Anesthesia for patients with LVADs and tansplants

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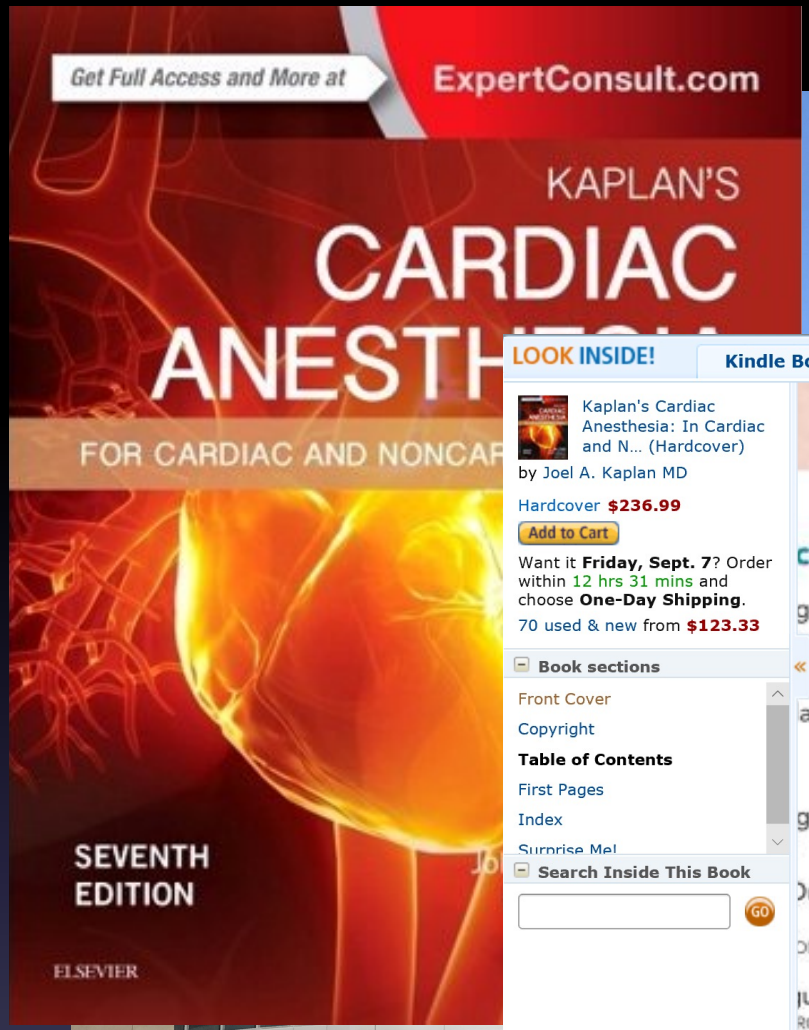
Disclosures

None



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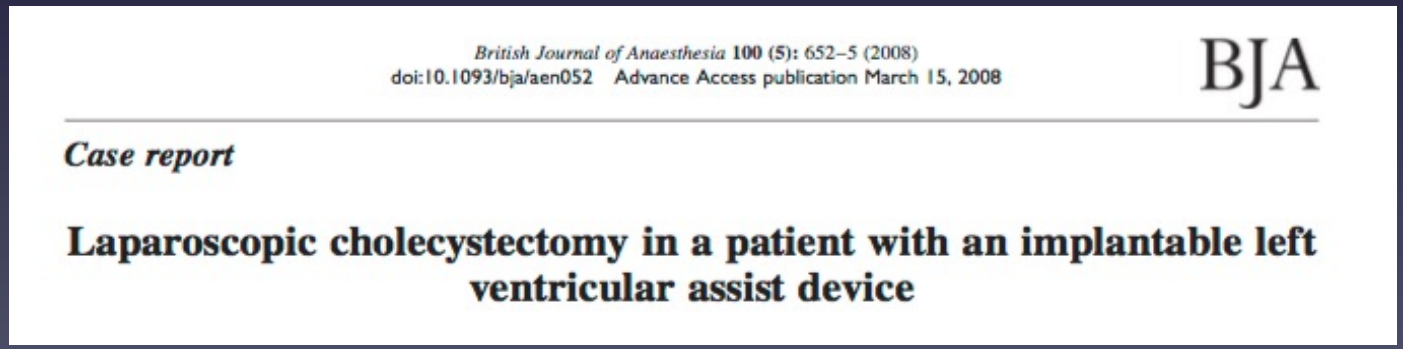
SECTION VII The Cardiac Patient for Noncardiac Surgery

Its Sunday morning, and you walk in to your call to find out…..

- 57 year old female patient needs an "urgent" Lap-Chole at 8 AM
- HTN, NICMP, A fib, ICD/PPM, CKD and TIA
- After you catch your breath, someone says: "Oh by the way, she has an LVAD"

What do you think

- I mean , aside from " Who else can I find to take my spot ?
- How do I assess her ? A line or not ? Will she crash on induction ? Can I extubate her ? How much fluid do I give ? Why does it always happen to me ?



British Journal of Anaesthesia **100 (5):** 652–5 (2008)
doi:10.1093/bja/aen052 Advance Access publication March 15, 2008

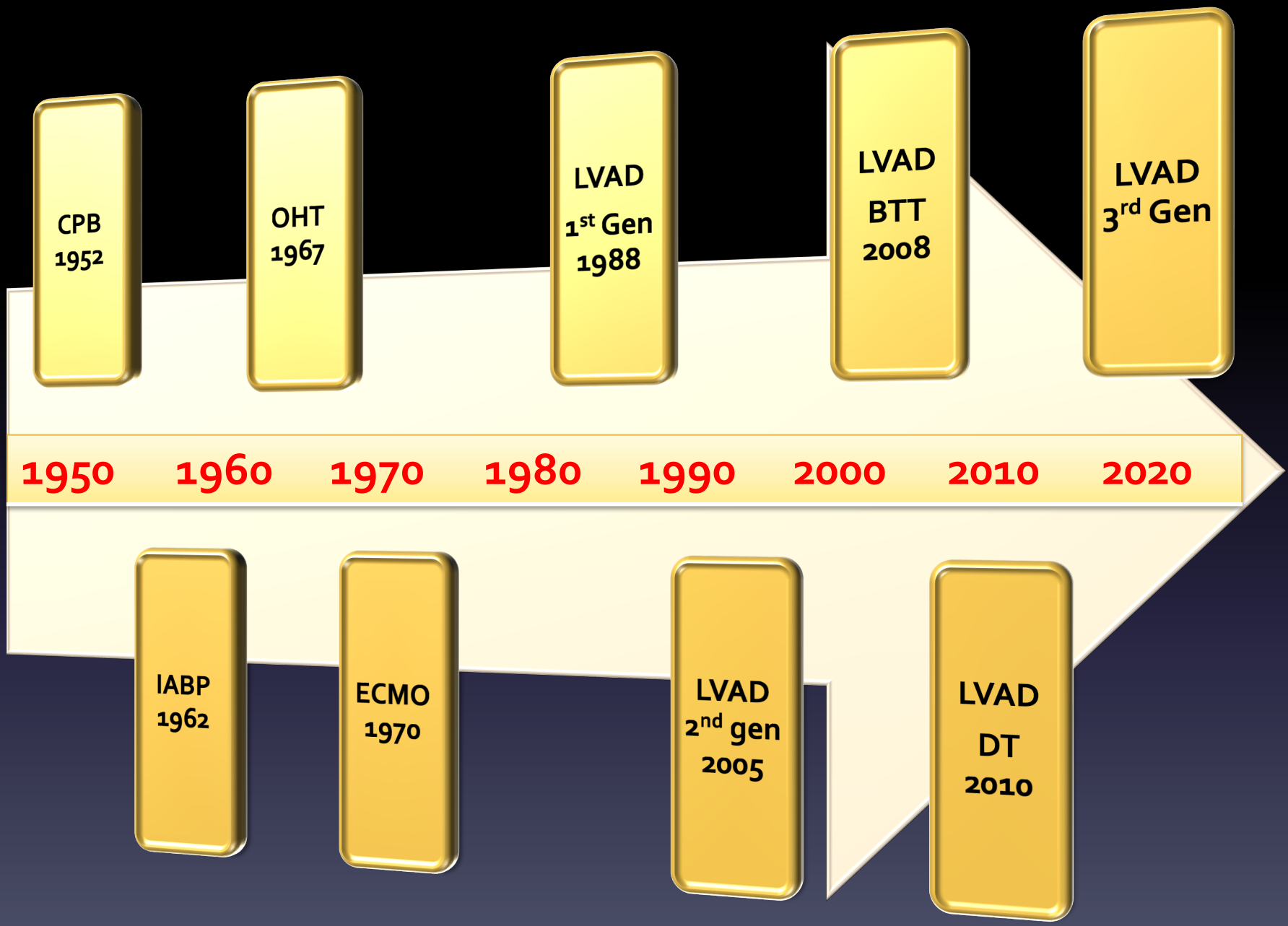
BJA

Case report

Laparoscopic cholecystectomy in a patient with an implantable left ventricular assist device

Heart Failure

- Most common cause : LV dysfunction
- 5.1 million people (2% of population)
  - 1 in 9 deaths attributable to HF
- Decreased quality of life, more admissions
  - 32 billion USD annually
  - 1 million admissions
- Transplants are curative, but organs are limited


CPB
1952
OHT
1967
LVAD
1st Gen
1988
LVAD
BTT
2008
LVAD
3rd Gen
1950
1960
1970
1980
1990
2000
2010
2020
IABP
1962
ECMO
1970
LVAD
2nd gen
2005
LVAD
DT
2010

Trends

CENTRAL ILLUSTRATION: Recent Trends in Left Ventricular Assist Device Implantation Strategies, Outcomes, and Management

Evolving Management Approaches

Surgical Approach
Thoracotomy-based implantation

Stroke
↓with HeartMate 3

Bleeding
Evaluation of ↓intensity antithrombotic therapy

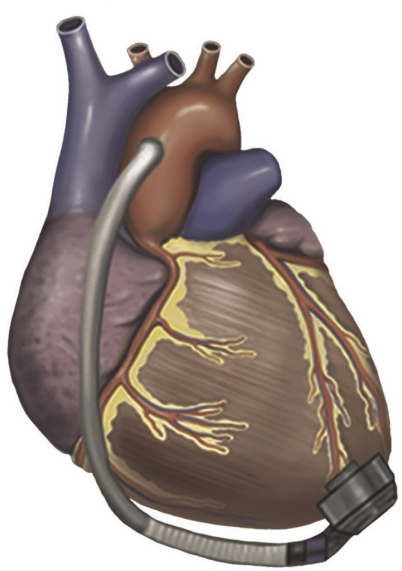
RV Failure
Assessment of RV reserve, evaluation of pulmonary vasodilators

Aortic Regurgitation
TAVR possible in select patients

Infection
Development of fully internalized devices

Myocardial Recovery
Possible with optimized mechanical unloading, pharmacotherapy, and serial functional assessment

Shared Decision Making
Implementation of decision aids



Recent Changes

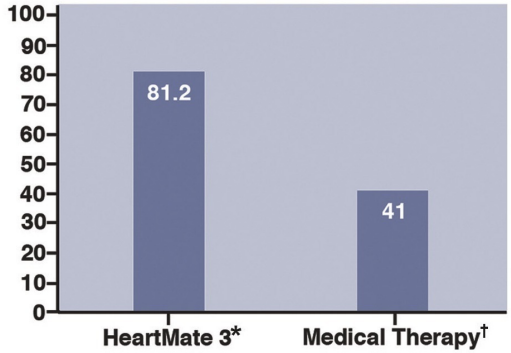
- HeartMate 3 LVAD FDA approved for DT
- UNOS donor heart allocation system revised
- Improved LVAD-related AE management

Contemporary Epidemiology

Recipient Phenotype
↑Comorbidities
↑Preoperative illness severity
> 50% in cardiogenic shock
> 1/3 on pre-implant TMCS

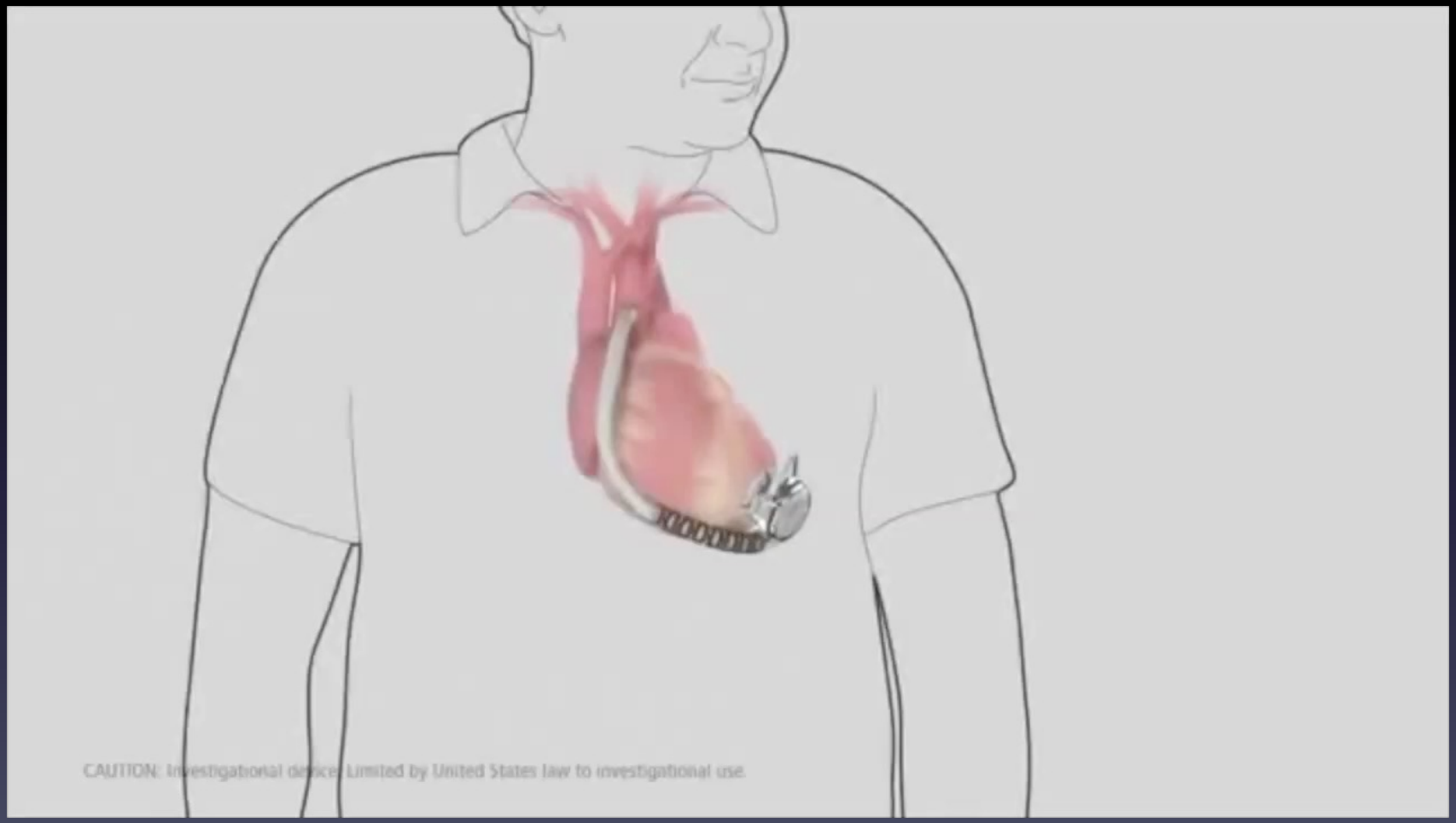
Implant Strategy
DT (73.1%) >> BTT (8.9%)
↓Durable LVAD at time of HT

2-Year Survival Rate of Advanced HF Patients Stratified by Treatment



Varshney AS, et al. J Am Coll Cardiol. 2022;79(11):1092-1107.

LVAD function



Device controller console

Pump Flow

Calculated

Pulsatility index

Volume status

Rotation

Set by operator

Pump power

Driving force

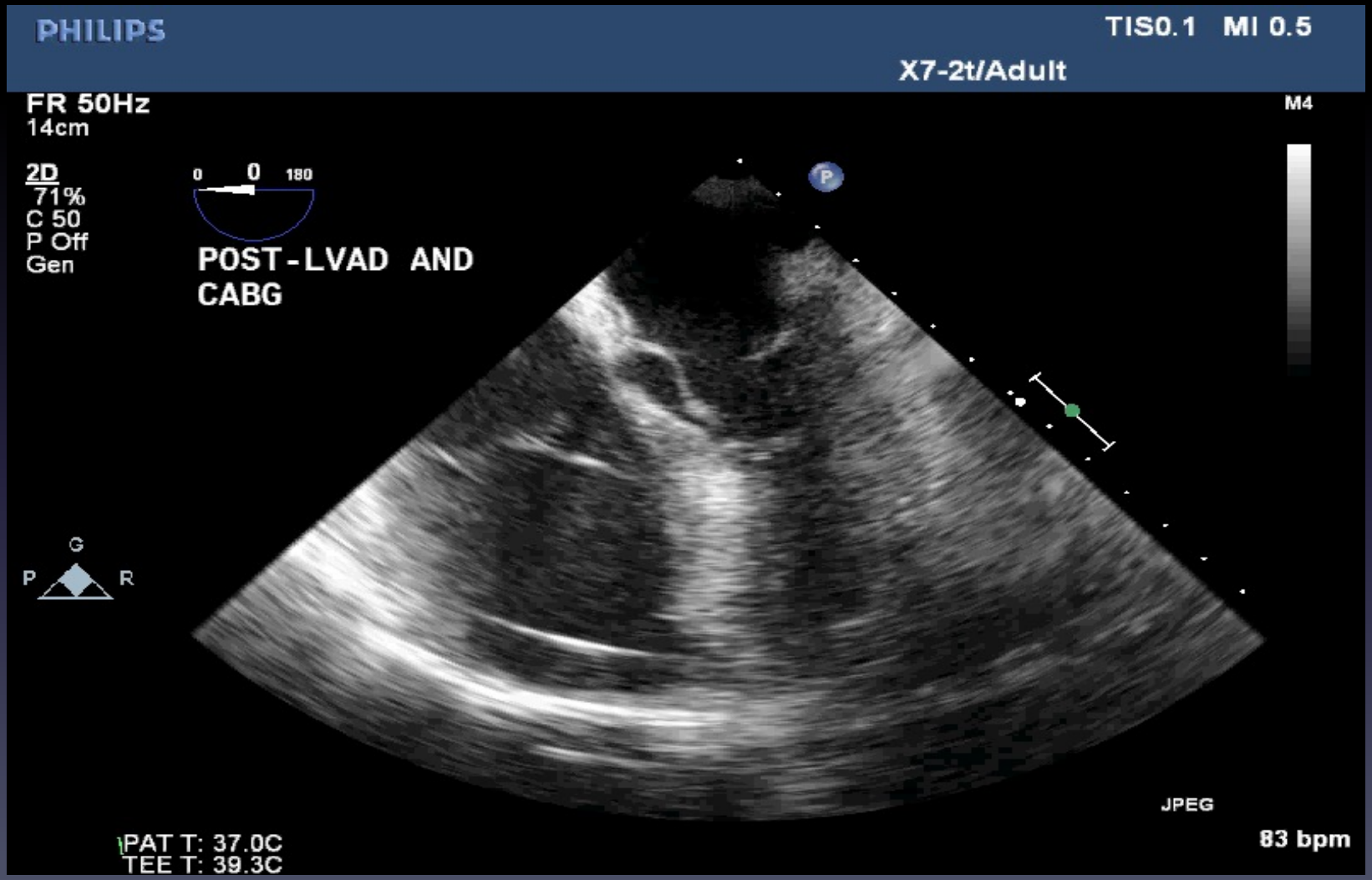
2001-2015 ; 3 generations

2nd Generation	3rd Generation
Continuous flow	Continuous flow
Rotary blade	Centrifugal pump
"Contact" , mechanical	"No Contact", Mag-Lev
Larger: pre-peritoneal	Smaller: intra-pericardial
Higher RPM (upto 15000)	Lower RPM (upto 4000)

Complications

- Infections: 46 % at 1 year
  - Driveline and pocket, fatal sepsis in 25 %
- Bleeding: 19-50 % with CF devices
  - Anticoagulation target INR 1.5-2.5 + ASA
  - GI bleed most common, related to AVM
- Stroke and peripheral thromboembolism
- Arrhythmia
  - Monomorphic VT
- RV failure : 9 – 44 %
  - Post implant RVF correlates with worse outcome
- Hemolysis

RV Failure and LV suckdown



Risk of NCS

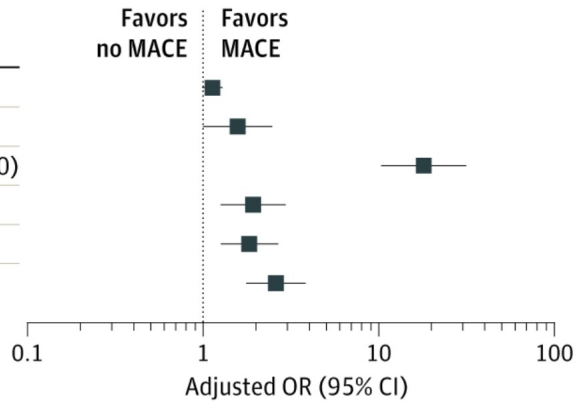
- 8118 patients with LVAD (mean age, 63.4 years; 6484 men)
  - 1326 (16.3%, or approximately 1 in 6) underwent NCS,
  - 1000 procedures (75.4%) were emergent or urgent and 326 (24.6%) were elective.
- The number of NCS procedures increased from 64 in 2012 to 304 in 2017.
- The median time from LVAD implantation to NCS was 309 days. The most frequent type of NCS was general (613 abdominal, pelvic, and GI [46.2%]).
- Perioperative MACEs occurred in 169 patients (16.9%) undergoing urgent NCS and 23 patients (7.1%) undergoing elective NCS.

JAMA Netw Open. 2020;3(11):e2025118. doi:10.1001/jamanetworkopen.2020.25118

Risk of NCS

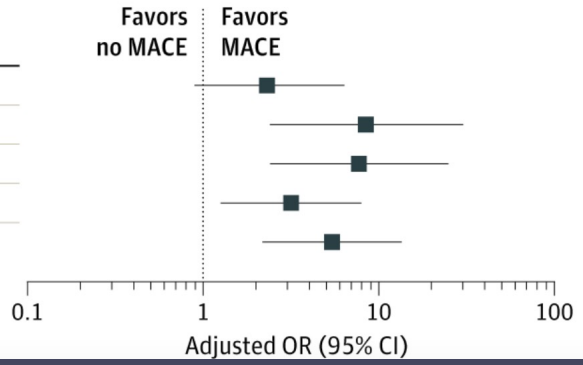
A Urgent or emergent noncardiac surgery

Source	Adjusted OR (95% CI)
Age at time of surgery (5-y increments)	1.13 (0.99-1.29)
Female	1.56 (1.00-2.48)
Vascular surgery	18.30 (10.43-32.00)
Thoracic surgery	1.94 (1.26-2.98)
Surgery within 6 mo of LVAD implantation	1.85 (1.27-2.68)
Acute kidney injury	2.62 (1.78-3.86)



B Elective noncardiac surgery

Source	Adjusted OR (95% CI)
Female	2.33 (0.90-6.34)
Vascular surgery	8.51 (2.39-30.26)
Thoracic surgery	7.77 (2.41-25.01)
Surgery within 6 mo of LVAD implantation	3.18 (1.27-7.97)
Acute kidney injury	5.44 (2.18-13.56)



JAMA Netw Open. 2020;3(11):e2025118. doi:10.1001/jamanetworkopen.2020.25118

Preoperative

- LVAD team model
  - Central information resource
  - Multi-specialty input
- Procedural considerations
  - Position
  - Site of surgery
- Preparation
  - Level of care afterwards
  - Device representative for adjustment

- Focus on end orga
  - Kidney / Liver
- Anticoagulation
  - Correction is tricky
    - Thrombosis versus blood loss
    - Elective versus emergent
    - Newer versus Older device
  - Under-correction is probably better, and consultation with hematology is recommended

Intraoperative

- Device power : Backup power
- USE THE BASE CONSOLE
- EMI
  - Newer devices are shielded
  - Flow of current away from the device
- Tachyarrhythmia therapy planning

Non pulsatile flow and monitoring

- Pulse oximetry can be difficult
  - Cerebral oximetry or serial ABG
- Blood pressure measurement
  - Arterial line or doppler measurement using a manual cuff

Journal of Cardiothoracic and Vascular Anesthesia

Volume 29, Issue 1, February 2015, Pages 17–26

Original Articles

Perioperative Management of Patients With Left Ventricular Assist Devices Undergoing Noncardiac Procedures: A Survey of Current Practices

1400 SCA members invited to survey, resulted in about 250 complete responses

Majority were experienced, cardiac anesthesiologists in a tertiary center

Average number patients with an LVAD a month : about 7

High volume institutions less likely to use invasive monitors

(57 vs 38 % endoscopy and 84 vs 66 % for surgical patients)

	Endoscopy %	Surgery %
NIBP	59	57
A line	49	71
Central venous Catheter	8	12
PA catheter	1	1
TEE	3	15
ECG, End tidal Co2 and pulse oximeter were almost universally used		

Choice of anesthetic technique

- Regional
  - Anticoagulation concerns
  - Difficulty in patient position
- MAC
  - Sedation without invasive monitors is safe
- General Anesthesia
  - Aspiration risk
  - Avoid sudden changes in preload/afterload
  - Prolongation of drug metabolism
  - Maintenance of normothermia

Intraoperative

- Monitoring of the RV
  - Swan Ganz catheter
    - Can measure right sided output, since the calculated CO from the LVAD is not always accurate
    - Can distinguish between RV failure versus increased right sided afterload
  - TEE for filling/suction events/contractility

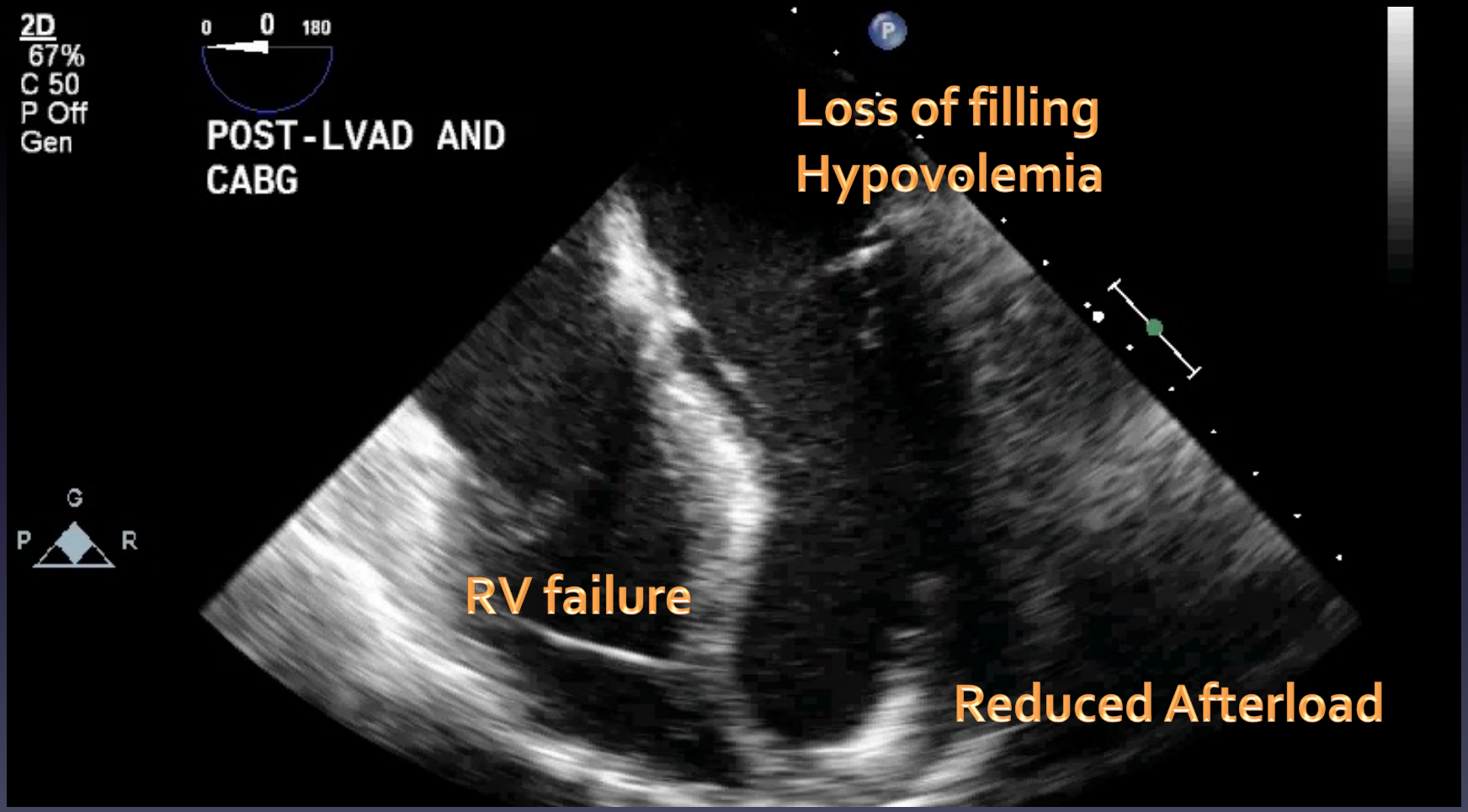
- Hydrate and line before induction
- Hemodynamic goals:
  - Adequate preload
  - Avoidance of abrupt SVR increases
  - Maintenance of RV forward flow
  - IPPV settings to promote venous return
  - Careful fluid replacement

Continuous flow LVADs are AFTERLOAD SENSITIVE

- Expect hypotension after intubation
- If the pulse ox beep goes off, pulsatility is lost, and ….
  - The VAD is doing all the work
  - Either preload is low
  - OR, the afterload is low

AVOID hypoxia /hypercarbia /acidosis

LV suckdown


2D
67%
C 50
P Off
Gen
0 0 180
POST-LVAD AND CABG
Loss of filling
Hypovolemia
G
P
R
RV failure
Reduced Afterload

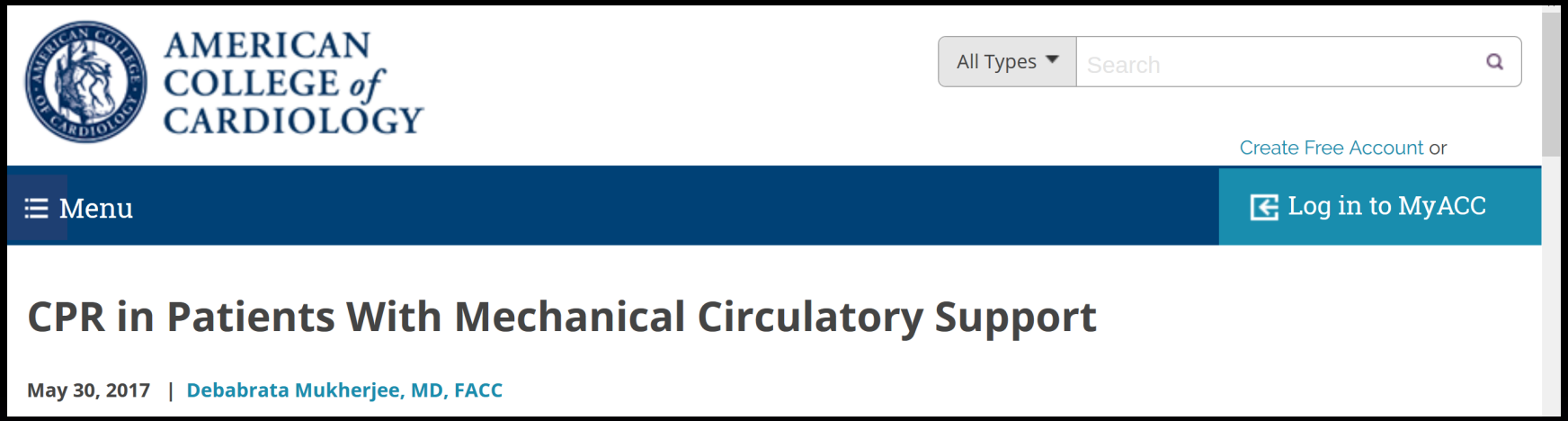
Hemodynamic management

	PI	CVP(mm Hg)	Management
Normal, goal	4-5	10-12	
Hypovolemeia	<3	<12	Fluids
			Ensure venous return
RV dysfunction	<3	>12	Inotropes
			Rule out hypoxia, hypercarbia & acidosis
			Inhaled nitric oxide
High Afterload	>5.5	<8	Vasodilators
			Ensure adequate flow in the VAD

TREAT HYPOTENSION AFTER ADEQUATE PRELOAD WITH INOTROPES AND VASOPRESSORS IN CONJUNCTION

Postoperative

- Frequent care in the ICU post operatively, especially after emergency surgery
- Transport to ICU critical, especially with manual ventilation
- Early re-institution of anticoagulation
- Recheck Labs



- etCO2 of < 20 surrogate to pulse-less-ness (Apart from MAP < 50 mm Hg)
- Heavy reliance on physical exam and capnography
- Troubleshoot the device, but initiate chest compressions (big change !)

Thank you