

Comparison of shunt types in the Norwood procedure for single-ventricle lesions.

- MBT N= 275, RVPA N= 274
- 12 months outcome
RVPA: 68 deaths and 4 transplantations (26.3%)
MBT: 91 deaths and 9 transplantations (36.4%)
95% CI, -17.8 to -2.4, $p= 0.01$
- All follow-up period
 1. The difference was no longer significant at all follow-up (Log-rank, $p= 0.06$)
 2. When cases who had shunt crossover (MBT 25, RVPA 32) were taken into account, the overall transplantation-free survival rate was higher in the RVPA ($p= 0.02$)

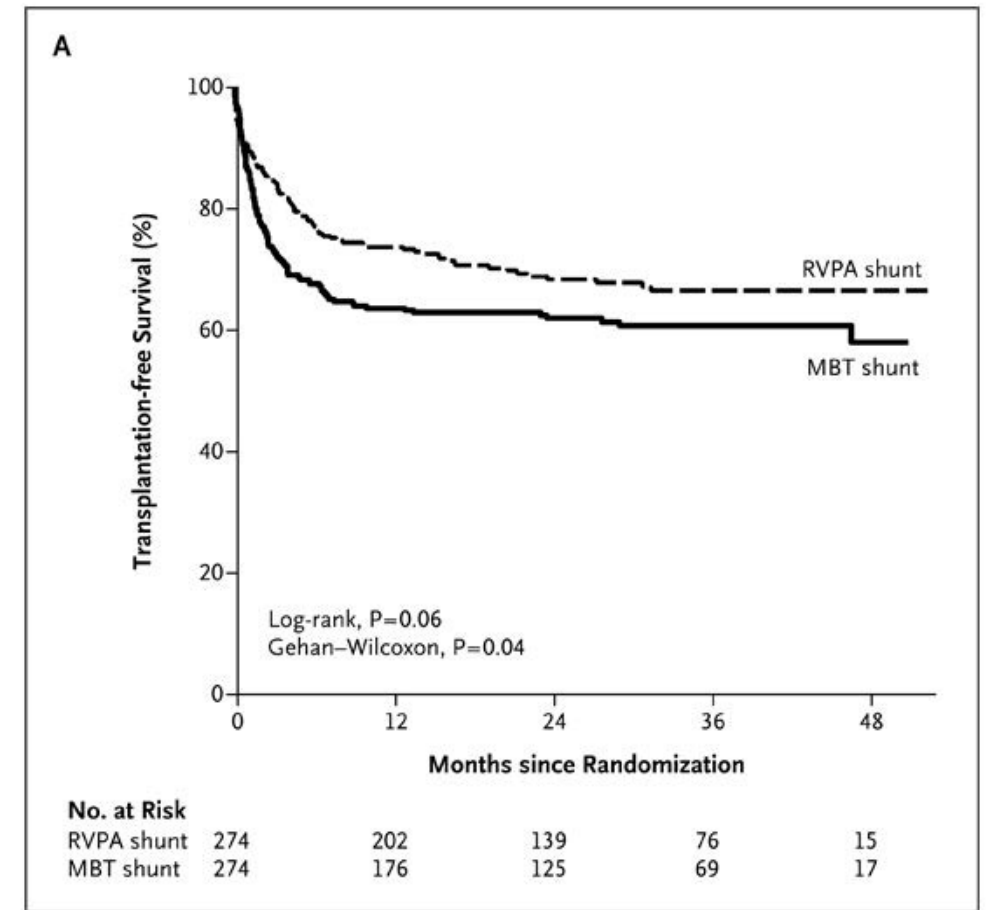


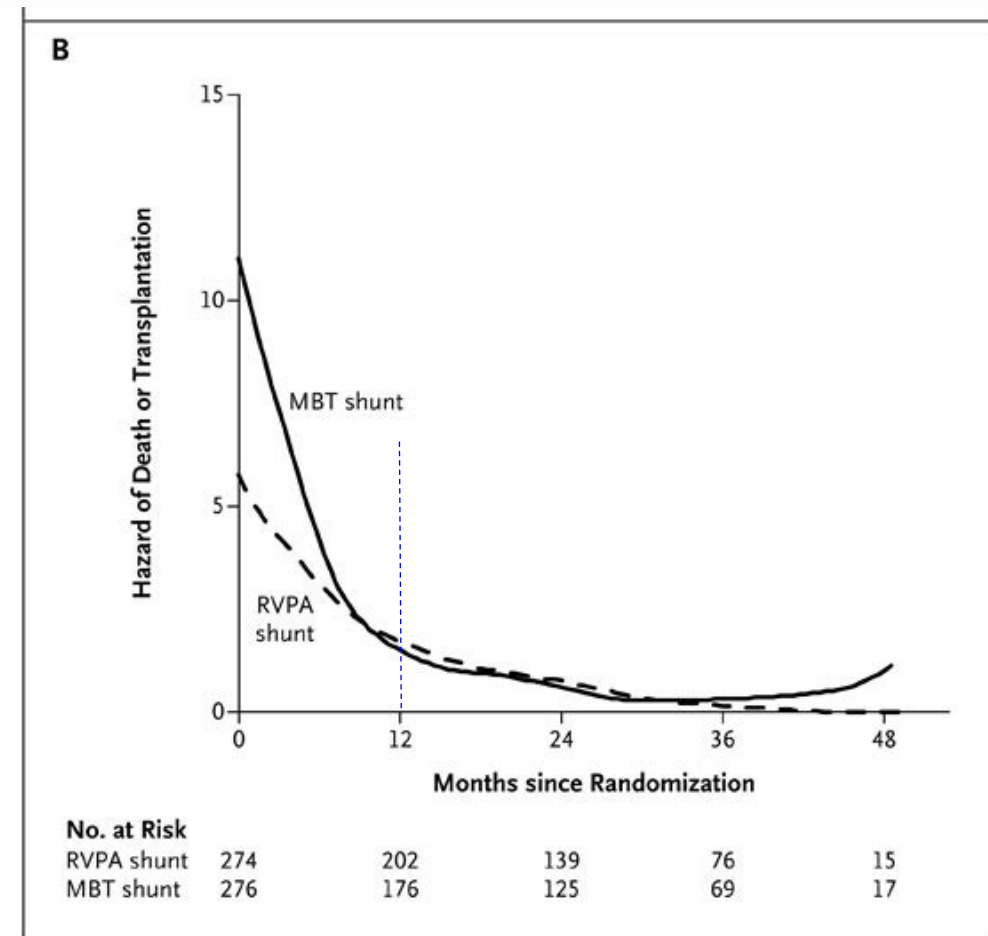
Fig. 1

Comparison of shunt types in the Norwood procedure for single-ventricle lesions.

- MBT N= 275, RVPA N= 274
- Treatment effect differed in the period before and the period after 12 months (P=0.02, Nonproportional-hazards test)

“...the negative factors related to use of the RVPA shunt including damage to the right ventricle from the ventriculotomy and smaller pulmonary arteries become evident later (after stage II)...”

Fig. 2



Comparison of shunt types in the Norwood procedure for single-ventricle lesions.

	RVPA	MBT	p
Norwood Hospitalization			
CPR (%)	13	20	0.04
Unintended interventions (n,rate)	4(1.5)	15(5.5)	0.01
Composite of serious adverse events (n,rate)	98(36)	133(48)	0.02
Norwood-Stage II			
Unintended interventions (n,rate)	96(41.2)	56(25.6)	0.01
Complications (n,rate)	515(221)	367(168)	0.002
Stage II-12mos			
Complications	145(72)	81(46)	0.03

Fig. 3

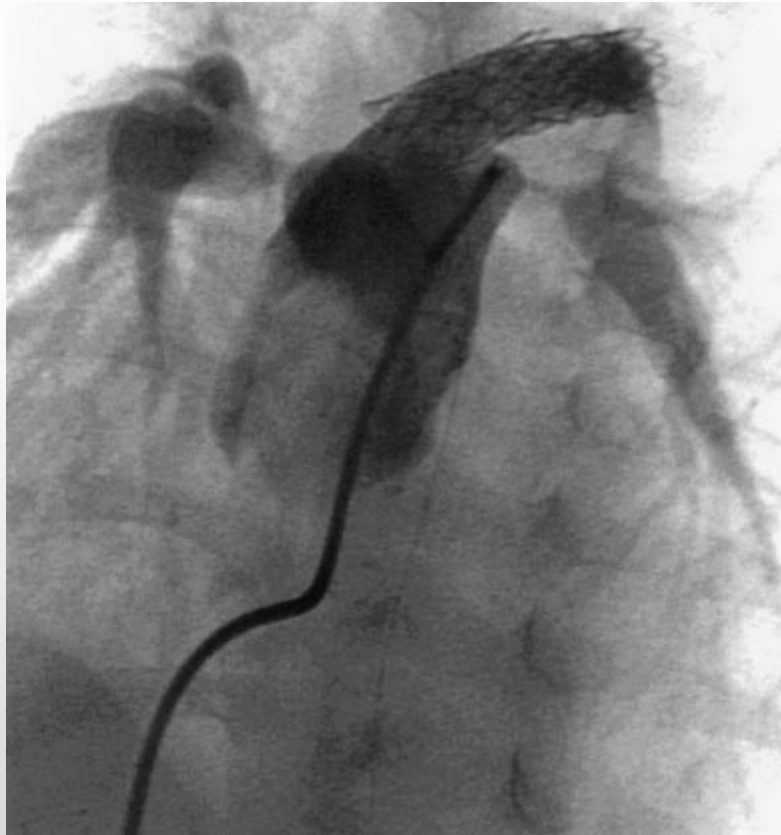
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	RVPA	MBT	p
After Norwood			
RVESV (median, ml/m ²)	44.2	50.1	0.001
EF (%)	48.5 ± 7.6	44.5 ± 7.6	<0.001
Before Stage II			
RVEDV (median, ml/m ²)	105.2	113.4	0.009
RVESV (median, ml/m ²)	57.9	63.2	0.004
rPAD (mm)	5.4 ± 1.7	6.1 ± 2.0	<0.001
Nakata Index (mm ² /m ²)	145	169	0.009
ratio of dis. To prox. IPAD	1.3 ± 0.6	1.1 ± 0.3	0.003

Fig. 4

Stenting of the arterial duct and banding of the pulmonary arteries: basis for combined Norwood stage I and II repair in hypoplastic left heart.

(Akintuerk H et al. Circulation. 2002;105:1099-103)



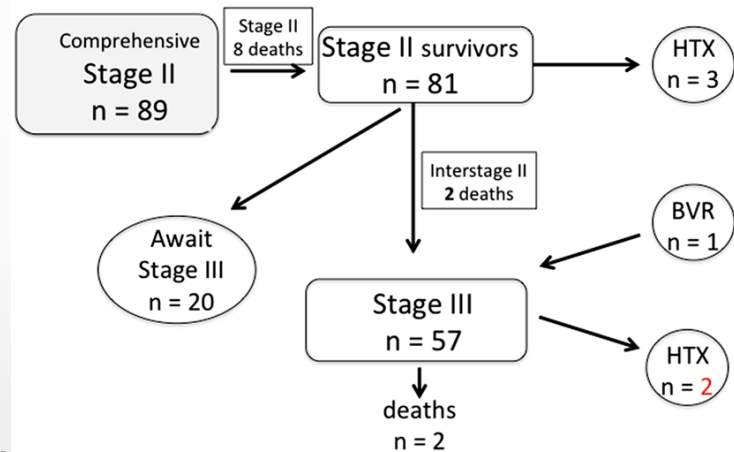
- 1998-2000
- N= 11
- Survived to Norwood + BDG: 8
- Survival rate after Norwood + BDG : 82%
- Follow up: 6m-3y
- **Fontan completion: 0**

Fig. 5

Fifteen-year single center experience with the "Giessen Hybrid" approach for hypoplastic left heart and variants: current strategies and outcomes.

(Schranz D et al. *Pediatr Cardiol.* 2015;36:365-73)

C 15-years single center experience with Hybrid stage II and III



- 1998-2013
- Undergo Norwood+BDG: 89
- Survivor: 81 after Norwood+BDG
- 53 survivor after Fontan without HTx (60%)
- 20 awaiting Fontan

- AA 58vs AS 49: no significance
- IPA stenting: 38 % (34 of 89)
- With vs without IPA stenting: no significance

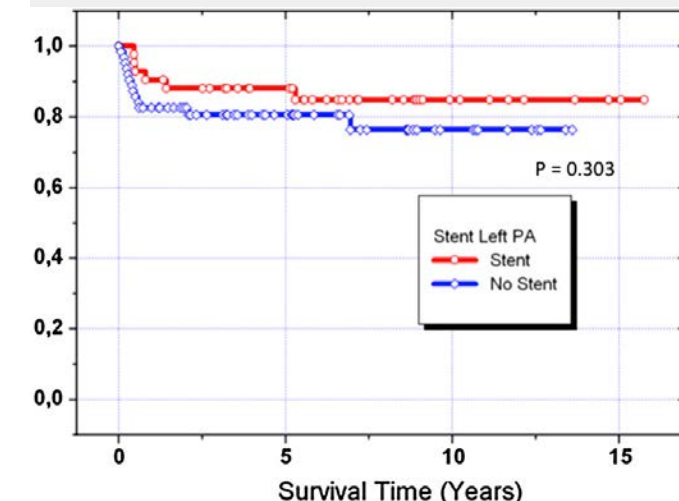
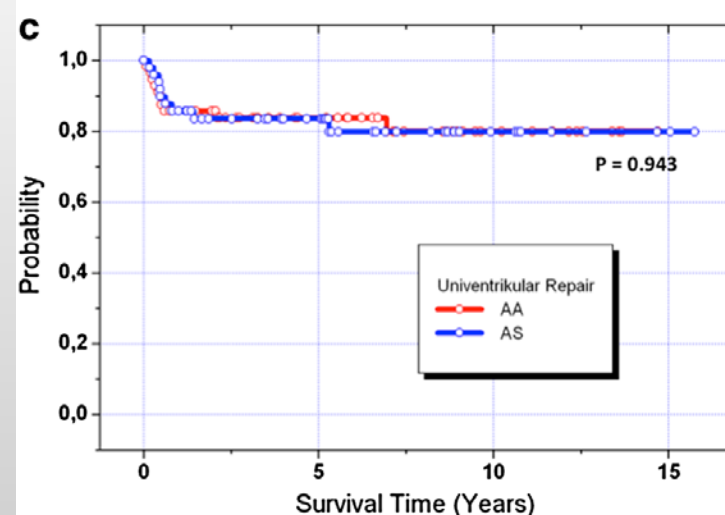
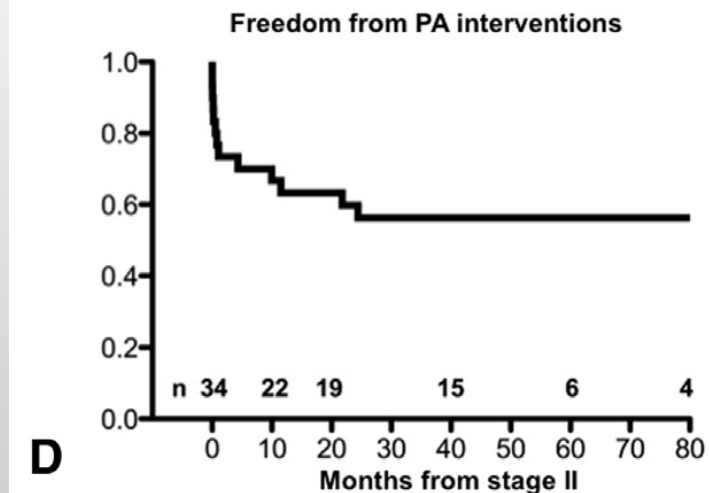
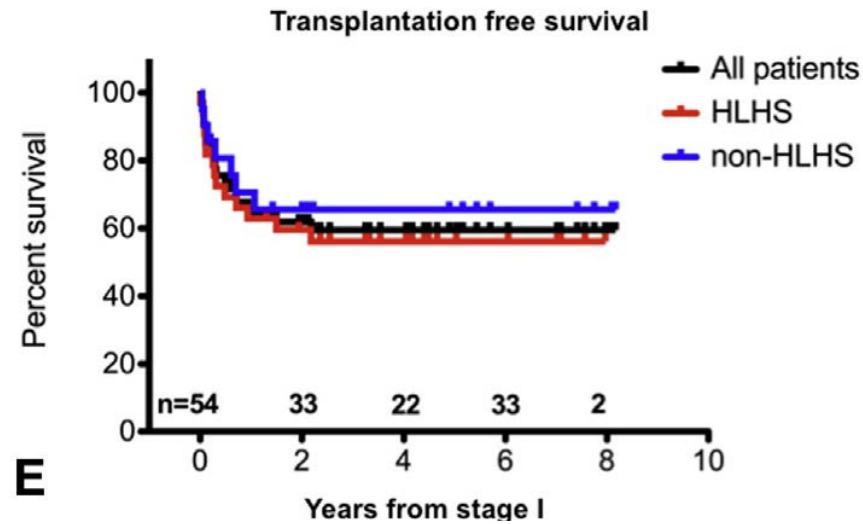


Fig. 6

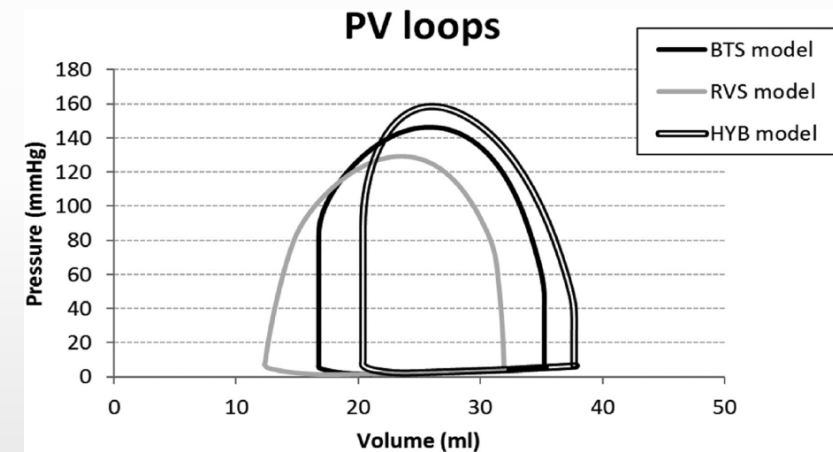
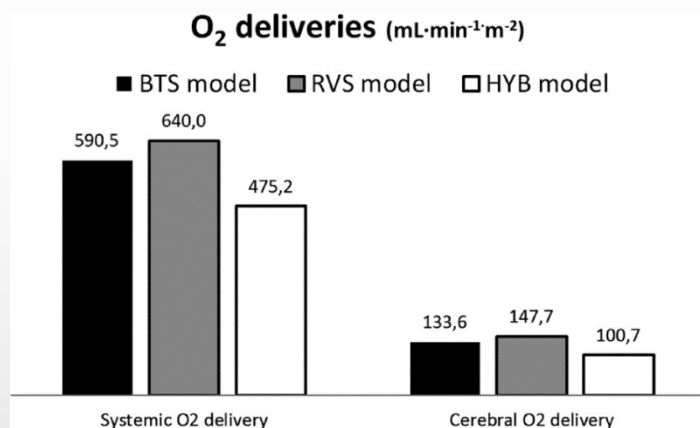
Pulmonary artery stenosis in hybrid single-ventricle palliation: High incidence of left pulmonary artery intervention. (Rahkonen O et al. J Thorac Cardiovasc Surg. 2015;149:1102-10)



- 2004-2012
- N= 54
- Survival 59%(@8yrs)
- Survive after Fontan: 19 (35%)
- The cumulative PA intervention rate: 50%
- Out of indication for Fontan: 6
Reason: IPA stenosis 5
- Risk factor for failure to reach Fontan: LPA size (p= 0.01, univariate)

Fig. 7

Use of mathematical modeling to compare and predict hemodynamic effects between hybrid and surgical Norwood palliations for hypoplastic left heart syndrome. Modeling of Congenital Hearts Alliance (MOCHA) Investigators. (Circulation. 2011:13;124(11 Suppl):S204-10)



- Both systemic and cerebral oxygen deliveries were considerably poorer in the hybrid model

- both Norwood models demonstrated higher ventricular performance than the hybrid model

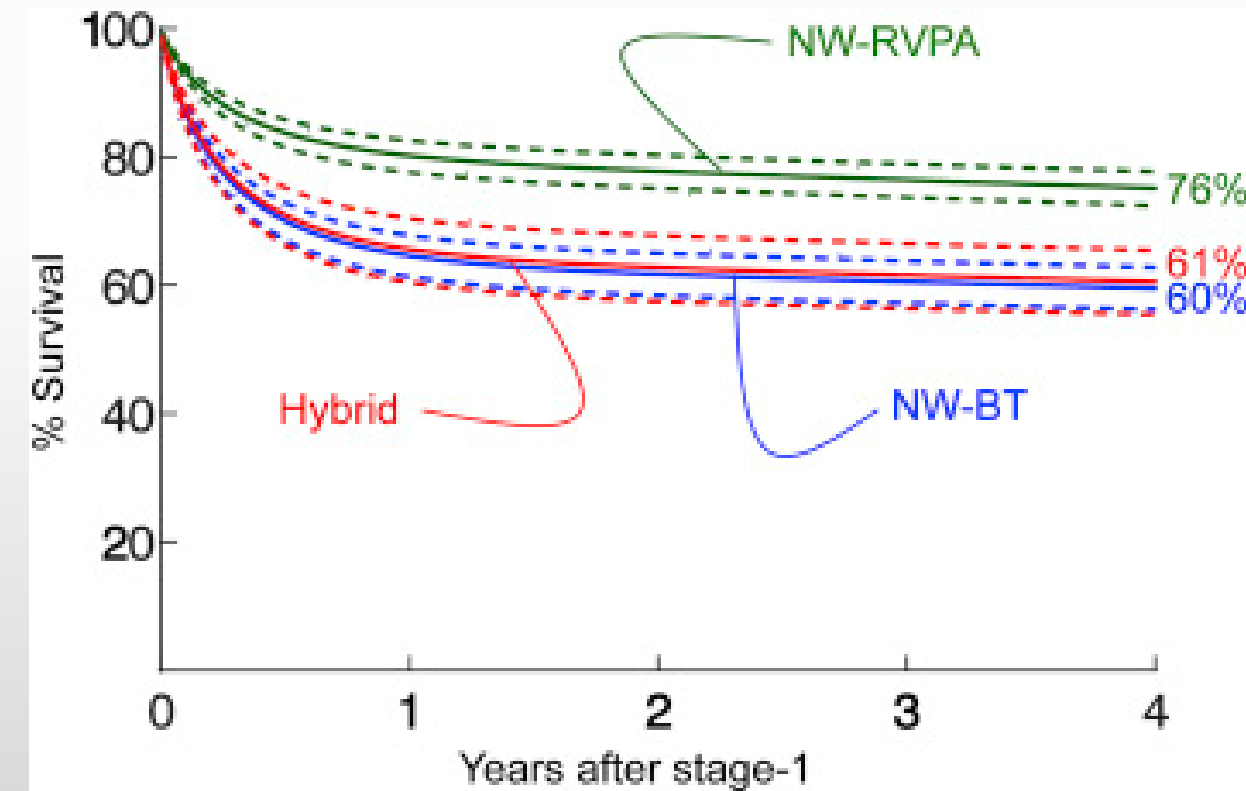
“...Diastolic runoff through the ductal stent can occur and can cause flow reversal in the brachiocephalic circulation...”

Fig. 8

Is a hybrid strategy a lower-risk alternative to stage 1 Norwood operation?

(Congenital Heart Surgeons' Society.

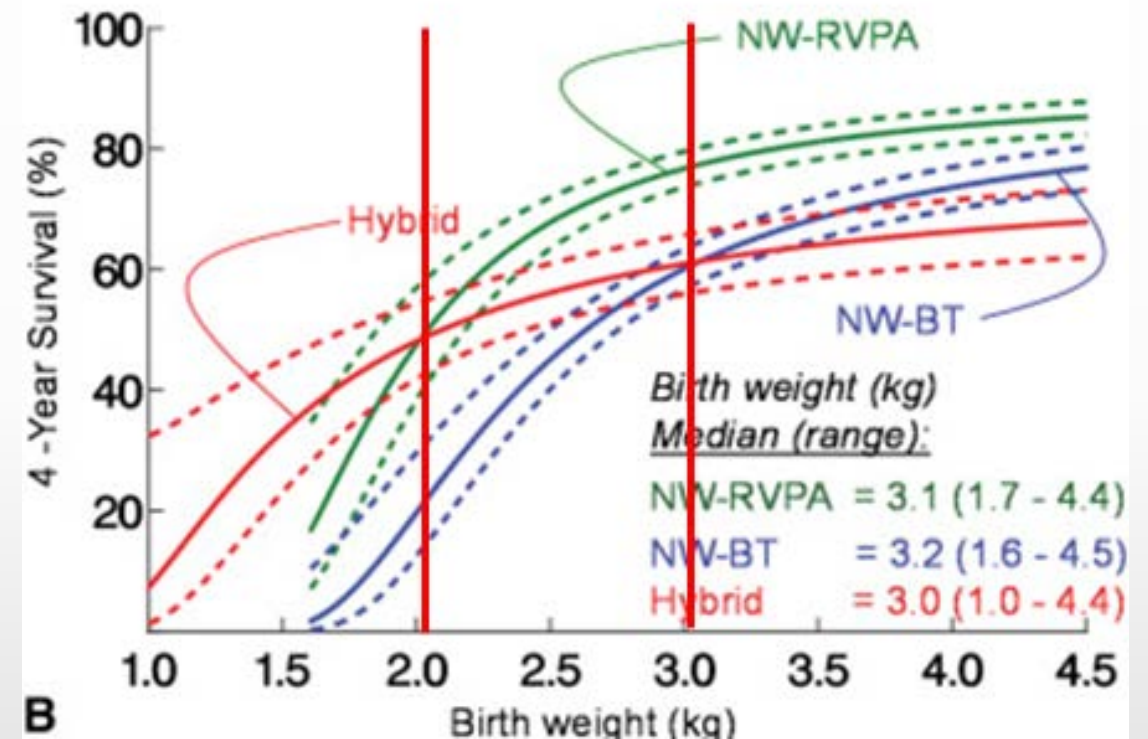
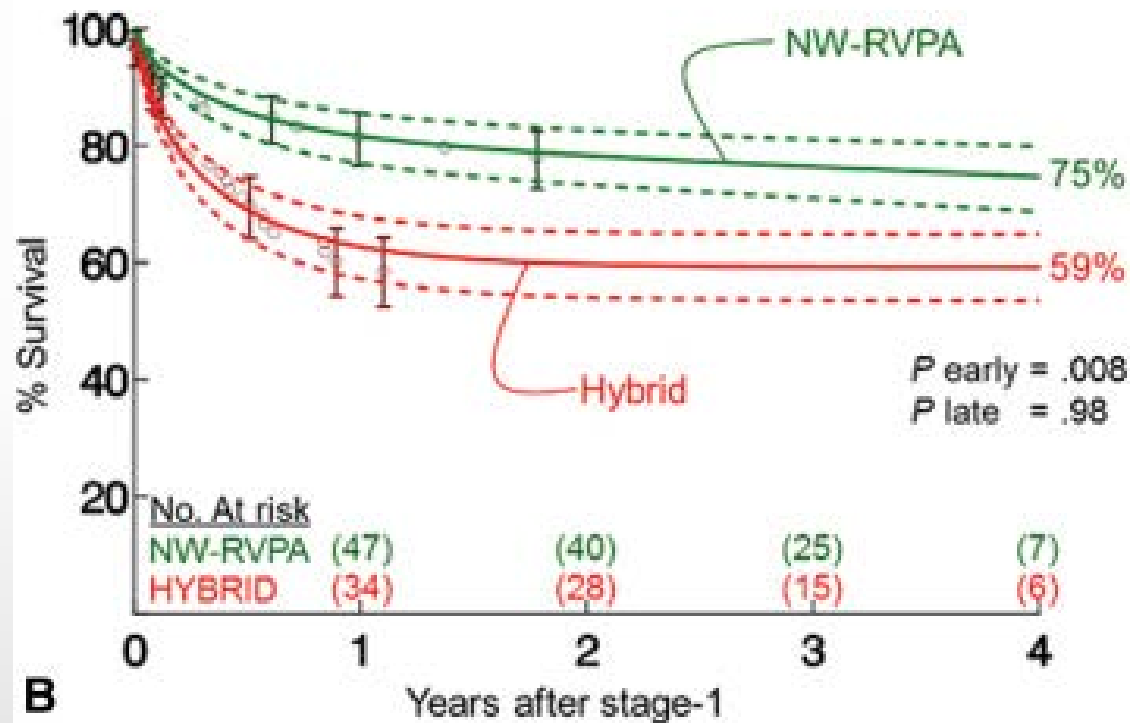
J Thorac Cardiovasc Surg. 2017;153:163-72)



- 2005-2014
- North America, 20 institutions
- N= 564 (Risk-adjusted)
- NW-RVPA 222, NW-BT 232, HS1P 110
- 4 years survival
 - NW-RVPA: 76%
 - HS1P: 61%
 - NW-BT: 60%
- **Better overall survival after NW-RVPA**

Fig. 9

Is a hybrid strategy a lower-risk alternative to stage 1 Norwood operation?



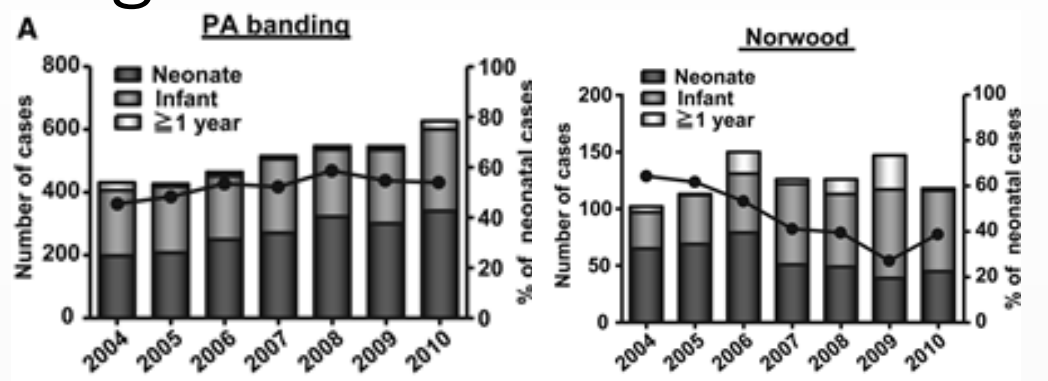
- NW-RVPA 88, HS1P 88 (propensity score matching)
- 4 years survival
NW-RVPA 75%
HS1P 59% ($p = 0.008$)

- Risk factor in the multivariable model: **BW**
- **HS1P: Survival advantage for neonates with lower BW**
(vs NW-RVPA: <2.0 , vs NW-BT: <3.0)

Fig. 10

Trends and outcomes in neonatal cardiac surgery for congenital heart disease in Japan from 1996 to 2010.

(Hasegawa et al. Eur J Cardiothorac Surg. 2016;51:301-7)



- Hospital mortality after Norwood:
40.0% (2004) to 15.6%(2010) (P = 0.0055)

“...In the past decade, the right ventricle–pulmonary artery conduit represented one of most important advances in the surgical technique of the Norwood procedure...”

“... encouraging results from bilateral PA banding with or without stenting of the ductus arteriosus for the management of HLHS could contribute to the increase in annual numbers of PA banding and the recent decrease in the annual number of Norwood procedures in neonates.”

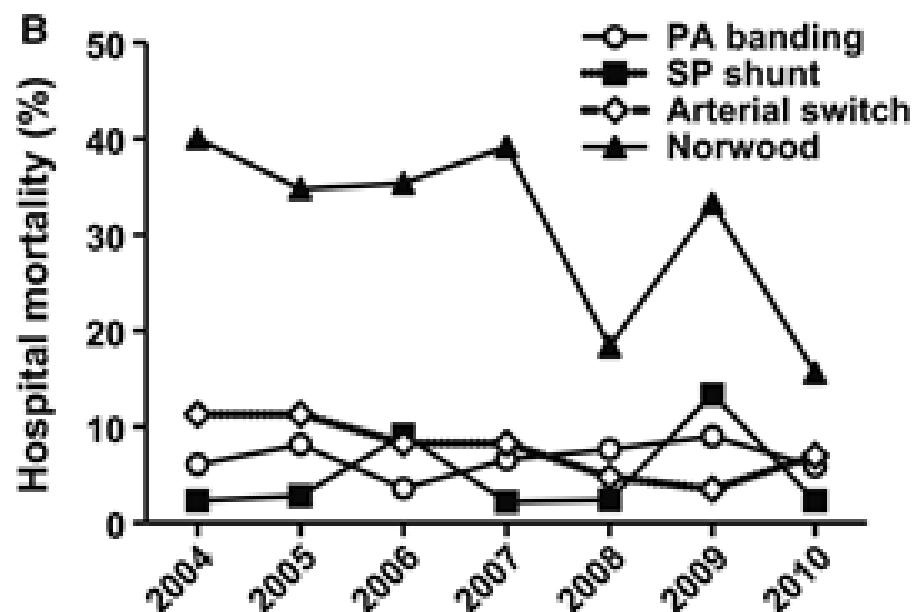


Fig. 11