Should intraoperative ECHO in children be universal and who should be doing it?

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IOE - History

Johnson (1972):

EPI / M-mode: Mitral commisurotomy

Takamoto (1985):

2D + PDE + CFM

- Large variety incl. CHD

Ungerlaider (1990):

Comprehensive analysis of 328 consecutive patients with CHD

IOE - Is it worthwhile?
[< 2000]

- **Complications**
  - esophageal compression, perforation, mucous erosion, tracheal compression, pulmonary venous compression
- **Time consuming**
  - surgeons excitement (!)
  - surgeons may predict result of surgery
- **Lack of experienced personnel**
  - cardiologist x anesthesiologist
- **Lack of equipment**
  - machines and probes

Smallhorn J, Echocardiography 2002

IOE - Is it worthwhile?

[> 2005]

- **Integral part of management of CHD**
- **Safe**, **quick** and **reliable** method which may significantly improve surgical outcome
- **Postoperative CICU ECHO not easy to perform** (opened chest, risk of bleeding, infection)
- Reduced repeated bypasses
  - **prevent from brain injury**
  - **high cost benefit**
- Success of operation must not be judged on the basis of survival alone

From survival to perfectionism

Incidence of IOE (TOE) associated complications in adult cardiac surgical patients

N= 6,255 consecutive adult cardiac surgical patients with IOE (TOE) examinations

- **TOE-associated complications occurred in 25 pts (0.4%)**
  - Oropharyngeal mucosal bleeding 15
  - Esophageal perforation occurred 1
  - Upper gastrointestinal bleeding 2
  - Dental injuries 7

- **TOE probe insertion failed 10**

Marymont J, Anaesthesiol Clin 2006

ECHO probes miniaturisation

Enables to assess neonates (> 2kg)

N=42, mean weight of 3.6 ± 0.9 kg (range 1.7 - 5 kg)
- 100% probe insertion
- No complications
- Surgical revision in 6/42

Zyblewski SC, Ann Thorac Surg 2010

RT-3D transesophageal approach

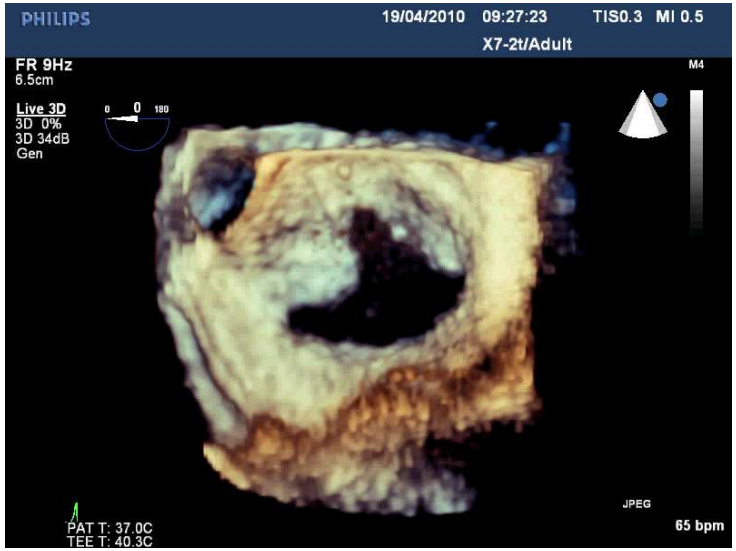
- **Real Time Live 3D** (single heart beat) no reconstruction
- **Four-seven (full volume) cycles**

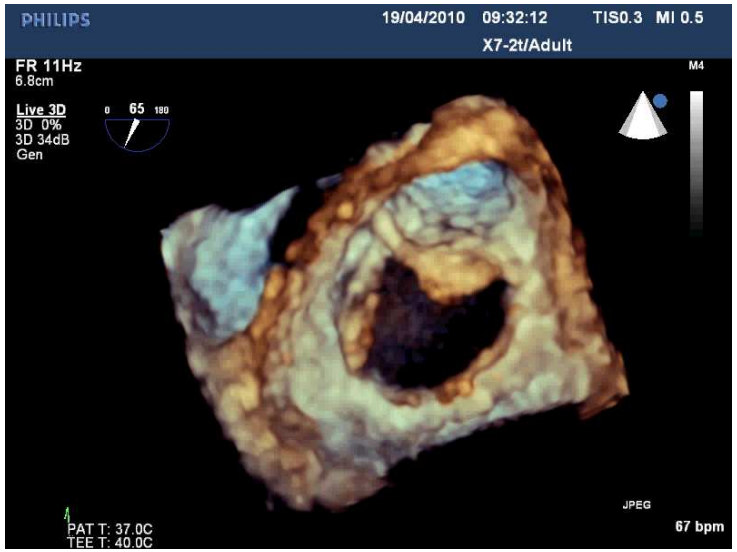
  Full volume data acquisition <15 sec.

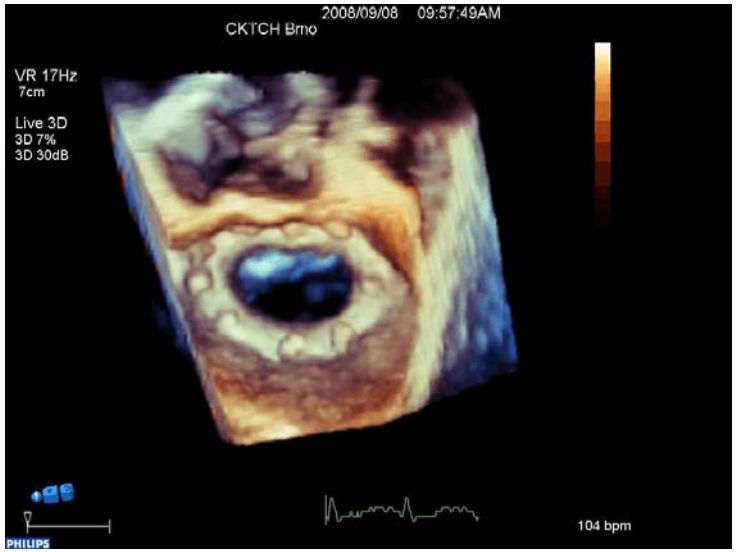
  Post-processing ~5min.
- **The real time `zoom mode`**

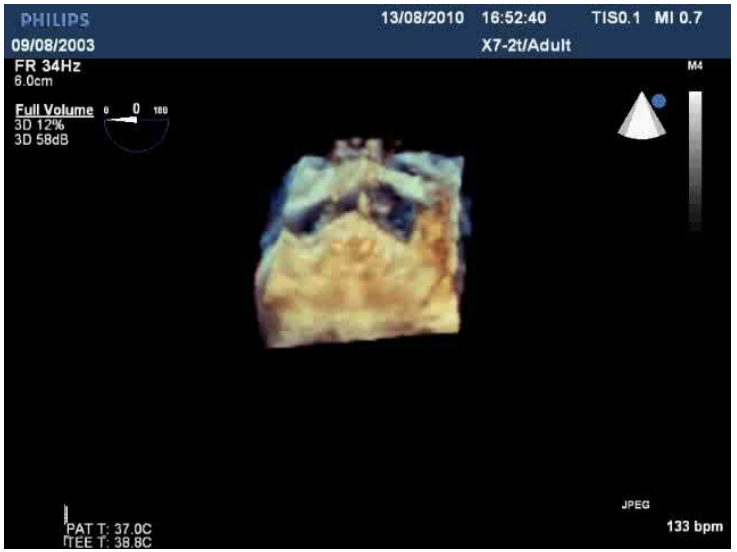
  Enlargement of a sub-segment of the small sector

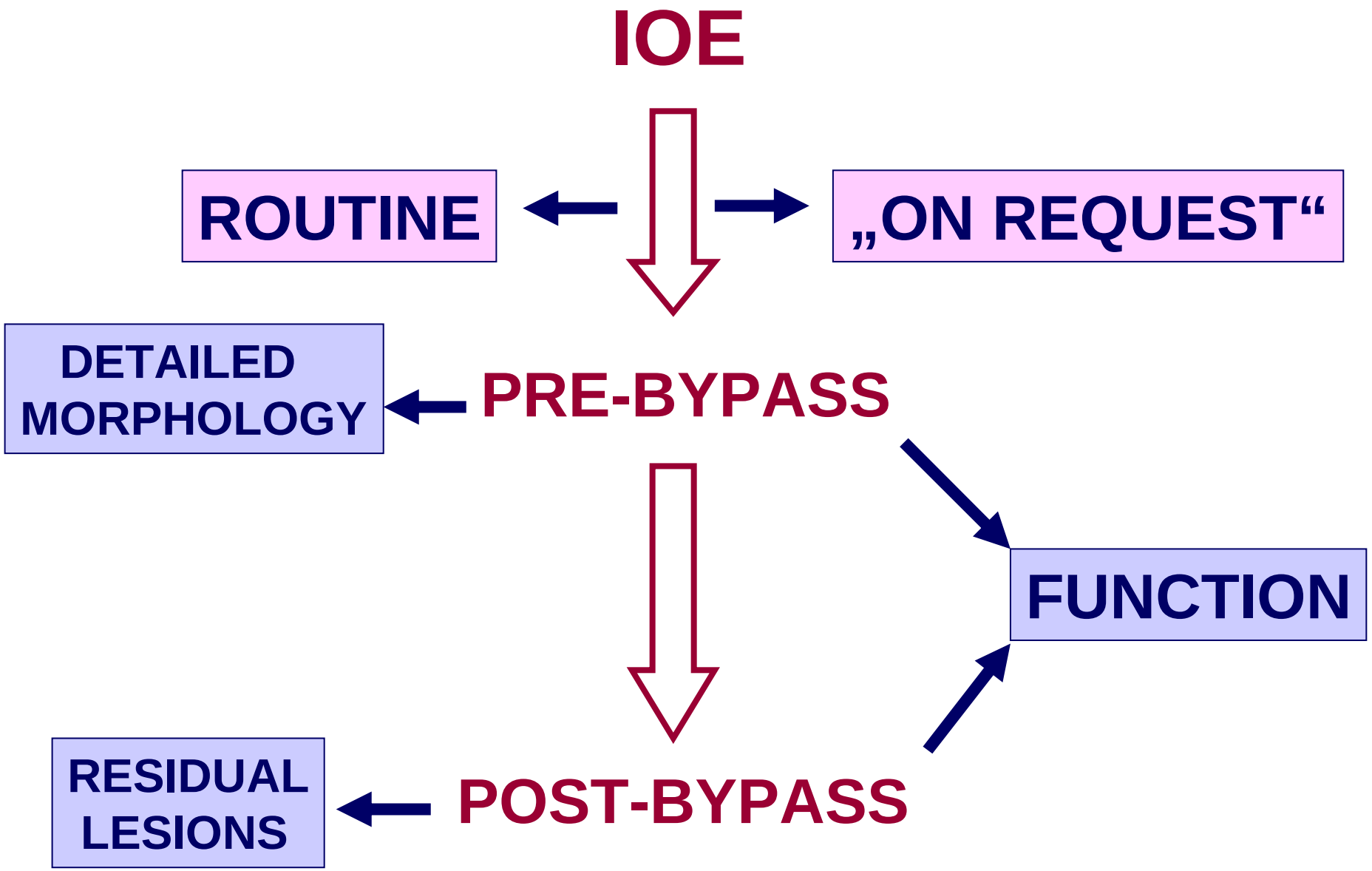
RT-3D Echocardiography










IOE
ROUTINE
„ON REQUEST“
DETAILED MORPHOLOGY
PRE-BYPASS
FUNCTION
RESIDUAL LESIONS
POST-BYPASS

IOE: Prague experience

- IOE - “ON REQUEST” in 345 (13%) out of 2,659 pts operated for CHD from 10/1994 to 12/2003

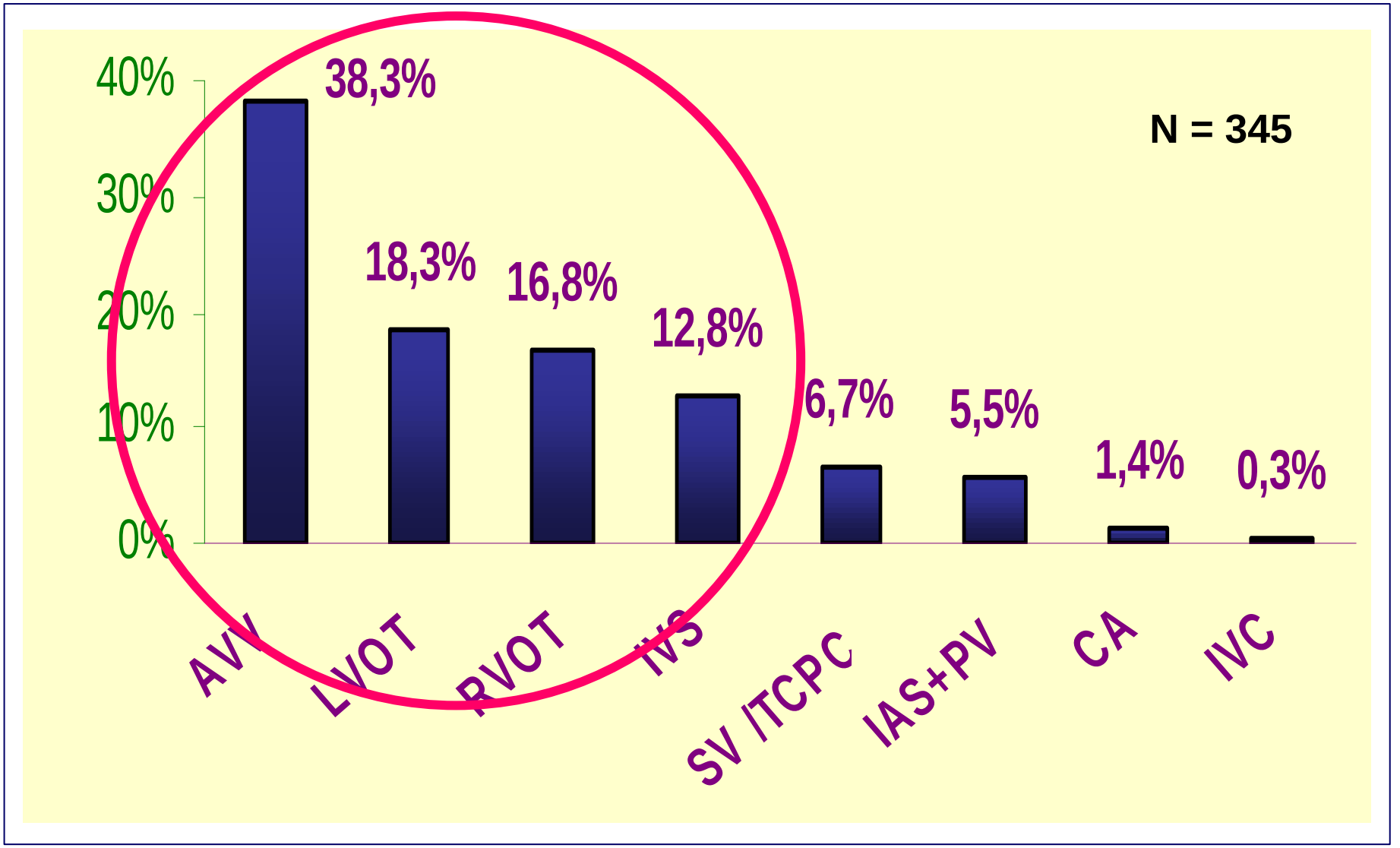
- Age range: from 4 days to 57 years (median 3.6 year)

- Equipment:
  TOE pediatric multiplane probe 5.0 - 9.5 MHz
  Epicardial probe 4.0 - 8.0 MHz with sterile sac

- Performed by consultant cardiologist specialized in ECHO

Gilik J, Cor Vasa 2006

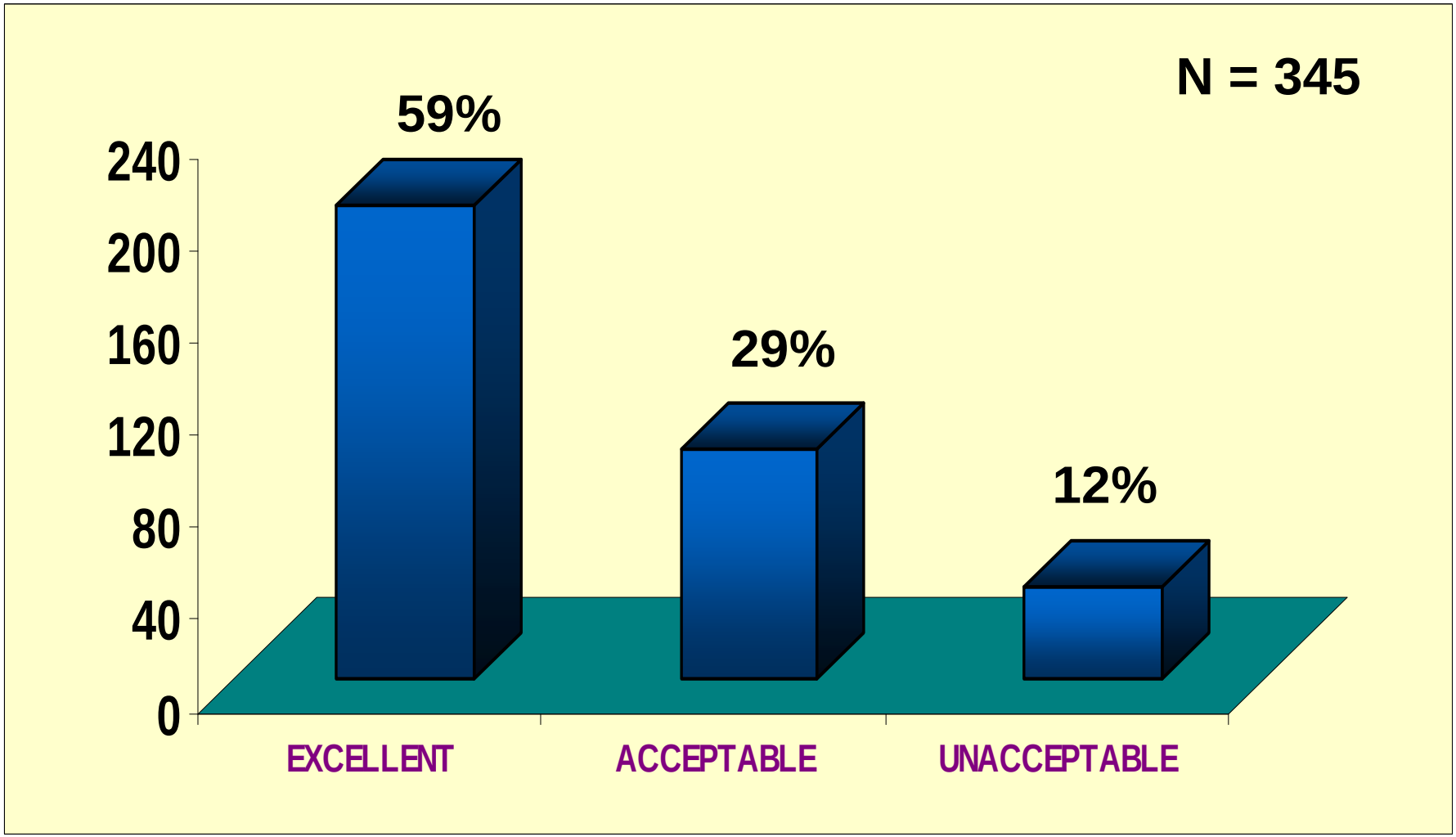
IOE: Regions of main surgical interest



Post bypass assessment- semi quantitative criteria

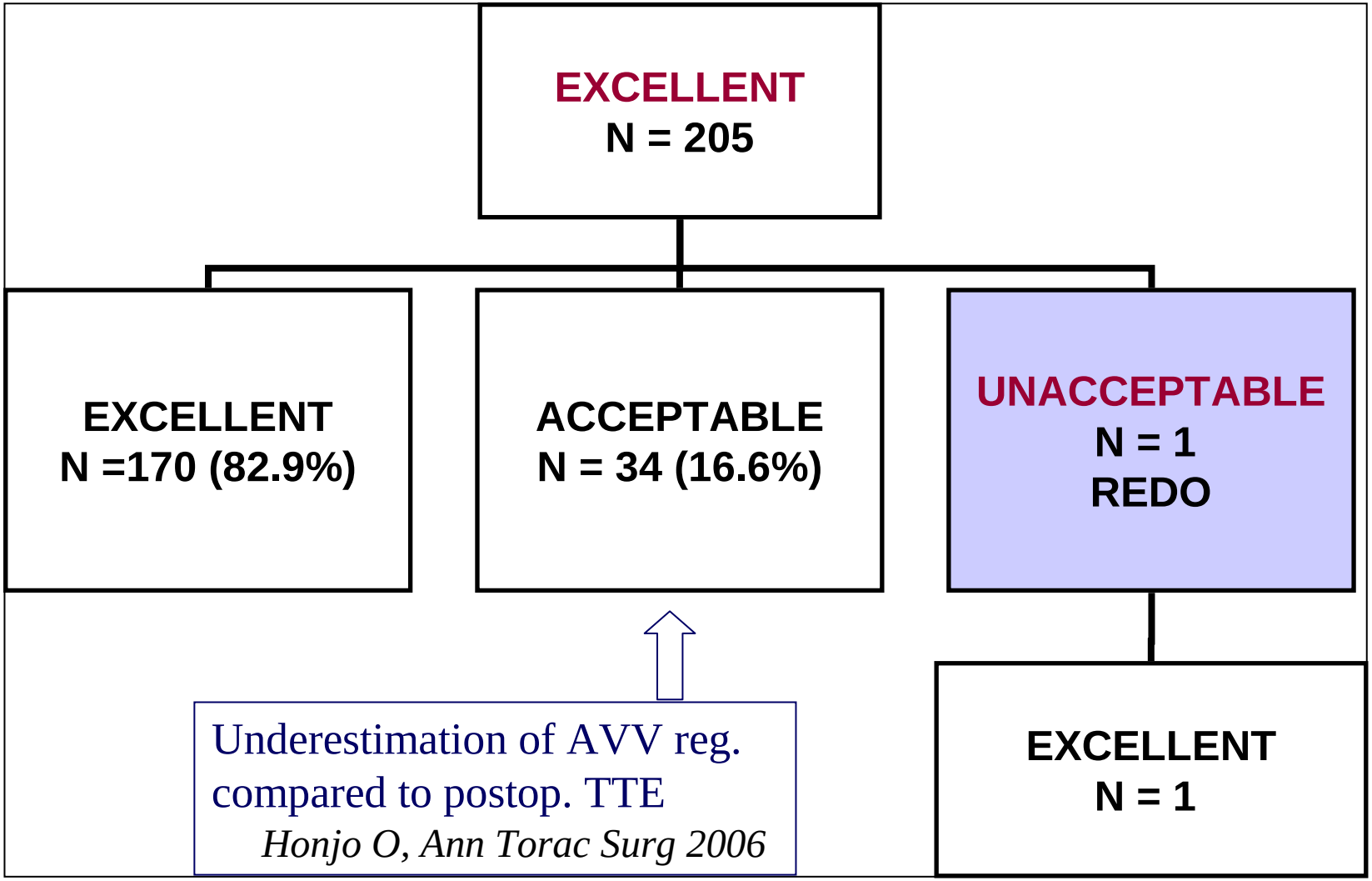
ECHO RESULT	RESIDUAL REGURGITATION	RESIDUAL STENOSIS	RESIDUAL SHUNT
EXCELLENT	**NO - MILD** (< 2. Grade)	**NO - MILD** AS/PS(<30mmHg)	**NONE** (Except leakage)
ACCEPTABLE	**MODERATE** (2.Grade)	**MODERATE** AS/PS(<50mmHg)	**MILD - MODERATE** (Restrictive)
UNACCEPTABLE	**SIGNIFICANT** (3.- 4. Grade)	**SIGNIFICANT** AS/PS(>50mmHgG)	**SIGNIFICANT** (Non-restrictive)

IOE: Results of surgery



IOE: Surgical results

IOE X EARLY POSTOP ECHO (TTE)



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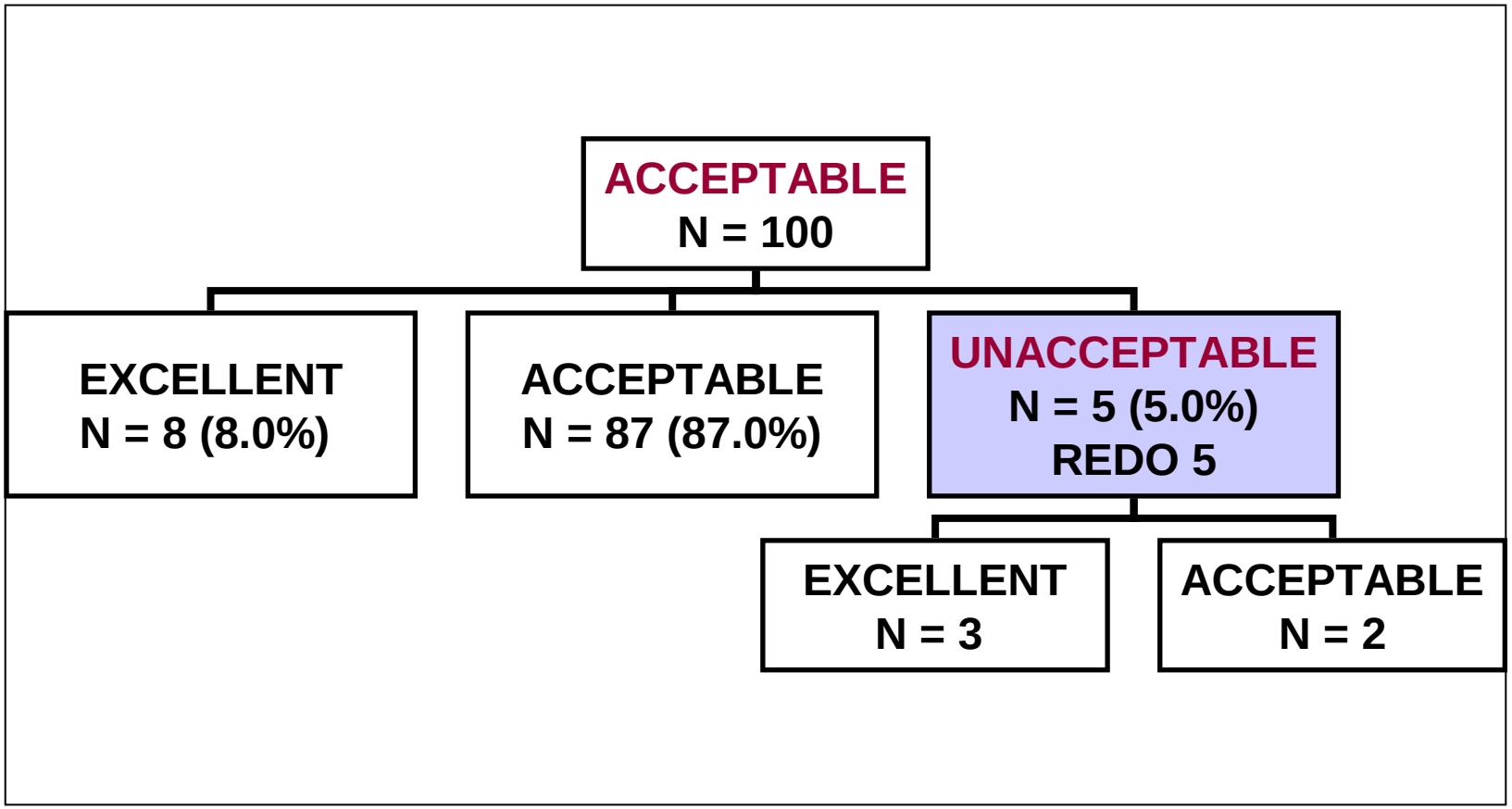

IOE: Surgical results

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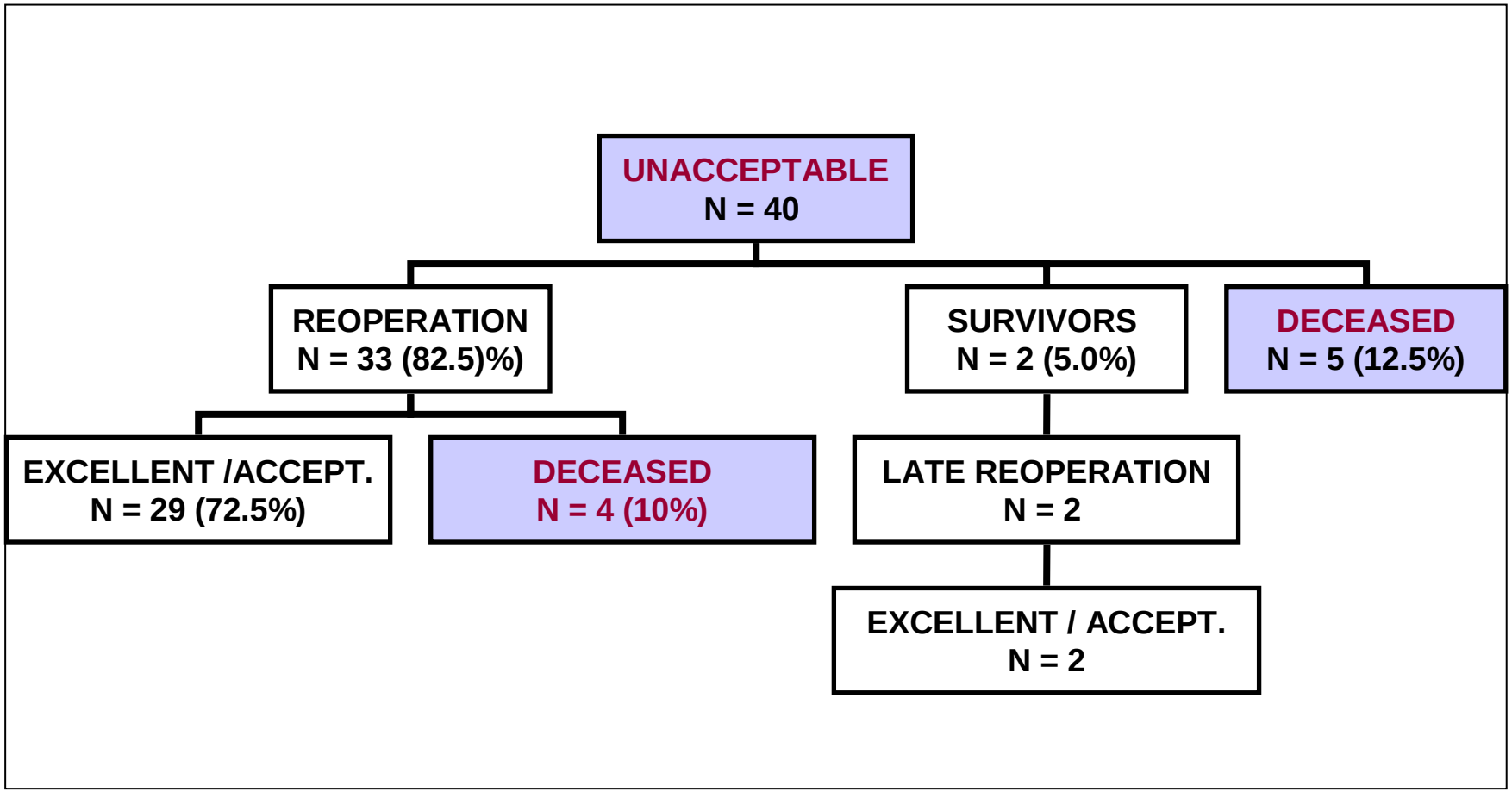


Intraoperative Echocardiography

Reoperation performed or considered

	N	REOPERATION N	REOPERATION %
IOE -	2,314	61	2.6 *
IOE +	345	40	11.6
TOTAL	2,659	101	3.8

* *P < 0.001*

Surgical revision

Author	Pts.	Revision	%
Gilik (2006)	**2,659 select.**	**101**	**3.8**
Randolph (2002)	1,002 select.	56	5.6
Sheil (1999)	200 cons.	7	3.5
O`Leary (1995)	104 cons.	9	8.7
Sreeram (1990)	94 cons.	6	6.4
Ungerleider (1990)	328 cons.	53	16.2

IOE: Cost benefit

- **Average costs for reoperation** (at the same hospitalization):

  $ 94,180.28 ± $ 33,881.63

- **Average costs for reoperation after IOE** (at the same ECC):

  $ 21,415.79 ± $ 8,215.74

(Mayo Clinic, Rochester, Minnesota, USA)

Reoperation after IOE in > 2.8% pts. is cost-effective

(Seattle, Washington, USA)

Ungerleider RM, Ann Thorac Surg, 1995
Stevenson JG, Acta Paediatr 1995

IOE: “Routine” setting

Inability of surgeon to consistently predict quality of initial repair:

1) Surgeon satisfied with intracardiac repair

– IOE revealed persistent problems in 15% of cases

2) Surgeon has concern about quality of repair

– IOE demonstrates still 30% likelihood of acceptable results

Ungerleider RM: JTCS, 1990

IOE: Cost benefit

Prague, ECC = 339 / 2nd run bypass 17

Cost for IOE: 3,114 – CZK, estimated cost for re-ECC: 184.000-CZK

IOE+ : N = 62 / REDO = 6

IOE – : N = 227 / REDO = 11

Total charges for IOE: 193.068 CZK

Total charges for 6 re-ECC: 1,104.000 CZK

Savings: 910.932 CZK

Calculation for IOE performed in all 339 pts.:

Total charges for IOE: 1,055.646 CZK

Total charges for 17 re-ECC: 3,128.000 CZK

Max. Savings: 2,072.354 CZK

IOE: GOSH protocol (2009, ~80% IOE)

- **Anesthetist (TOE and routine assessment only):**
  - Experienced in assessing physiology (most of them)
  - Experienced in assessing CHD (not all)
- **Junior cardiologist (SpR, fellow):**
  - Pre-bypass and post-bypass as part of training (local and international specialty body requirements, accreditation requirements)
- **Consultant cardiologist:**
  - In any situation requiring decision making pre- or post- bypass, in all complex cases, or in those in disagreement of IOE with surgeon's view and/or haemodynamic condition

IOE: GOSH protocol (2009, ~80% IOE)

- **Operations requiring IOE regardless surgeon`s opinion:**

  AVSD repair, AV valve repair, multiple VSD closure

  LVOT repair (Ross, HOCM, AS)

- **Operations with IOE performed on routine basis:**

  TOF/complex TGA/DORV, CTGA, other

  complex lesions post-Fontan, semilunar valve repair

- **Operations rarely requiring IOE:**

  ASD (ovale fossa), simple VSD, AO arch repair

Surgeon - Cardiologist - Anaesthetist partnership

- **Anaesthetist**

  -Primarily **not trained in cardiology and TOE**
  if trained, than only in ***"adult-functional"*** and
  not *"paediatric-congenital"* TOE
  -However, once he receives support from cardiologist, he may become expert ***"paediatric-congenital"*** echocardiographer

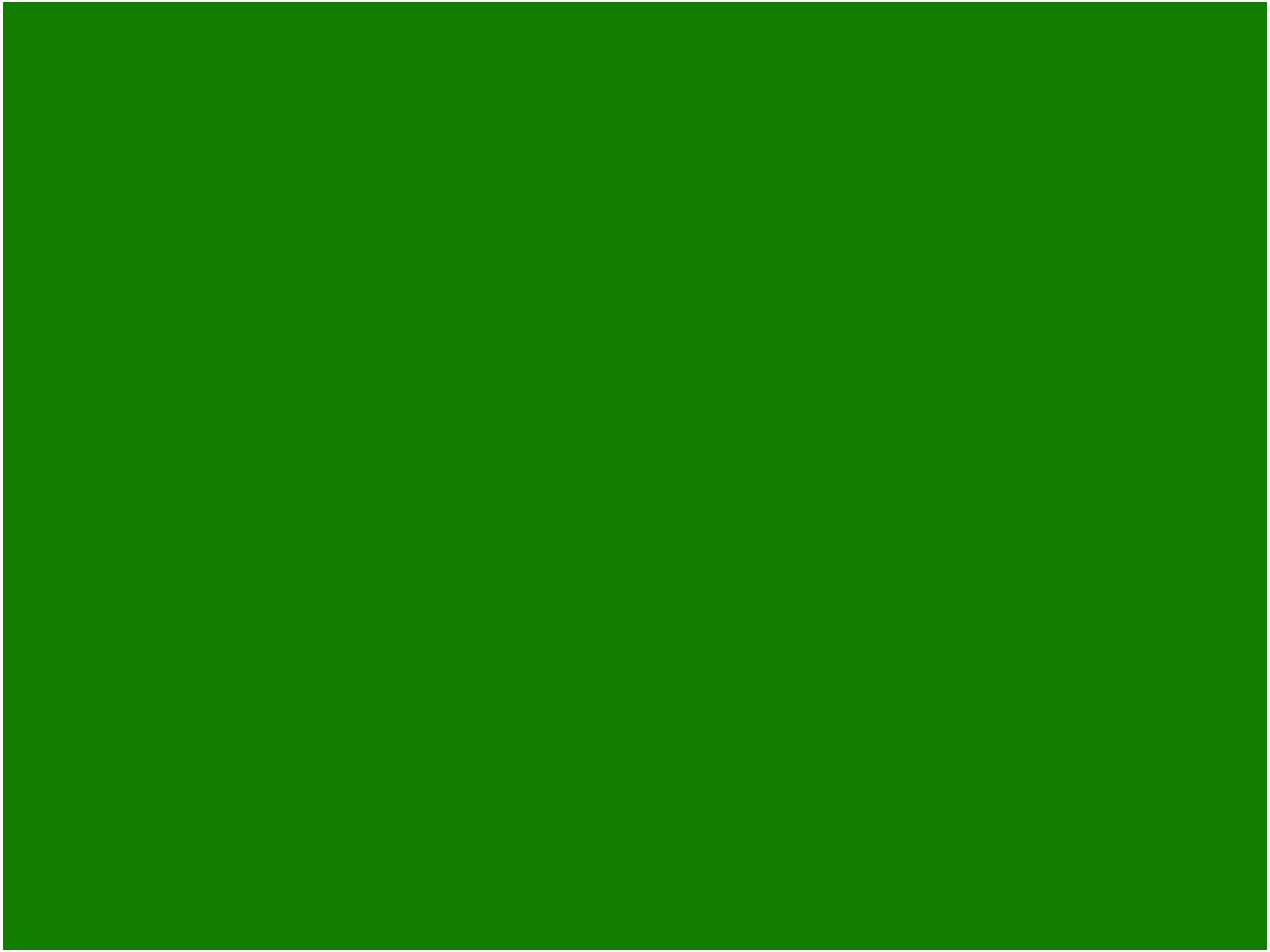
- **Surgeon**

  -**Senior** surgeon **may not fully understand** what the ECHO shows, but he is ***more patient*** (but not always) to wait for steady state physiology
  -**Younger** surgeon is ***rushing*** believing he is ***the best surgeons in the world***, but he **may understand ECHO better**

Surgeon - Cardiologist - Anaesthetist partnership

- **Cardiologist**
  - -Often ***better (theoretical) surgeon*** than the surgeon himself
  - -However, he ***does not have a clue*** what to do when looking over surgeon's shoulder

S-C-A Interaction crucial for achieving best possible result of treatment



Screenplay: J. Marek & M. Cohen
Camera: D.Vondrys Starring: M. Kostolny