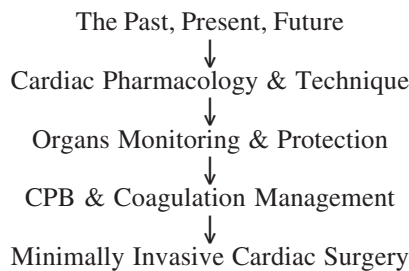


Cardiac Anesthesia & Surgery: Past, Present & Future

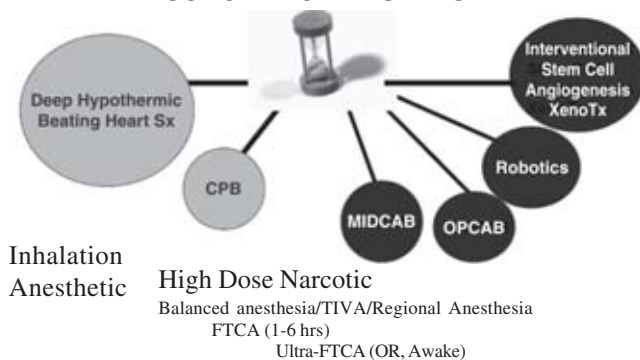
Davy C. H. Cheng, MD, MSc, FRCPC

Professor & Chair/Chief
Department of Anesthesia & Perioperative Medicine University of Western Ontario
London, Ontario, Canada

OBJECTIVES



REVOLUTION/EVOLUTION IN CARDIAC SURGERY & ANESTHESIA



EXTRACORPOREAL MILESTONES

- 1915 - Jay McLean discovered the anticoagulant effect of heparin.
- 1927 - Dr. Charles Best, Toronto, proceeded to purify heparin and reported on his research.

- 1937 - Dr. John Gibbon employed the first use of heparin in an extracorporeal circuit to successfully perfuse cats.

DEBAKEY ROLLER PUMP

- 1937 - DeBakey recognized the dependability of the roller pump as a reliable mechanism for milking large volumes of blood along a flexible piece of tubing. It is still used as the premier bloodpumping system in the operating room.

SURGICAL MILESTONES

- 1938 - Dr Robert Gross, of Boston Children's Hospital, performed the first successful ligation of a patent ductus on a seven year old female patient.
- 1940 - Dr. Gordon Murray, of Toronto, described his clinical experience with his surgical approach to the mitral valve using a valvulotome.

CARDIAC ANESTHESIA & SURGERY

First Publication: Anesthesiology 1946
Harmel MH, Lamont A: Anesthesia in the surgical treatment of congenital pulmonic stenosis

100 cases	Mortality rate 23%
Premedication	Morphine or Nembutol & Atropine or Scopolamine (heavy sedation)
Induction	Cyclopropane or Vinesthene
Maintenance	Cyclopropane and/or Ether
	Spontaneous assisted ventilation
	A few patients not intubated
	No postoperative chest drain

SURGICAL MILESTONES: SURFACE HYPOTHERMIA

- Wilfred Bigelow (Toronto): Experimental Hypothermia for Cardiac Surgery
 - American Journal of Physiology, 1950 direct closure of an ASD, under direct vision, utilizing short (6 minute) periods of tolerance to inflow occlusion under the conditions of moderate surface hypothermia.
- C. Walton Lillehei (Minneapolis): had heard Bigelow present his animal research work on hypothermia and went to work in his own lab studying its effect.



CAMPBELL COWAN BIOLOGIC OXYGENATOR, 1952

- 21 cases
- 3 survivors



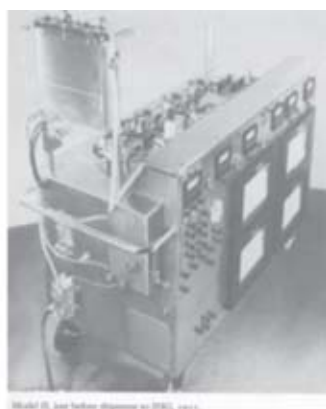
JOHN GIBBON JR. - PHILADELPHIA

- 1953 - May 6, Dr. John Gibbon Jr. performed the world's first successful closure of an ASD in an 18 year old female while her cardiorespiratory function was maintained by an extracorporeal circuit which consisted of a mechanical heart and lung
The Gibbon heart lung machine

THE PRESENT - THE CPB AGE



THE PAST – THE ICE AGE



WILLIAM T. MUSTARD - TORONTO

- 1951- Dr. Mustard performed his monkey lung experiments. Mustard suspended the monkey lungs inside bell jars, into which pure oxygen was forced and linked the lungs with tubing that connected to a pump. After priming with human blood, Mustard would hook up the patient.

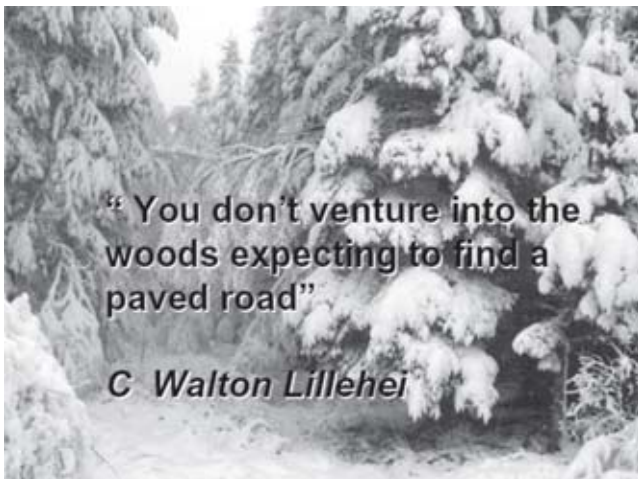
4TH INTERNATIONAL CONGRESS ON THORACIC & CARDIOVASCULAR SURGERY, BEIJING 1997



SIGNIFICANT ADVANCEMENT IN CARDIAC ANESTHESIA

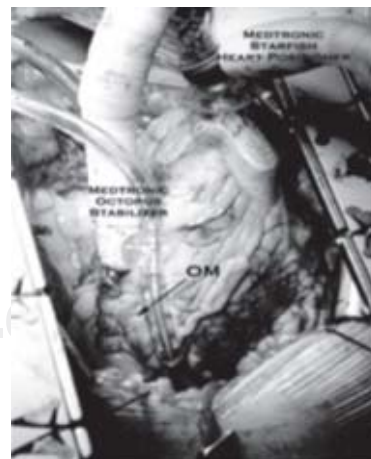
- PAC/TEE/IABP: Cardiac Pharmacology
- CPB Management
- Fast-Track Cardiac Anesthesia & Recovery
- Perioperative Monitoring & Organs Protection
- Antifibrinolytic Drugs – Blood Management
- Post-Operative Pain Relief
- Perioperative Outcomes Improvement and Resource Utilization: EBM

THE PRESENT - THE CPB AGE



«And don't give me any of those local anesthetics.
Get me the imported stuff».

PRESENT / FUTURE – THE MICS AGE





CARDIAC SURGERY A HISTORICAL VIGNETTE

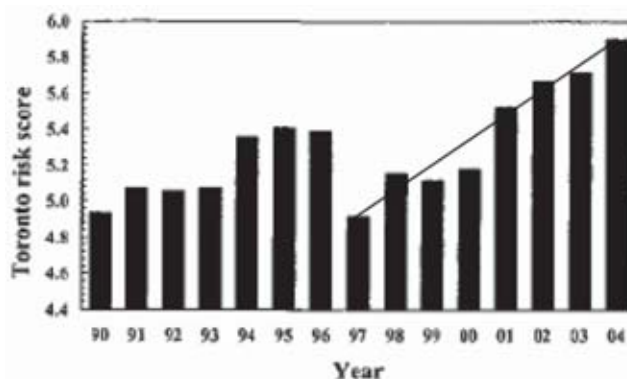
«Advance in anesthesia, membrane oxygenators, heat exchangers and myocardial protection have challenged surgeons to invent new procedures for all kinds of cardiac anomalies».

Norman Shumway
Can J Cardiol 21:
1066-1068, 2005



Profile (%)	Toronto (n > 12 K)	STS (n > 600 K)
Age (yr)	62	65
Female	27	28
Urgent Sx	42	45.3
Emergent Sx	2.8	4.3
Redo Sx	9.5	8.2
NYHA Class IV	48	21
Triple VD/LM	46/14	74.9/26
DM	23	35.7
PVD	12	15.6
Hypertension	48	76.6
Renal Dialysis	1.2	1.5
Renal Failure	5.1	5.3
COPD	4.3	19.2

INCREASING RISK FACTORS IN CABG PATIENTS

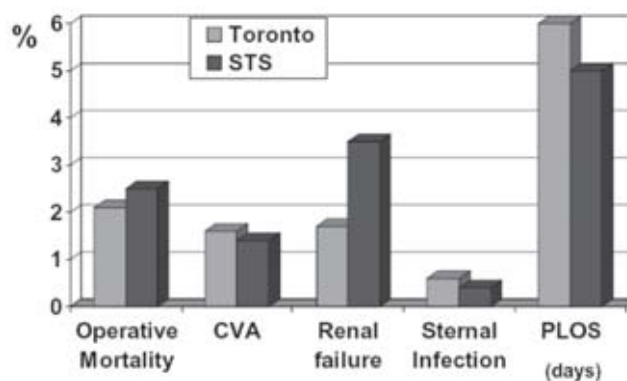


Any Adverse Event

9.8%

8.6%

POSTOPERATIVE OUTCOME (%)



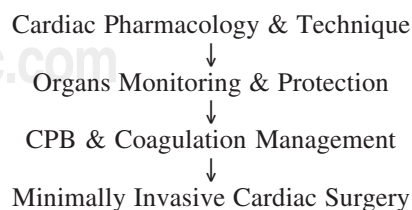
1) Ivanov et al. Can J Cardiol 2006; 22: 221-7

2) STS Report 2006

SIGNIFICANT ADVANCEMENT IN CARDIAC ANESTHESIA

- PAC/TEE/IABP: Cardiac Pharmacology
- CPB Management: F-P, Cerebral
- Fast-Track Cardiac Anesthesia & Recovery
- Perioperative Monitoring & Organs Protection
- Antifibrinolytic Drugs – Blood Management
- Post-Operative Pain Relief
- Perioperative Outcomes Improvement and Resource Utilization: EBM

TODAY TO TOMORROW



CARDIAC ANESTHESIA & SURGERY

First Publication: Anesthesiology 1946

Harmel MH, Lamont A: Anesthesia in the surgical treatment of congenital pulmonic stenosis

100 cases	Mortality rate 23%
Premedication	Morphine or Nembutol & Atropine or Scopolamine (heavy sedation)
Induction	Cyclopropane or Vinesthene
Maintenance	Cyclopropane and/or Ether Spontaneous assisted ventilation A few patients not intubated No postoperative chest drain

EDWARD LOWENSTEIN, M.D.

- Cardiovascular Response to Large Doses of Intravenous Morphine in Man
– N Engl J Med, 1969
- Morphine Doses (0.5 to 3.0 mg per kilogram of body weight)



EDWARD LOWENSTEIN, M.D.

«It is challenging to describe briefly the milieu and circumstances that set the stage for a new concept of anesthesia for our most dreadfully ill patients. At least three things were necessary:

- An environment that tolerated and even encouraged radically creative solutions;
- A clinical problem that caused an unacceptably high death rate;
- A cast of characters with imagination, vision, courage, and clinical credibility»

ISOFLURANE–A POWERFUL CORONARY VASODILATOR IN PATIENTS WITH CORONARY ARTERY DISEASE

Sebastian Reiz, M.D., Ph.D.,* Eve Båhrn, M.D.,† Mogens Brøndgaard Sørensen, M.D., Ph.D.‡
Sandro Arias Jr.,† Arnold Friedman, M.D.,§ Itzhak Friedmann, M.D., Ph.D.‡

The coronary haemodynamic effects of 1% isoflurane administered in oxygen-adequate by intermittent positive-pressure ventilation (IPPV) were investigated in 11 patients with stable coronary artery disease. Baseline standard central haemodynamic measurements, coronary artery blood flow was measured by continuous dopplerflowmetry, and arterial and coronary artery blood flow was measured by oxygen gas balance. Isoflurane decreased coronary perfusion pressure (–45%) by a combination of systemic vasodilation and decrease in cardiac performance. Coronary artery blood flow did not change; consequently, coronary vascular resistance was reduced (–28%). With myocardial oxygen consumption (–35%) and arteriovenous (–15%) were reduced. Two patients developed ST-T segment depression as T-wave inversions in sinus rhythm with markedly decreased myocardial lactate extraction (–85%) during isoflurane, suggesting regional ischemia. Patients without ECG changes had unchanged myocardial lactate extraction. Intravenous phenylephrine and atropine were used to correct coronary perfusion pressure to avoid arterial hypotension, and heart rate was kept at normal by atropine in the last 10 patients of the series. Five of these patients had ECG and metabolic evidence of regional myocardial ischemia during moderate isoflurane anesthesia. Coronary artery blood flow increased to avoid arterial hypotension, and coronary vascular resistance was unchanged. Myocardial oxygen arteriovenous gradient at the same low level as during administration of isoflurane alone, suggesting profound myocardial oxygenation (coronary vascular resistance). When perfusion pressure was raised, the ECG changes reversed coronary artery perfusion in two of the five patients in parallel, with increases in myocardial lactate extraction. In the three remaining patients, ECG remained unchanged, so did myocardial lactate extraction. It is suggested that 1% isoflurane induces coronary vasodilation that is not related to normal autoregulation, and that both decrease coronary perfusion pressure and redistribution of myocardial blood flow may cause development of regional myocardial ischemia. Key words: Anesthesia, volatile; isoflurane; myocardial blood flow; myocardial; coronary circulation; electrocardiogram; right ventricular catheterization.

The results of studies on the coronary circulation during isoflurane anesthesia are conflicting and restricted to observations in the dog. Turner and co-workers¹ reported a decreased myocardial oxygen extraction without change in myocardial blood flow (coronary vasodilation), whereas Merin² was not able to reproduce these results and concluded that isoflurane did not affect coronary vascular tone. In patients with critical stenoses in their coronary arteries, a reduction in perfusion pressure may lead to regional myocardial ischemia despite a reduction in myocardial oxygen consumption.^{3,4} An anesthetic compound with direct coronary vasodilating property might impair further postoperative oxygenation by dilating non-asthmatic coronary arteries, thereby causing a redistribution of blood flow within the myocardium (coronary steal).

Symbol, Definition, and Units
SAP = systolic arterial pressure (mmHg)
DAP = diastolic arterial pressure (mmHg)
MAP = mean arterial pressure (mmHg)
MPAP = mean pulmonary arterial pressure (mmHg)
PCWP = pulmonary capillary wedge pressure (mmHg)
HRAP = mean right atrial pressure (mmHg)
HR = heart rate (beats·min ⁻¹)
CI = cardiac index (l·min ⁻¹ ·m ⁻²)

DOSE-RESPONSE RELATIONSHIP OF ISOFLURANE AND HALOTHANE VERSUS CORONARY PERFUSION PRESSURES

Effects on Flow Redistribution in a Collateralized Chronic Swine Model

Devy C. H. Cheng, M.D., M.Sc., F.R.C.P.C.* John R. Moyers, M.D.,† Ronald M. Knutson, M.D.,‡
Mark N. Gomez, M.D.,§ John H. Tinker, M.D.†

The authors studied the redistribution of myocardial blood flow in a collateral-dependent (CD) zone as a function of coronary perfusion pressure (CPP) during isoflurane and halothane anesthesia. A swine model with CD myocardium distal to a chronically occluded left anterior descending coronary artery was developed and studied. Sixteen pigs were allowed to grow for 8–10 weeks after ligation of the left anterior descending coronary artery. They were randomly anesthetized with either isoflurane (n = 8) or halothane (n = 8) as the sole anesthetic, which was used to maintain specific CPP. The coronary regional myocardial blood flows were measured using radiolabeled microsphere. Four randomly allocated CPPs, of 30, 40, 50, and 60 mmHg, were studied in each animal. Four additional collateralized animals were anesthetized with α-chloralose, and the same CPPs were obtained using an intermittent positive-pressure ventilation (IPPV) to calculate this model. There was a proportional decrease in heart rate and blood pressure in both the isoflurane and the halothane group with CPP. Cardiac output was significantly decreased in the halothane group at 30 mmHg when compared to 50 mmHg CPP, but it was maintained in the isoflurane group. Systemic vascular resistance was significantly lower in the isoflurane group at 30 and 40 mmHg when compared to 50 mmHg CPP. Both the isoflurane and the halothane group showed a proportional and significant decrease in total coronary blood flow at 30 mmHg CPP when compared to baseline. In both CD and normal perfusion zones, isoflurane consistently maintained a higher end-diastolic blood flow than halothane (5.7–6.1 l·min⁻¹). Although both anesthetics minimally affect coronary vascular resistance, isoflurane appears to be a relatively more potent coronary vasodilator than halothane over the CPPs studied. No significant heterogeneity or transmural redistribution of blood flow was present with either anesthetic at any decrease of CPP. Intravenous adenosine was a difficult positive control, causing significant intracranial and transmural coronary steal from CD myocardial regions in a flow-regime fashion. The authors conclude that neither isoflurane nor halothane as the sole anesthetic in clinical concentrations causes significant

coronary vasodilation or coronary steal from 30 to 50 mmHg CPP in a swine model of chronic coronary occlusion with collateral development. (Key words: Anesthesia; cardiovascular; Anesthetics, volatile; isoflurane; halothane; Artery; coronary; such coronary perfusion pressure; blood flow; collateral; myocardial)

THERE IS EVIDENCE that isoflurane is a direct-acting coronary vasodilator.^{1–6} This coronary vasodilation has been contended to cause redistribution of myocardial blood flow away from collateral-dependent (CD) myocardial regions.⁷ A diagram of the coronary circulation in a swine model of chronic coronary occlusion with collateral development is shown. The diagram illustrates the coronary artery system, including the left coronary artery (LAD), the circumflex artery (Cx), and the right coronary artery (RCA). The diagram also shows the distribution of blood flow to various myocardial regions, including the anterior wall, the lateral wall, and the posterior wall. The diagram is labeled with various abbreviations, including SAP, DAP, MAP, MPAP, PCWP, HRAP, HR, and CI. The diagram is also labeled with various symbols, including R₁, R₂, R₃, R₄, R₅, R₆, R₇, R₈, R₉, R₁₀, R₁₁, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, R₁₇, R₁₈, R₁₉, R₂₀, R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, R₂₈, R₂₉, R₃₀, R₃₁, R₃₂, R₃₃, R₃₄, R₃₅, R₃₆, R₃₇, R₃₈, R₃₉, R₄₀, R₄₁, R₄₂, R₄₃, R₄₄, R₄₅, R₄₆, R₄₇, R₄₈, R₄₉, R₅₀, R₅₁, R₅₂, R₅₃, R₅₄, R₅₅, R₅₆, R₅₇, R₅₈, R₅₉, R₆₀, R₆₁, R₆₂, R₆₃, R₆₄, R₆₅, R₆₆, R₆₇, R₆₈, R₆₉, R₇₀, R₇₁, R₇₂, R₇₃, R₇₄, R₇₅, R₇₆, R₇₇, R₇₈, R₇₉, R₈₀, R₈₁, R₈₂, R₈₃, R₈₄, R₈₅, R₈₆, R₈₇, R₈₈, R₈₉, R₉₀, R₉₁, R₉₂, R₉₃, R₉₄, R₉₅, R₉₆, R₉₇, R₉₈, R₉₉, R₁₀₀.

FAST TRACK CARDIAC ANESTHESIA & RECOVERY

- Safety: morbidity & mortality
J Thorac Cardiovasc Surg
112:755– 64, 1996
- Cost benefits, improve resource utilization
Anesthesiology 85: 1300–10, 1996
- Cost reduction in oneyear follow up
Anesthesiology 98: 651–7, 2003



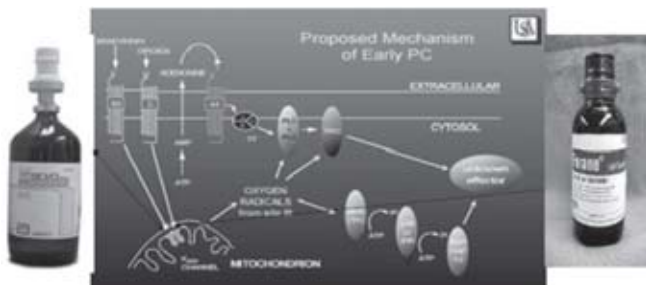
FTCA: REMIFENTANYL VS FENTANYL PRDB MULTI-CENTERS STUDY

Propofol induction and infusion, VCB/NBX, REMI 1 ug/kg/min vs FENT 10 ug/kg, ISO

Median	REMI (n = 150)	FENT (n=154)
Extubation (h)	3.3	3.3
Less Monitor (h)	7.8	7.0
ICU LOS (d)	1.1	1.0
Hospital LOS (d)	5.0	4.9

Cheng D, Newman M, et al. *Anesth Analg* 2001; 92: 1094
Howie M, Cheng D, et al. *Anesth Analg* 2001; 92: 1084

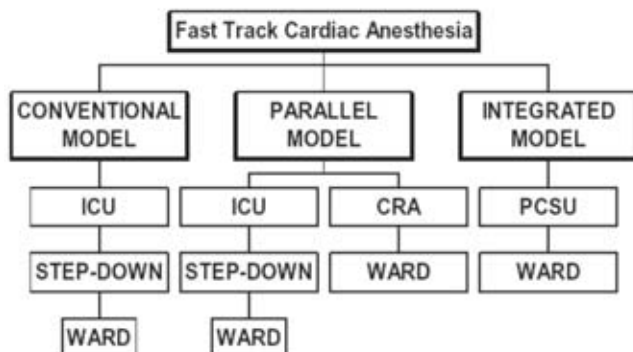
VOLATILE ANESTHETICS: PRECONDITIONING



ANESTHETIC AGENTS: MOA

- GABA receptor
Propofol, thiopental, inhalational agents
- NMDA receptor
Nitrous oxide, ketamine, xenon
- Receptor-synapse based/kinetics of cellular events

CARDIAC SURGICAL RECOVERY MODELS



Cheng D, et al. *Crit Care Med* 1999; 27: 2321-3

IMPACT OF THE OPENING OF A SPECIALIZED CARDIAC SURGERY RECOVERY UNIT ON POSTOP OUTCOMES

In Hospital Mortality

	Predicted	Observed
2004/5	2.1 ± 3.0%	17/967 (1.8%)
2005/6	2.5 ± 4.4%	16/979 (1.6%)
p value	0.08	0.86

Incidence of Major Complications

	Predicted	Observed
2004/5	14.7 ± 8.4%	127/967 (13.1%)
2005/6	15.3 ± 8.2%	96/979 (9.8%)
p value	0.22	0.003

Novick, Cheng, et al. *SCA*, 2006

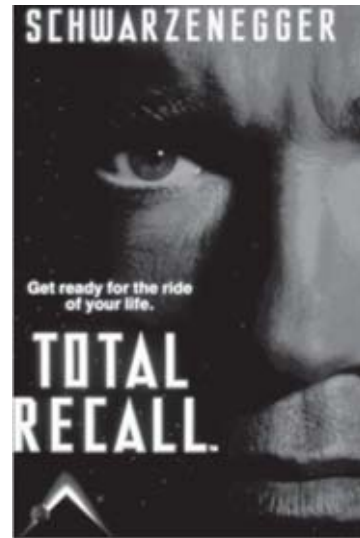


PUBLIC VS PRIVATE INSTITUTIONAL PERFORMANCE REPORTING

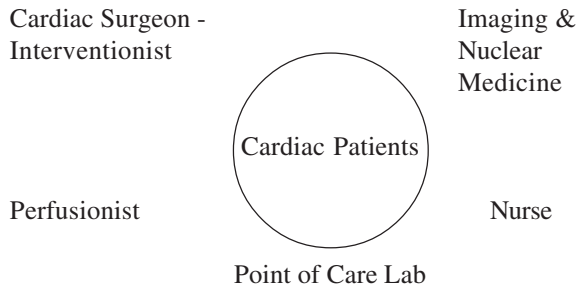
- Longitudinal study (1991-2002): 67,693 Ontario CABG surgery pt
- 30-day mortality rate decreased by 29% between no reporting (1991-1993) and confidential reporting (1994-1998)
- No further decrease with public reporting (1999-2001)
- Confidential disclosure of outcomes is sufficient to accelerate Quality Improvement in a public health care system

Guru, Fremes, Naylor. *Am Heart J* 2006;152:573-8

PARADIGM SHIFT IN MANAGEMENT OF CARDIAC SURGERY PATIENTS



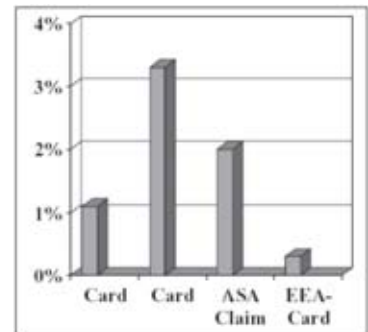
CARDIAC ANESTHESIOLOGIST (PERIOPERATIVE MEDICINE)



FTCA: INTRAOPERATIVE AWARENESS

- Last memory before surgery:
Holding Area / OR: (n = 608) 100%
- Next memory:
ICU: (n = 606) 99.7%
Intraop: (n = 2) 0.3%
0%

Dowd N, Cheng D, et al.
Anesthesiology
1998;89:1068

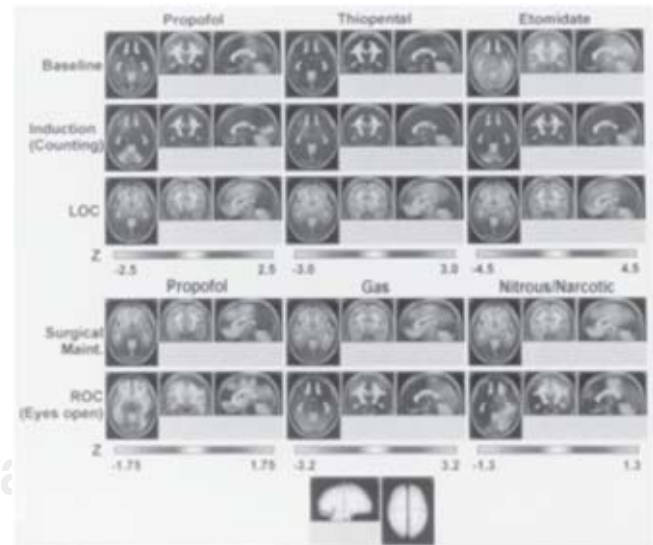
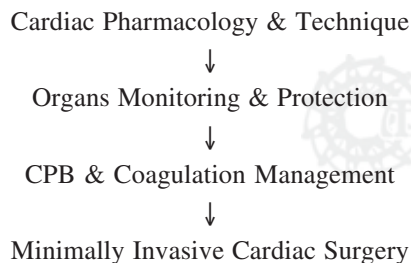


CARDIAC PHARMACOLOGY & TECHNIQUE

Future Projections

- Genomic and Risk Stratification
- 'Personalized' 'Perioperative' Medicine
- MOA Anesthetics
- Safety, Cost-Effectiveness and Evidence-Based Practice

TODAY TO TOMORROW



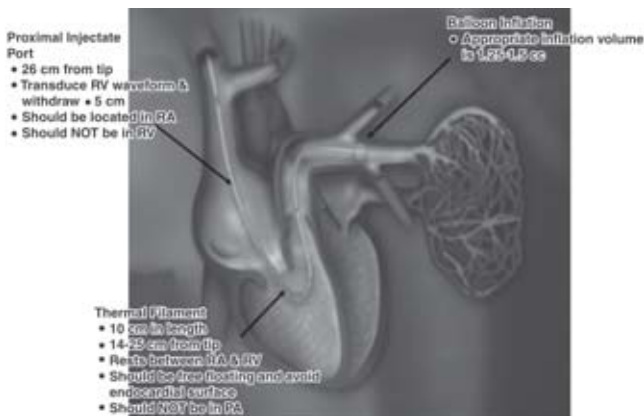
John ER et al. Conscious Cogn 10:165-183, 2001
Depth of Anesthesia - CATEEM, BIS, SFI

INVOS 5100 CEREBRAL OXIMETER (NIRS – NEAR INFRARED REFLECTANCE SPECTROPHOTOMETRY)

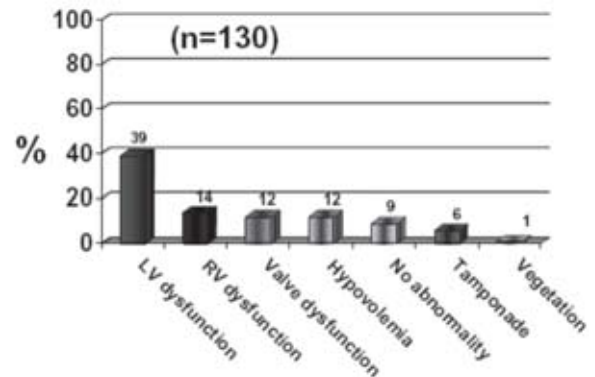


Trans-Cranial Doppler (TCD)

SWAN-GANZ® VOLUMETRIC THERMODILUTION CATHETER

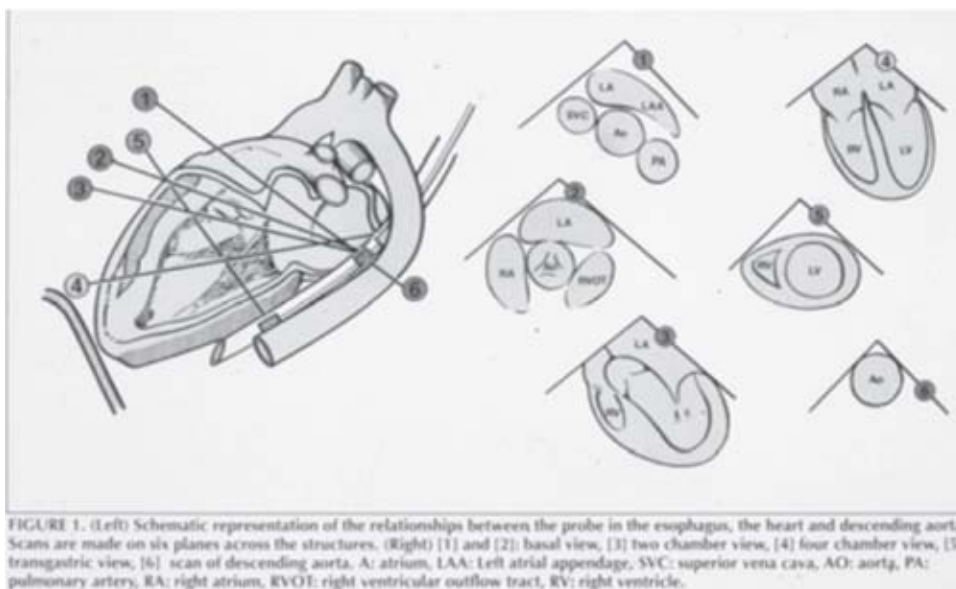
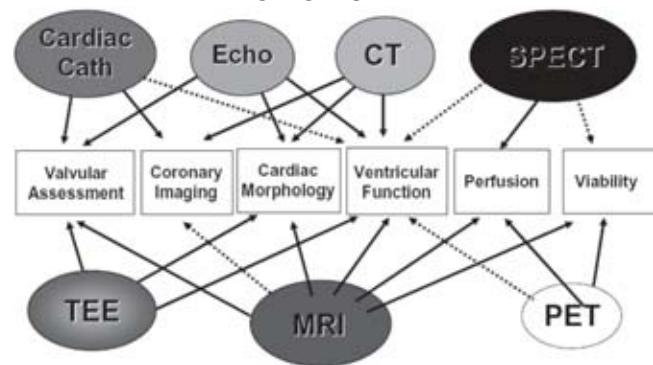


TEE DX IN UNEXPLAINED HEMODYNAMIC INSTABILITY AFTER CARDIAC SURGERY

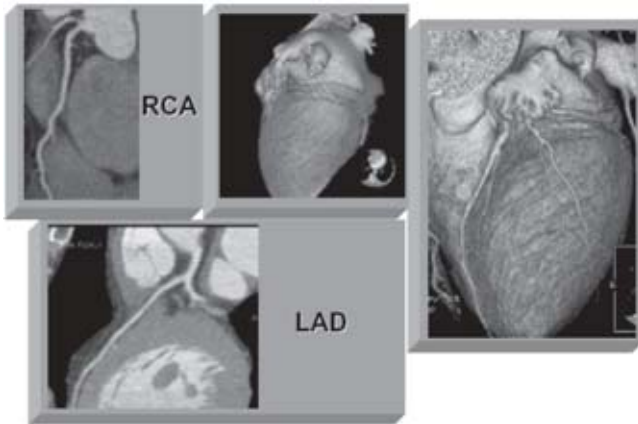


- In 58.5% of the unstable patients, clinical management was changed by TEE result
 - In surgical intervention, mortality is improved
- Wake P, Ali M, Cheng D, et al. Can J Anesth 48:778-83, 2001

IMAGING MODALITY

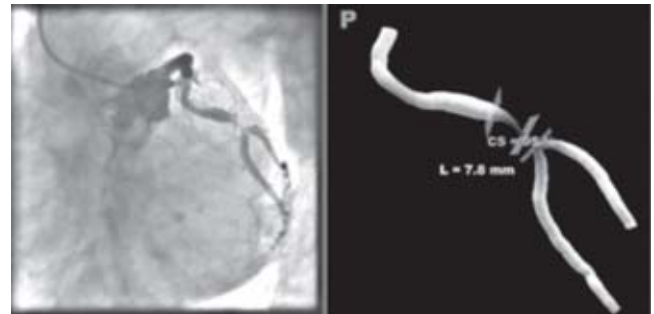


CORONARY CTA

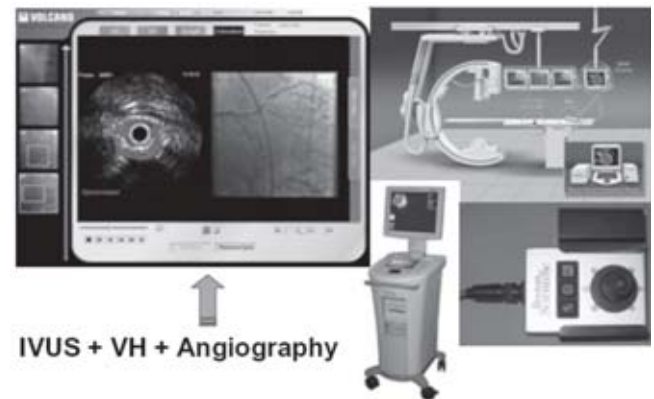


3D ANGIOGRAPHY

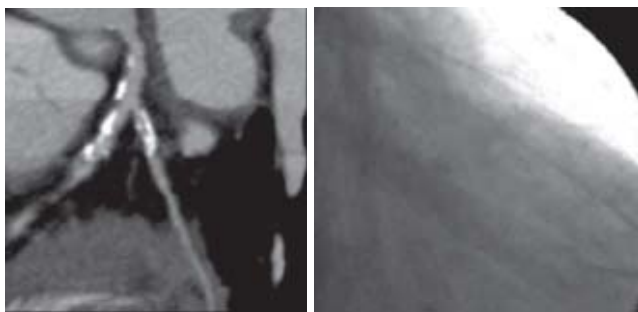
(using image reconstruction techniques)



FULLY INTEGRATED IVUS SYSTEMS



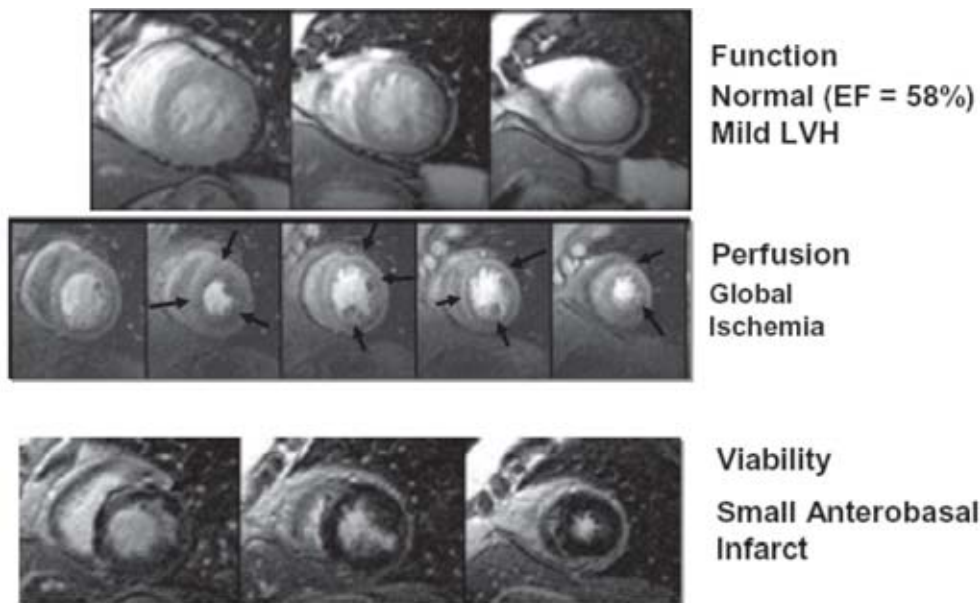
CALCIFIED PLAQUE: 1ST DIAGONAL



CTA

Cath

NON-INVASIVE FUNCTIONAL AND MORPHOLOGICAL IMAGING

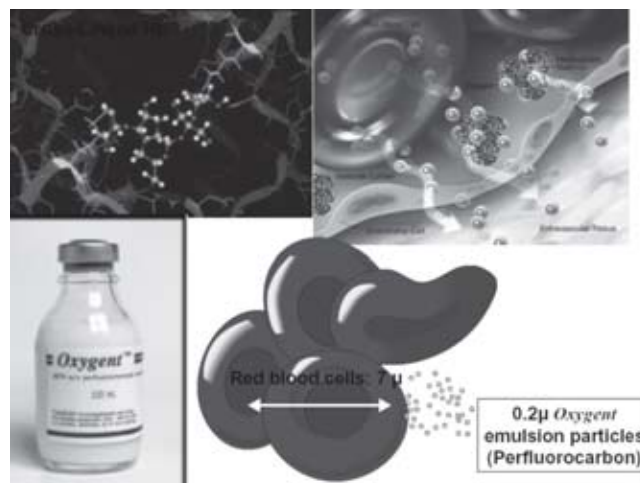
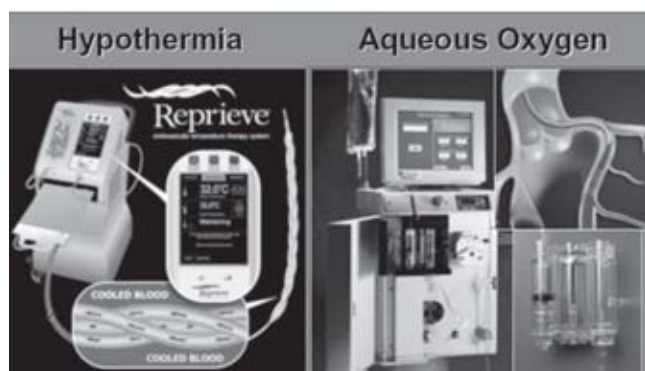


TwinSpeed Excite II

MYOCARDIAL PRODUCTION THE PRESENT

- Temperature: Tepid
- Direction: Combined, continuous when possible
- Composition: Arrest- Perfuse- Protect
K⁺ lowest to induce arrest
Mg⁺⁺ to facilitate arrest and protect
- Additives: Insulin, adenosine, L-Arginine,
Beta-adrenergic blocker

NOVEL DEVICES TO REDUCE INFARCT SIZE



ORGANS MONITORING & PROTECTION

Future Projections

- Specific target organs monitoring and protection (brain, heart)
- Decrease utilization of PAC and increasing TEE
- Multi-functional IVUS (+ enhancements) achieves wide-spread acceptance and use
- MRI and CT techniques evolve further as versatile non-invasive
high resolution diagnostic modalities
- Gene induced Angiogenesis
- Stem Cell therapy to restore heart function

DIRECT INTRA-MYOCARDIAL INJECTIONS: STILETTO™



TODAY AND TOMORROW

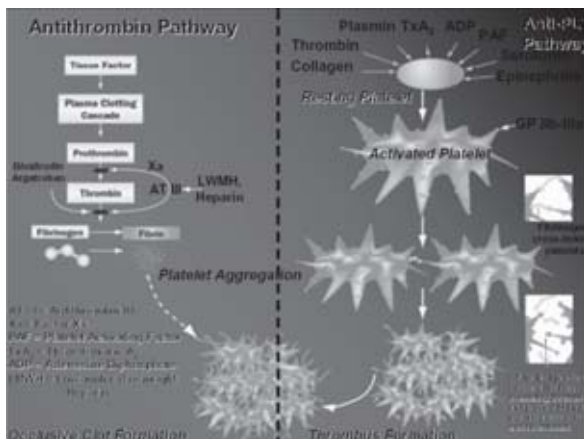
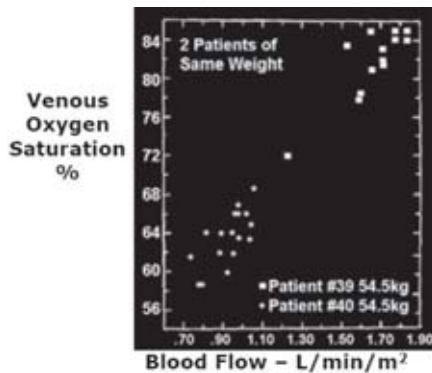
Cardiac Pharmacology & Technique
↓
Organs Monitoring & Protection
↓
CPB & Coagulation Management
↓
Minimally Invasive Cardiac Surgery

EMERSON MOFFITT, M.D.

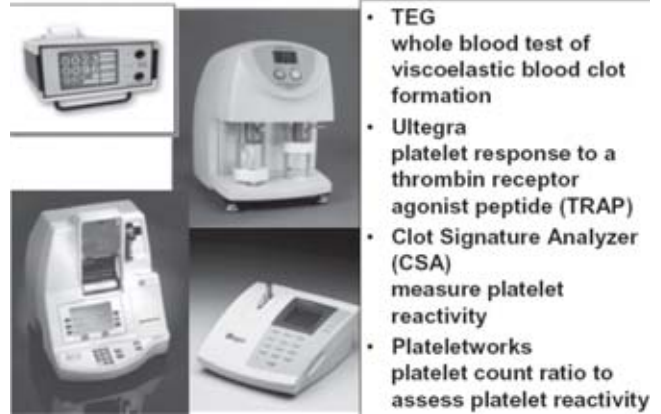
- Extracorporeal Circulation:
Relationship of Blood Flow and Volume
– Surgical Forum, 1957
- Cardiac Support with the Gibbon Oxygenator
– Anesthesiology, 1957



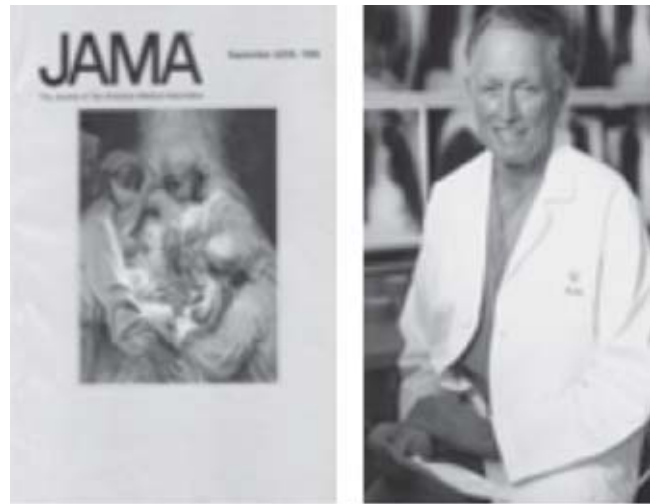
RELATION OF VENOUS OXYGEN SATURATION TO BLOOD FLOW DURING TOTAL PERFUSION



COAGULATION MONITORING



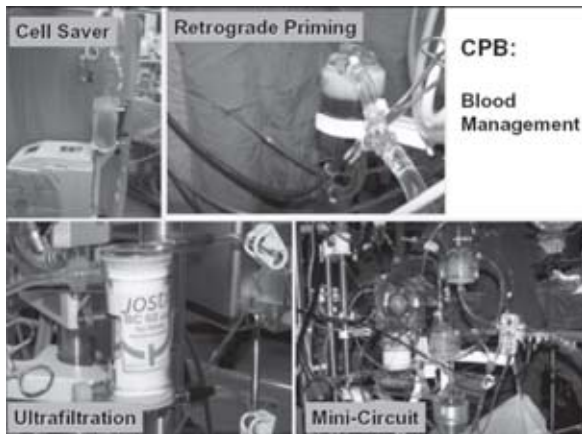
BLOODLESS SURGERY



Ott DA, Cooley DA. Cardiovascular surgery in Jehovah's Witnesses. Report of 542 operations without blood transfusion. JAMA. 1977 Sep 19;238(12):1256-8.

Jehovah's Witnesses who require operation represent a challenge to the physician because of the patients' refusal to accept blood transfusion. We report a 20-year experience with a consecutive series of 542 Jehovah's Witness patients ranging in age from 1 day to 89 years who underwent operation. Early mortality (within 30 days after operation) was 9.4%. In 362 patients requiring temporary cardiopulmonary bypass, early mortality was 10.7%. Mortality was 13.5% among 126 patients who had single- or double-valve replacement. The only deaths among patients who had aortic valve replacement or repair of a ventricular septal defect occurred in those who had some serious complication before operation. Preoperative or postoperative anemia was a contributing factor in 12 deaths, and loss of blood was the

direct cause of three deaths. Cardiovascular operations can be performed safely without blood transfusion.



Mortality Associated With Aprotinin During 5 Years Following Coronary Artery Bypass Graft Surgery

Abstract Acute safety concerns have been raised recently regarding certain hemorrhage-quenching medications commonly used in cardiac surgery. However, no comprehensive data exist regarding their association with long-term mortality.

Objective: To contrast long-term all-cause mortality in patients undergoing coronary artery bypass graft (CABG) surgery according to use of 2 lysine analog antifibrinolytic medications (aminocaproic acid and tranexamic acid), the active protease inhibitor aprotinin, or no antifibrinolytic agent.

Design, Setting, and Participants: Observational study of mortality conducted between November 15, 1996, and December 7, 2006. Following initial hospitalization (1074 patients, 40 medical centers), survival was prospectively assessed at 6 weeks, 4 months, and annually for 5 years after CABG surgery among 1074 patients enrolled in a 42-center international cohort study. The associations of survival with hemorrhage-quenching medications were compared using multivariable analyses including propensity adjustments.

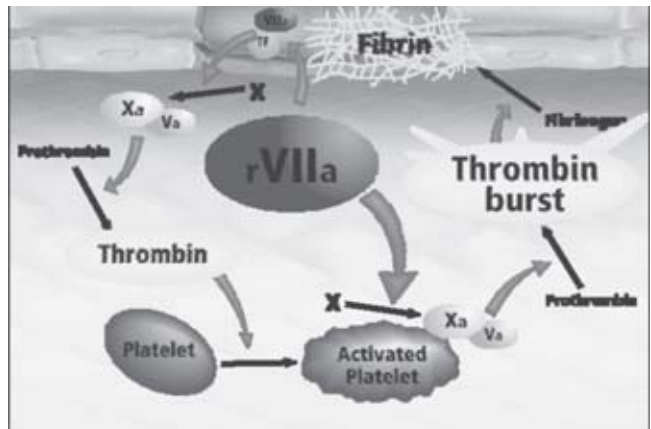
Main Outcome Measures: Deaths (all causes) over 5 years.

Results: Aprotinin treatment (223 deaths among 1072 patients [20.8%, 95% confidence interval, 1.48-3.48]) was associated with significantly increased mortality compared with control (128 deaths among 1039 patients [12.3%, confidence interval, 1.48-3.48]). In patients with aortic cross-clamp time of 15 to 45 minutes, aprotinin treatment was associated with significantly increased mortality (15.8%, confidence interval, 1.13-2.33) compared with control (12.3%, confidence interval, 1.48-3.48). In patients with aortic cross-clamp time of more than 45 minutes, aprotinin treatment was associated with significantly increased mortality (15.8%, confidence interval, 1.13-2.33) compared with control (12.3%, confidence interval, 1.48-3.48). In patients with aortic cross-clamp time of 15 to 45 minutes, aprotinin treatment was associated with significantly increased mortality (15.8%, confidence interval, 1.13-2.33) compared with control (12.3%, confidence interval, 1.48-3.48). In patients with aortic cross-clamp time of more than 45 minutes, aprotinin treatment was associated with significantly increased mortality (15.8%, confidence interval, 1.13-2.33) compared with control (12.3%, confidence interval, 1.48-3.48).

Conclusions: These findings indicate that in addition to the previously reported acute renal and cardiac safety concerns, aprotinin use is associated with an increased risk of long-term mortality following CABG surgery. Use of aprotinin among patients undergoing CABG surgery does not appear justified because of the low magnitude of its association with mortality compared with control.

Keywords: aprotinin, coronary artery bypass graft surgery, mortality, hemorrhage-quenching medications.

RFVIIA MECHANISM OF ACTION: BOOSTS THROMBIN GENERATION ON ACTIVATED PLATELETS



CPB & Coagulation Management

Future Projections

- Extracorporeal Circuit:
 - Use of new non-thrombogenic materials
 - Simplified and miniaturized ECC
 - Total automation of the ECC
 - Automated neuroprotective devices
- Blood Management: Techniques & Pharmacology
- Oxygen Therapeutics

TODAY TO TOMORROW

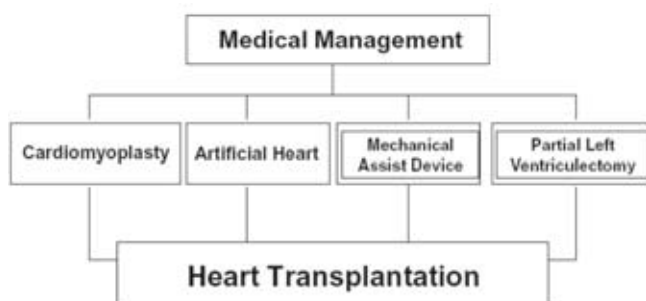
Cardiac Pharmacology & Technique
 ↓
 Organs Monitoring & Protection
 ↓
 CPB & Coagulation Management
 ↓
 Minimally Invasive Cardiac Surgery



TCI-HEARTMATE LVAD



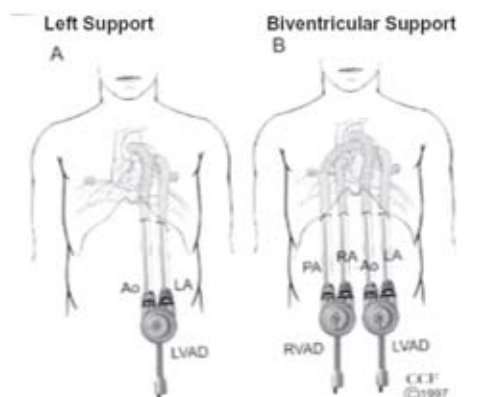
END STAGE CHF: TREATMENT OPTIONS



VENTRICULAR ASSIST DEVICES

- Extracorporeal pulsatile pump:
ABIOMED BVS 5000, Thoratec Assist
- Intracorporeal implantable:
HeartMate, Novacor – LVAD
ABIOMED, TAH

THORATEC VENTRICULAR ASSIST DEVICE

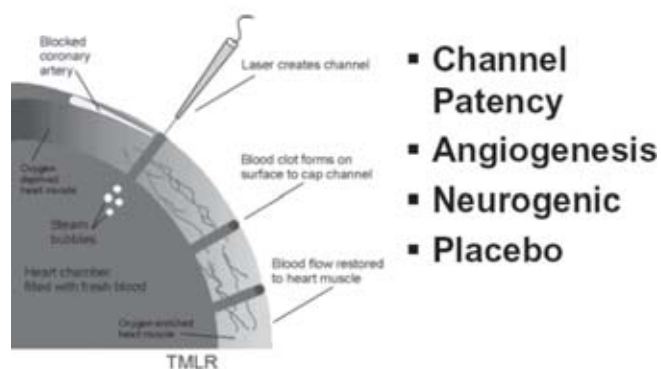


Naughton P and Bashour CA.
Semin Cardiothorac Vasc Surg 6:237-57. 2002

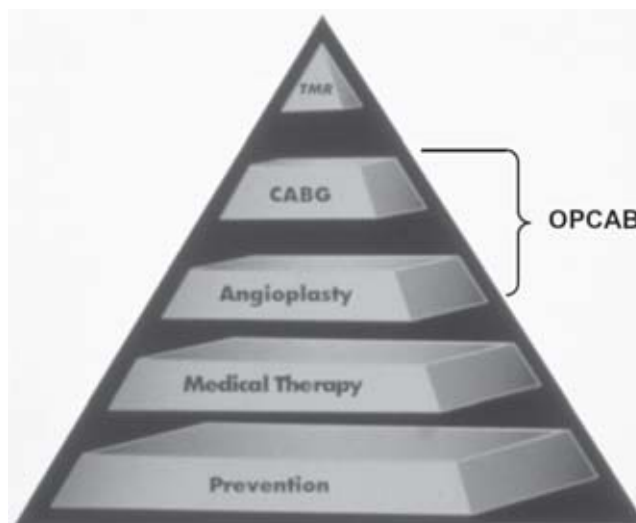
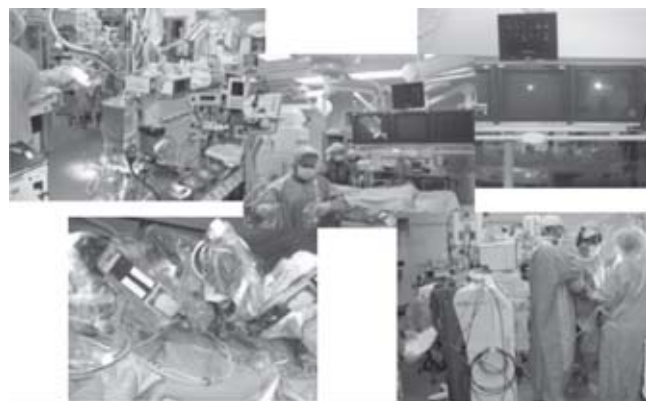




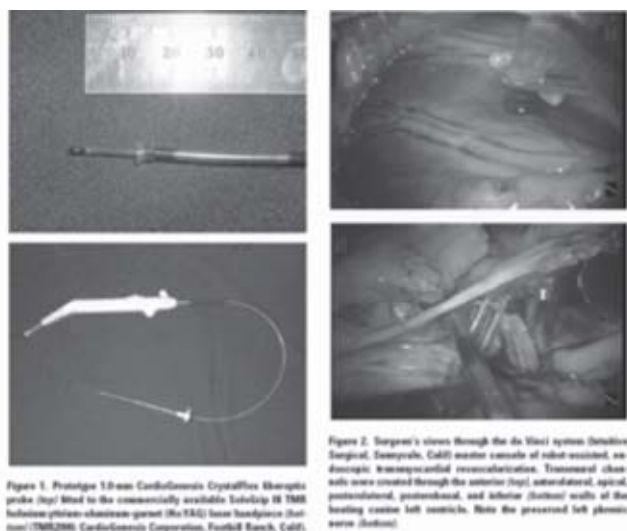
TMR: MECHANISM OF ACTION?



HYBRID OR: LHSC



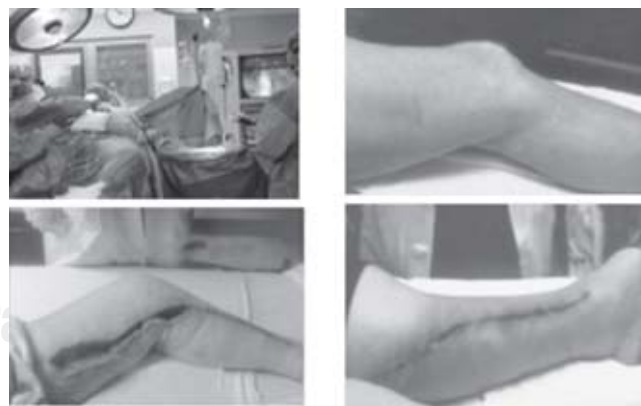
TRANSMYOCARDIAL REVASCULARIZATION



Yuh DD et al. J Thorac Cardiovasc Surg 13:120-4. 2005

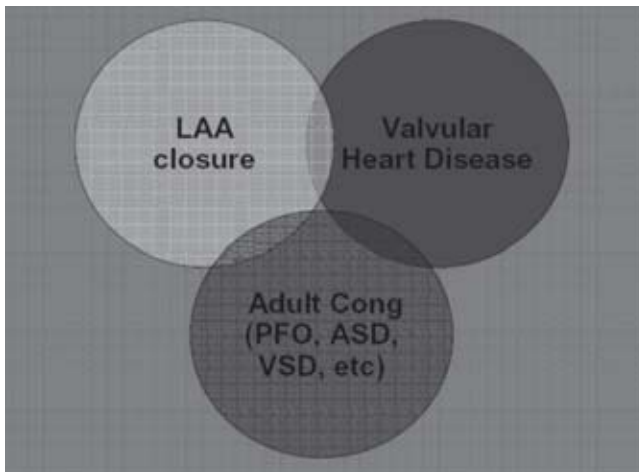
SURGICAL TECHNIQUE: ENDOSCOPIC VEIN HARVESTING

wound drainage, necrosis, infection, and leg edema

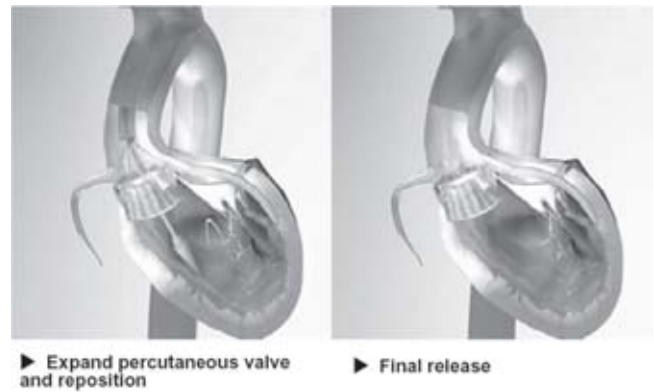


Cheng, Allen, Cohn, et al. Innovations 2005; 1: 61-74

PERCUTANEOUS INTERVENTION FOR STRUCTURAL HEART DISEASE



THE LOTUS™ VALVE BY SADRA MEDICAL

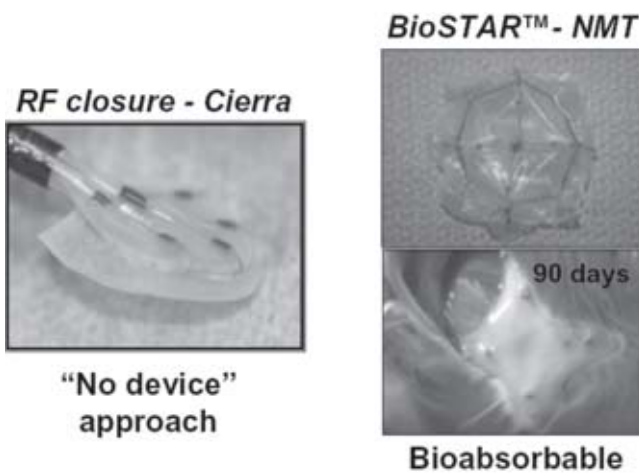


PRESENT / FUTURE – THE BIO-TECHNOLOGY AGE



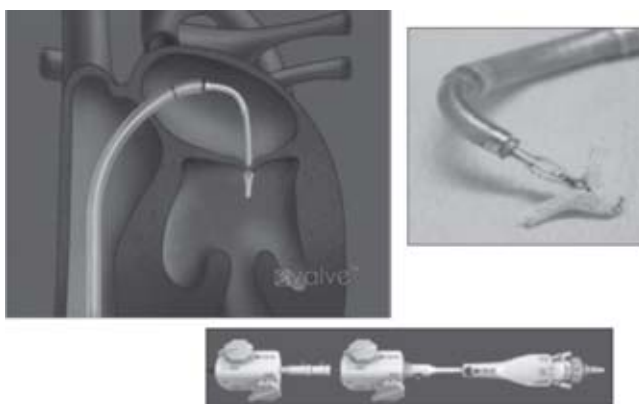
- Interventional Cardiology
- Hybrid procedure
- Angiogenesis
- Tissue Engineering
- Xenotransplant
- Stem cell therapy

NEW PFO CLOSURE DEVICES



"No device"
approach

ENDOVASCULAR MITRAL REPAIR SYSTEM (EVALVE)



Robotics Operating Suite Floor Plan - Level 2

MINIMALLY INVASIVE CARDIAC SURGERY

Future Projections

- Minimally invasive coronary and valve surgery
- Robotic hybrid procedure
- Interventional cardiovascular procedures
- Anesthesia imperative to complement the advancement in Biotechnology

