centers (n = 34 369)	p-Value
Recipient age: mean (SD)	+2.1 (2.1)	+2.7 (1.8)	0.14
Donor age: mean (SD)	**−0.6 (2.9)**	**+1.8 (4.1)**	**0.008**
Recipient creatinine: mean (SD)	+0.4 (0.3)	+0.4 (0.2)	0.93
Cold ischemia hours: mean (SD)	**−1.6 (1.5)**	**−0.3 (1.6)**	**0.001**
Albumin: mean (SD)	+0.06 (0.22)	+0.11 (0.26)	0.39
INR: mean (SD)	+0.06 (0.31)	+0.04 (0.35)	0.77
MELD at listing: mean (SD)	+0.73 (1.76)	+0.67 (1.88)	0.88
MELD prior to transplant: mean (SD)	+0.85 (2.49)	+1.01 (2.42)	0.78
Donor risk index: mean (SD)	+0.02 (0.08)	+0.02 (0.08)	0.45
Length of stay: mean (SD)	−0.02 (0.21)	−0.02 (0.29)	0.99
Distance to center (miles): mean (SD)	−7.1 (39.7)	+4.9 (57.0)	0.32
HCV (%)	+7%	+3%	0.12
DCD (%)	**−1%**	**+3%**	**0.001**

Buccini et al. American journal of Transplantation 2014

What happen without risks in kidney transplantation



Schold et al. American journal of Transplantation 2013

Patients Benefit ? MELD >30

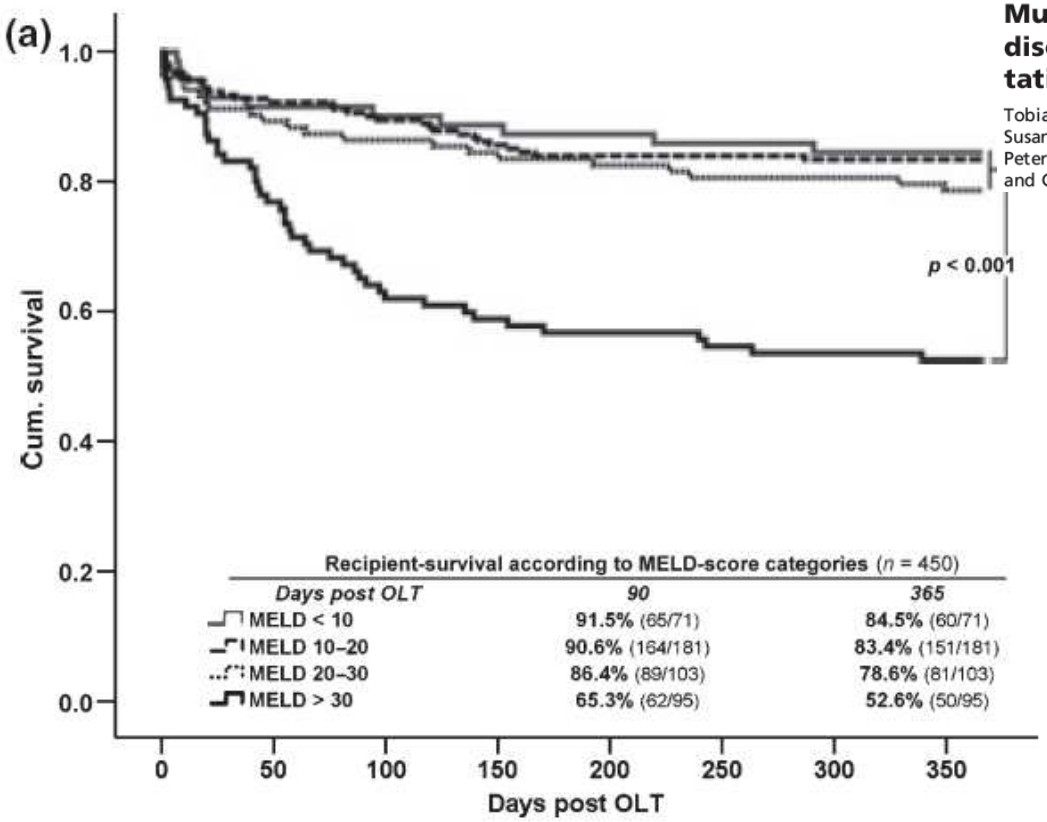
Transplant International

Transplant International ISSN 0934-0874

ORIGINAL ARTICLE

Multicentric evaluation of model for end-stage liver disease-based allocation and survival after liver transplantation in Germany – limitations of the 'sickest first'-concept

Tobias J. Weismüller,[1,2] Panagiotis Fikatas,[3] Jan Schmidt,[4] Ana P. Barreiros,[5] Gerd Otto,[5] Susanne Beckebaum,[6,7] Andreas Paul,[7] Markus N. Scherer,[8] Hartmut H. Schmidt,[9] Hans J. Schlitt,[8] Peter Neuhaus,[3] Jürgen Klempnauer,[2,10] Johann Pratschke,[3] Michael P. Manns[1,2] and Christian P. Strassburg[1,2]



we would not generally recommend to restrict OLT to pts with MELD <30

But common principles among different organ allocation policies…

- Equity
- Clear and common rules
- Patients benefit

Liver transplantation begun with this indication

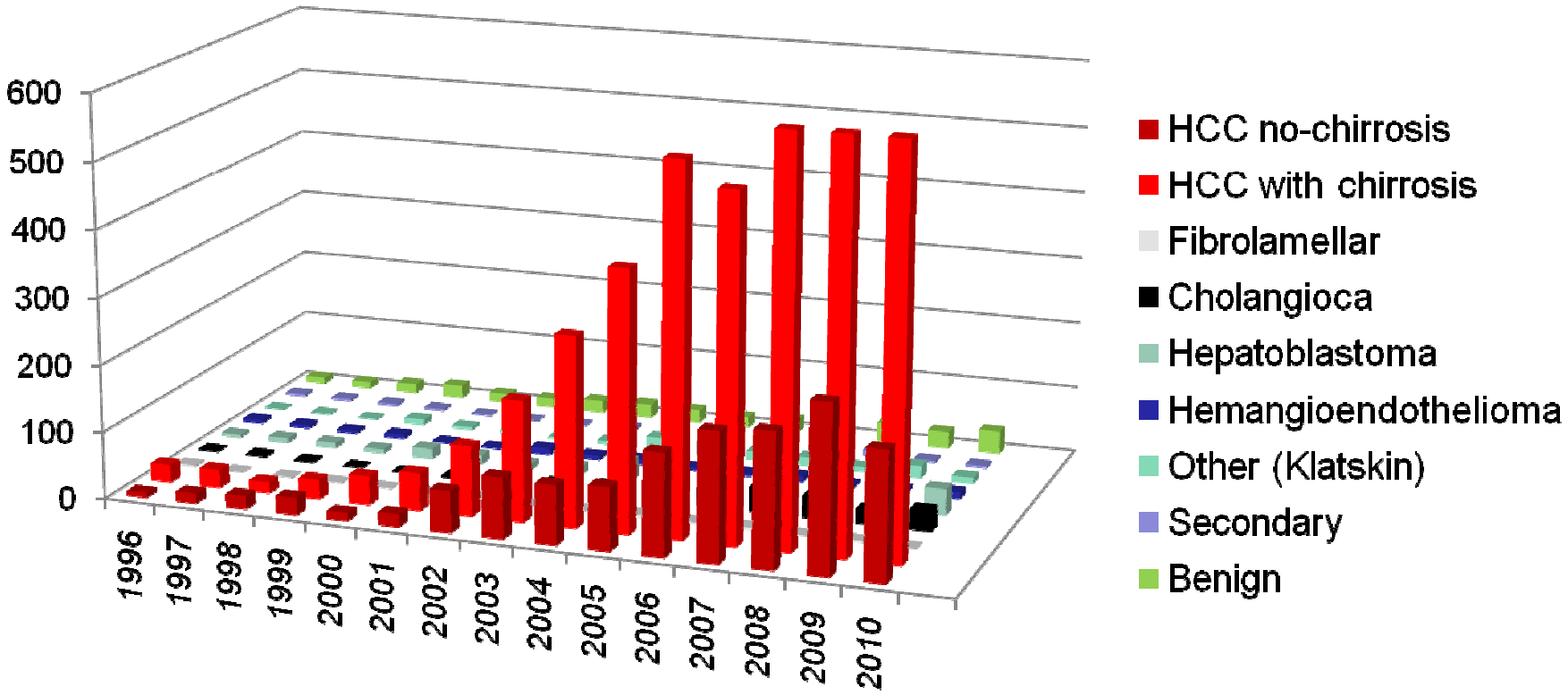
Although now non HCC malignancies represent borderline indications to LT, the history of this procedure is founded on these cases

Table 3. The First Seven Human Liver Recipients

Age (y)	Date	City (ref)	Liver disease	Survival (d)	Main cause of death
3	3-1-63	Denver (60)	Biliary atresia	0	Intraoperative bleeding
48	5-5-63	Denver (60)	Hepatoma, cirrhosis	22	Pulmonary emboli, sepsis
68	6-3-63	Denver (60)	Duct cell carcinoma	7.5	Pulmonary emboli
52	7-10-63	Denver (64)	Hepatoma, cirrhosis	6.5	Gastrointestinal bleeding, pulmonary emboli/edema, liver failure
58	9-16-63	Boston (65)	Colon metastases	11	Pneumonitis, hepatic abscesses, failure
29	10-4-63	Denver (64)	Hepatoma	23	Sepsis, bile peritonitis, pulmonary emobli
75	1-?-64	Paris (66)	Colon metastases	0	Intraoperative hemorrhage

Starzl et al. J Am Coll Surg 2002

UNOS data


600
500
400
300
200
100
0
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1998
1999
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2001
2002
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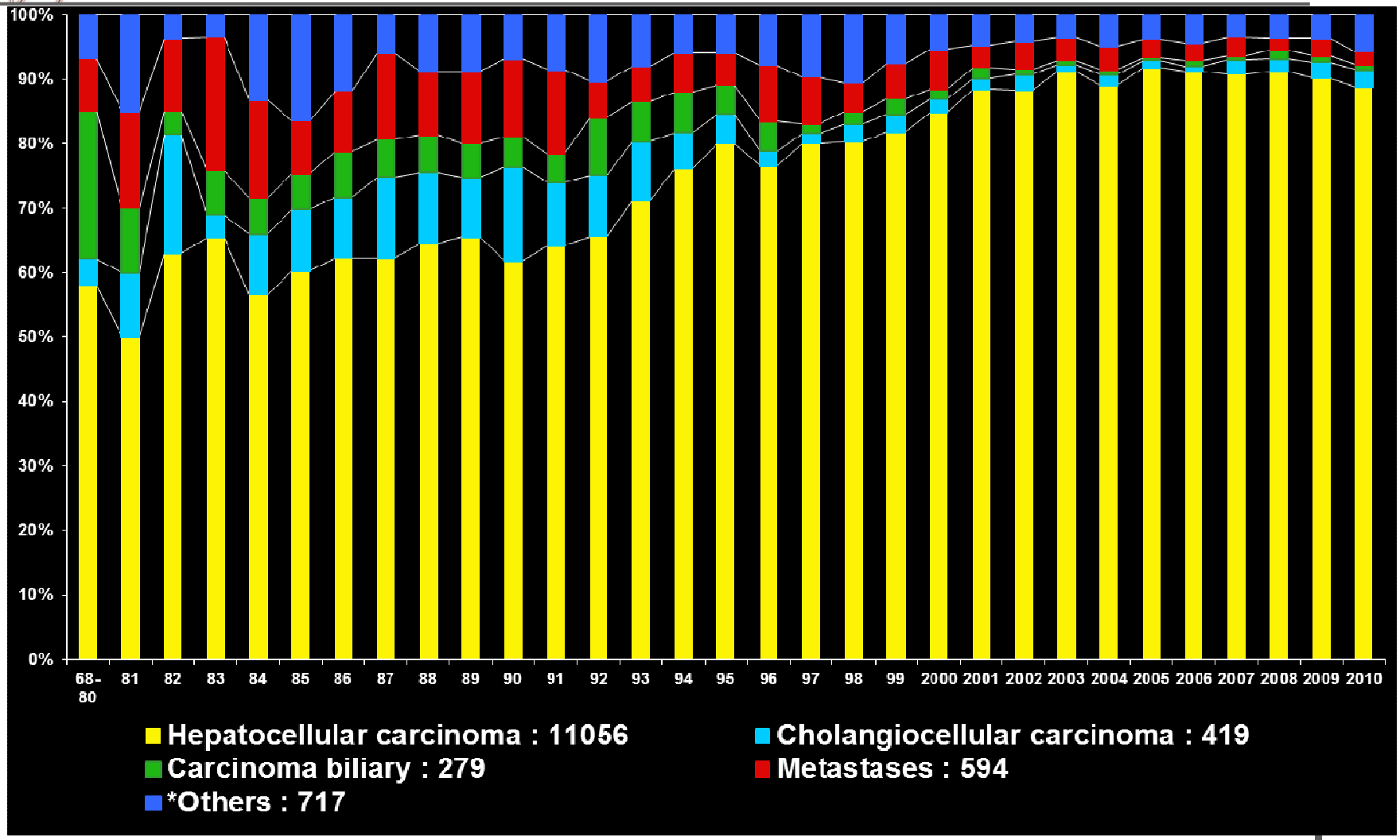
2006
2007
2008
2009
2010
HCC no-chirrosis
HCC with chirrosis
Fibrolamellar
Cholangioca
Hepatoblastoma
Hemangioendothelioma
Other (Klatskin)
Secondary
Benign

ELTR data


100%
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2010
Hepatocellular carcinoma : 11056
Cholangiocellular carcinoma : 419
Carcinoma biliary : 279
Metastases : 594
*Others : 717

LT for metastases from colorectal cancer

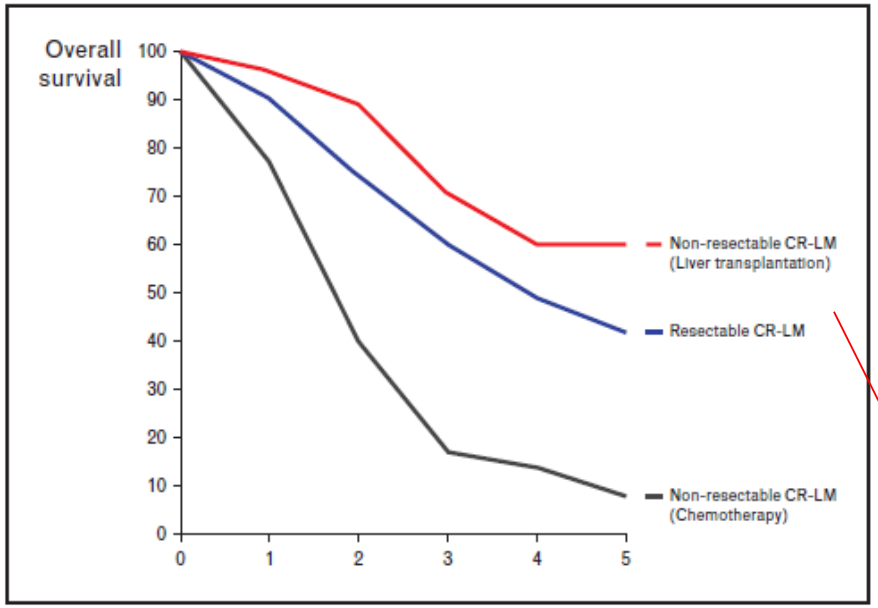


FIGURE 1. Overall survival of CR-LM patients. Red line: Liver transplantation in patients with nonresectable liver metastases (data from the SECA study). Blue line: Resectable liver metastases (data from [13]). Grey line: Nonresectable patients treated with chemotherapy (FOLFOXIRI) (Data from [2]).

- 2006-2011 period
- 21 patients transplanted
- median n° of liver metastasis

= 8 (range 2-40)

- median size of largest lesion

= 4.5 cm (range 2.8-13)

1-year survival: 96%
3-years survival: 70%
5-years survival: 60%

….but…

- patient cohort is small
- control arm lacking
- 90% patients experienced recurrence (> lung → pulmonary resection)

Hagness, Ann Surg 2013

ECD, other strategies to improve the outcome?

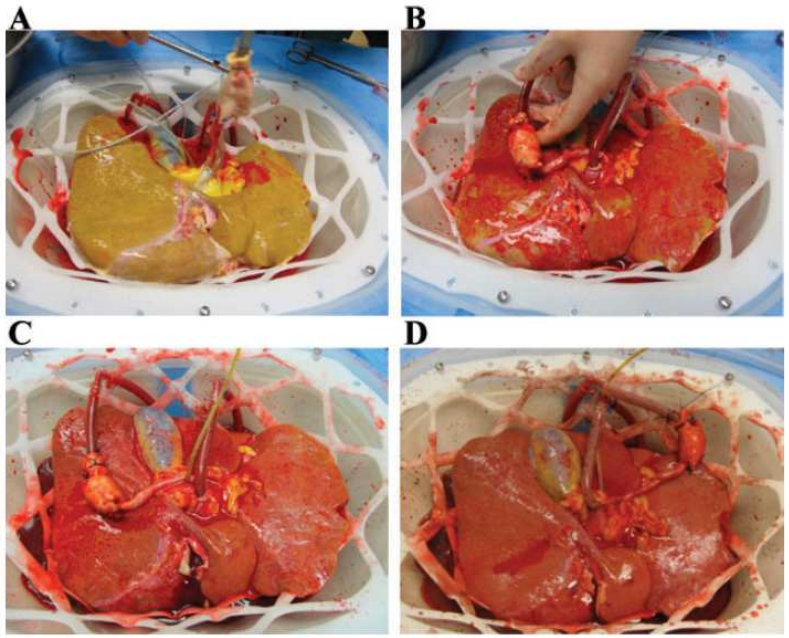
Ex vivo Normothermic Machine Perfusion and Viability Testing of Discarded Human Donor Livers

American Journal of Transplantation 2013; 13: 1327–1335

S. op den Dries[a,b], N. Karimian[a,b], M. E. Sutton[a,b], A. C. Westerkamp[a,b], M. W. N. Nijsten[c], A. S. H. Gouw[d], J. Wiersema-Buist[b], T. Lisman[a,b], H. G. D. Leuvenink[b] and R. J. Porte[a,*]

[a]Section of Hepatobiliary Surgery and Liver Transplantation, Department of Surgery; [b]Surgical Research Laboratory; [c]Department of Critical Care and [d]Department of Pathology, University Medical Center Groningen, University of Groningen, Groningen, The Netherlands

**Corresponding author: Robert J. Porte, r.j.porte@umcg.nl*



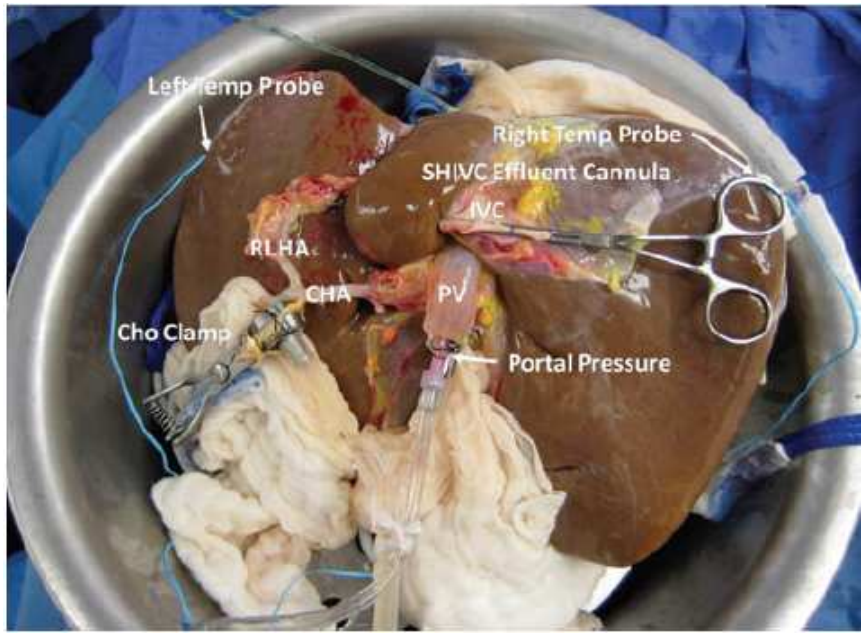
ECD, other strategies to improve the outcome?

Hypothermic Machine Preservation in Human Liver Transplantation: The First Clinical Series

American Journal of Transplantation 2010; 10: 372–381

J. V. Guarrera[a,*], S. D. Henry[a], B. Samstein[a], R. Odeh-Ramadan[a], M. Kinkhabwala[d], M. J. Goldstein[a], L. E. Ratner[a], J. F. Renz[c], H. T. Lee[b], R. S. Brown, Jr.[a] and J. C. Emond[a]

[a]*Center for Liver Disease and Transplantation, Department of Surgery and* [b]*Department of Anesthesiology, Columbia University Medical Center, New York, NY*
[c]*Division of Transplantation, University of Arizona, Tuscon, AZ*
[d]*Division of Transplantation, Montefiore Medical Center, Bronx, New York, NY*
**Corresponding author: James V. Guarrera, jjg46@columbia.edu or liverpreservation@gmail.com*



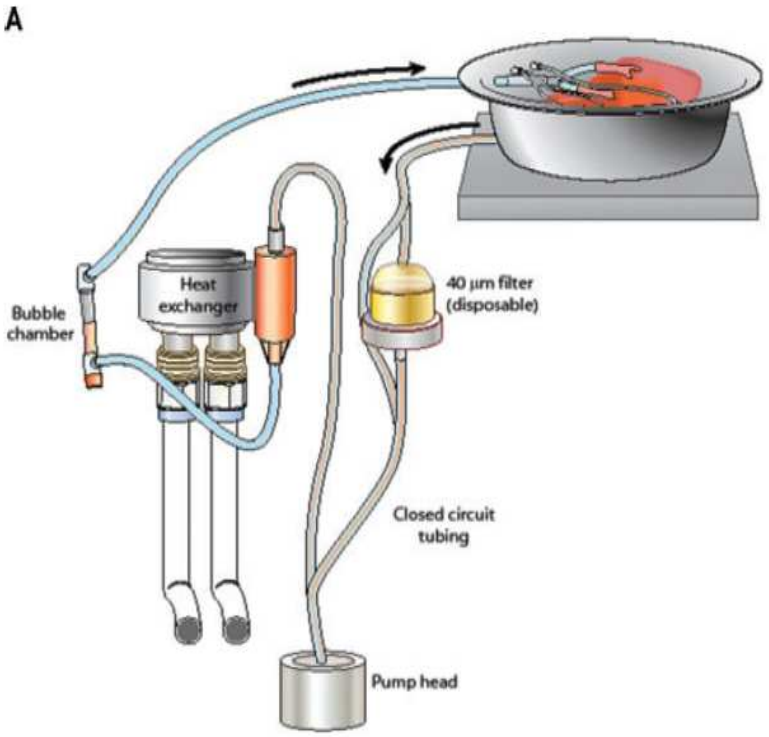
ECD, other strategies to improve the outcome?

20 LTs HMP preserved vs. 20 a matched group transplanted with CS livers

	Machine perfusion (HMP)	Cold storage (CS)
Primary nonfunction	0	0
Early allograft dysfunction	1* (5%)[1]	5 (25%)
Vascular complications (total)	0	1
Hepatic artery stenosis		1
Biliary complications (total)	2	4
Early bile leak	1	1
Biliary stricture	1	3
Hospital length of stay (days)	10.9 ± 4.7[2]	15.3 ± 4.9
Actual graft and patient survival	18/20 (90%)	18/20 (90%)
Deaths with fuctional grafts	2 Cardiovascular death at 1 month; Pneumonia and sepsis at 3 months	2 Recurrent cancer at 5 months; Recurrent HCV and sepsis at 7 months

[1]$p = 0.08$, [2]$p = 0.006$.
*Technically met criteria but occurred in the setting of early acute cellular rejection.

Early allograft dysfunction Rates were 5%in the HMP group versus 25% in controls (p = 0.08)



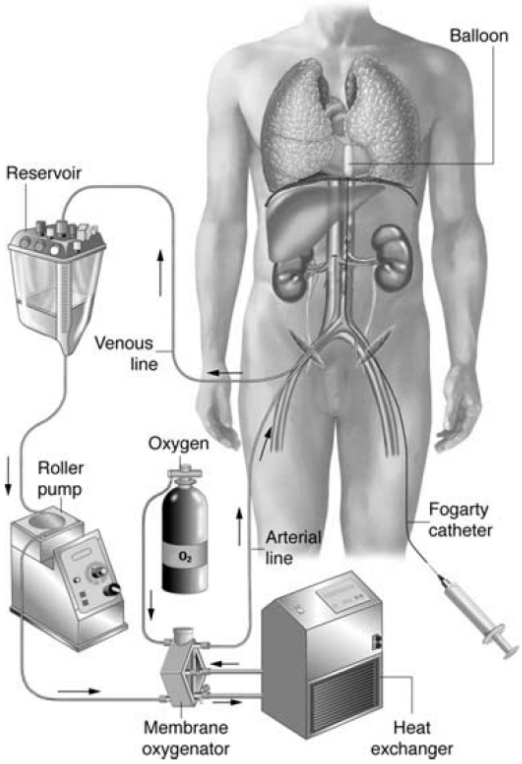
ECD, other strategies to improve the outcome?

Liver Transplant Using Donors After Unexpected Cardiac Death: Novel Preservation Protocol and Acceptance Criteria

American Journal of Transplantation 2007; 7: 1849–1855

C. Fondevila[a,*], A. J. Hessheimer[a], A. Ruiz[b], D. Calatayud[a], J. Ferrer[a], R. Charco[a], J. Fuster[a], M. Navasa[c], A. Rimola[c], P. Taurá[d], P. Ginés[c], M. Manyalich[b] and J. C. García-Valdecasas[a]

[a]Departments of Surgery, [b]Transplant Coordination, [c]Gastroenterology and [d]Anesthesia, Institut de Malalties Digestives, Hospital Clínic, Institut d'Investigacions Biomèdiques August Pi I Sunyer (IDIBAPS), University of Barcelona, 08036 Barcelona, Spain
**Corresponding author: Constantino Fondevila, cfonde@clinic.ub.es*



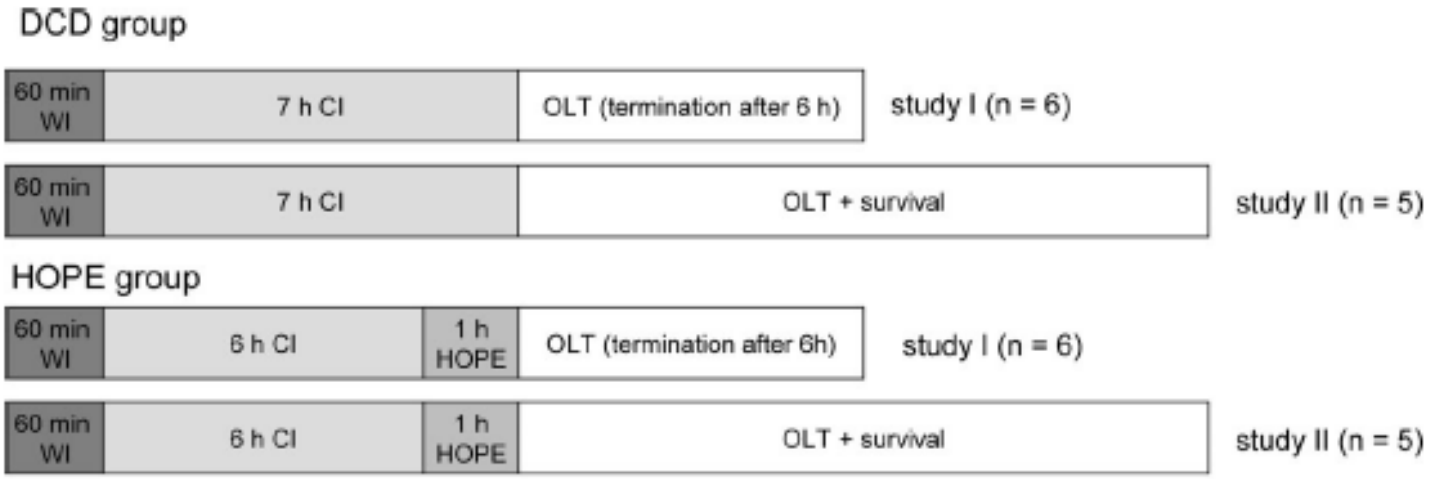
Donors after cardiac death (DCD) maintain with normothermic extracorporeal membrane oxygenation (NECMO)

ECD, other strategies to improve the outcome?

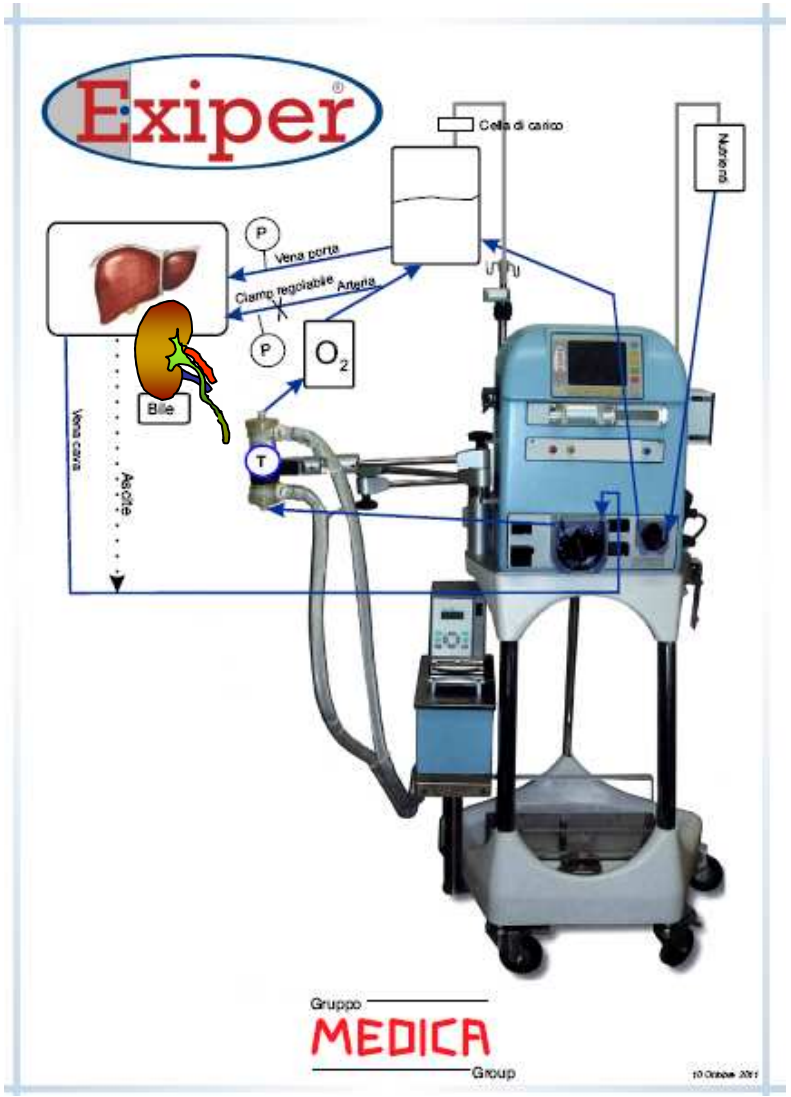
One Hour Hypothermic Oxygenated Perfusion (HOPE) Protects Nonviable Liver Allografts Donated After Cardiac Death

Olivier de Rougemont, MD, Stefan Breitenstein, MD,* Boris Leskosek,* Achim Weber, MD,† Rolf Graf, PhD,* Pierre-Alain Clavien, MD, PhD,* and Philipp Dutkowski, MD**

(*Ann Surg* 2009;250: 674–683)



ECD, other strategies… Bologna researches..



Conclusions: *centers can choose their transport but do not forget any passengers*