TTT @ TCTAP 2024

Mechanical Circulatory Support in CHIP PCI

IABP – our old friend

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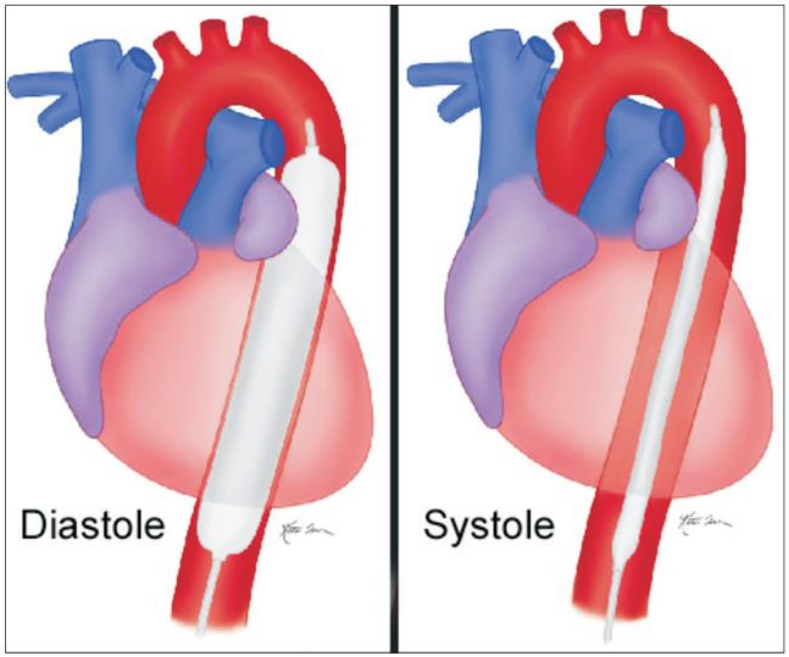
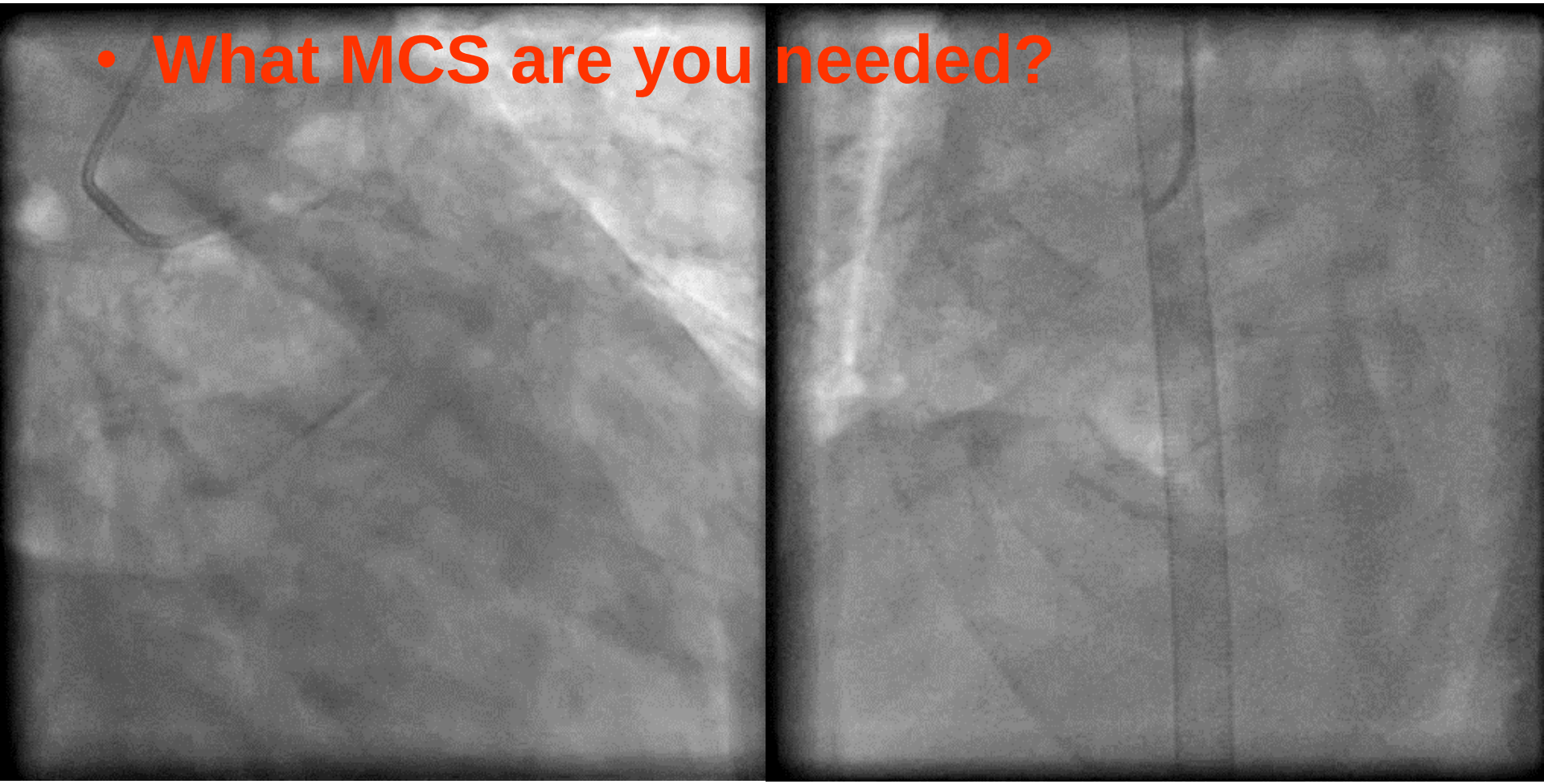


Conflict of interest to declare

None

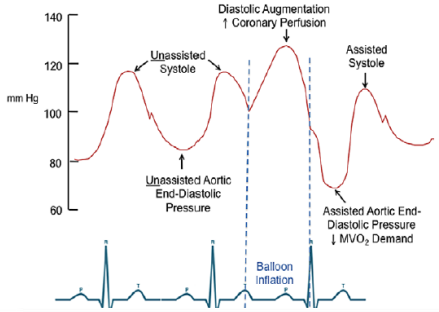
- **54 Y/O, Cardiogenic shock, TVD with RCA and LAD total occlusion, LVEF 23%**
- **SYNTAX score: 47.5**
- **STS mortality score: 18.97%,**

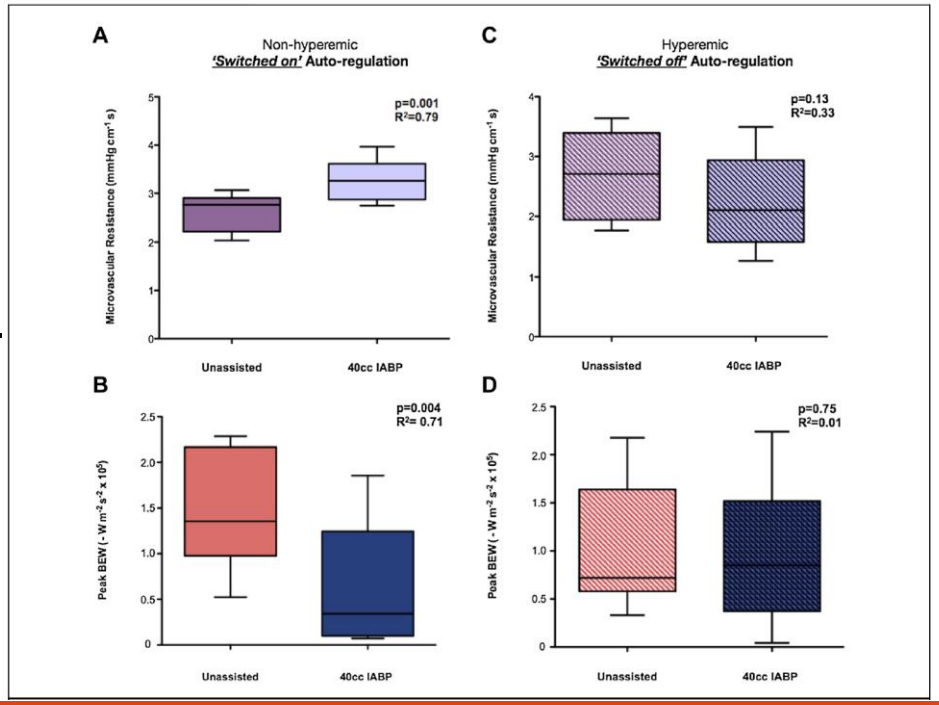
- **What MCS are you needed?**



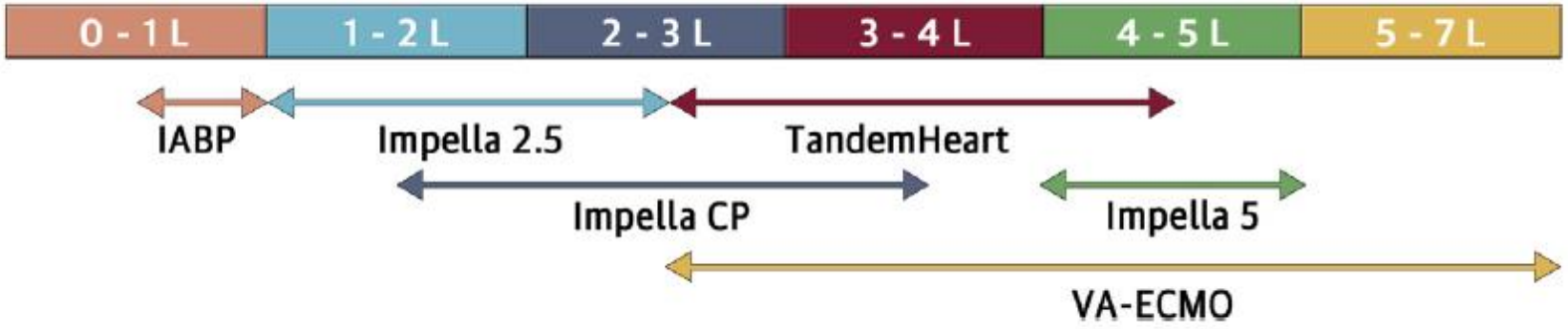
Intra-Aortic Balloon Pump (IABP) – Hemodynamic Effects

- First introduced into clinical practice in 1968
- Reduce end-diastolic aortic pressure
- LV wall tension decrease
- Lower LV afterload and decrease myocardial oxygen demand
- Cardiac output increase
- Coronary blood flow increase; Post-stenotic coronary blood flow: controversial *(related to coronary autoregulation)*





Mechanical circulatory support



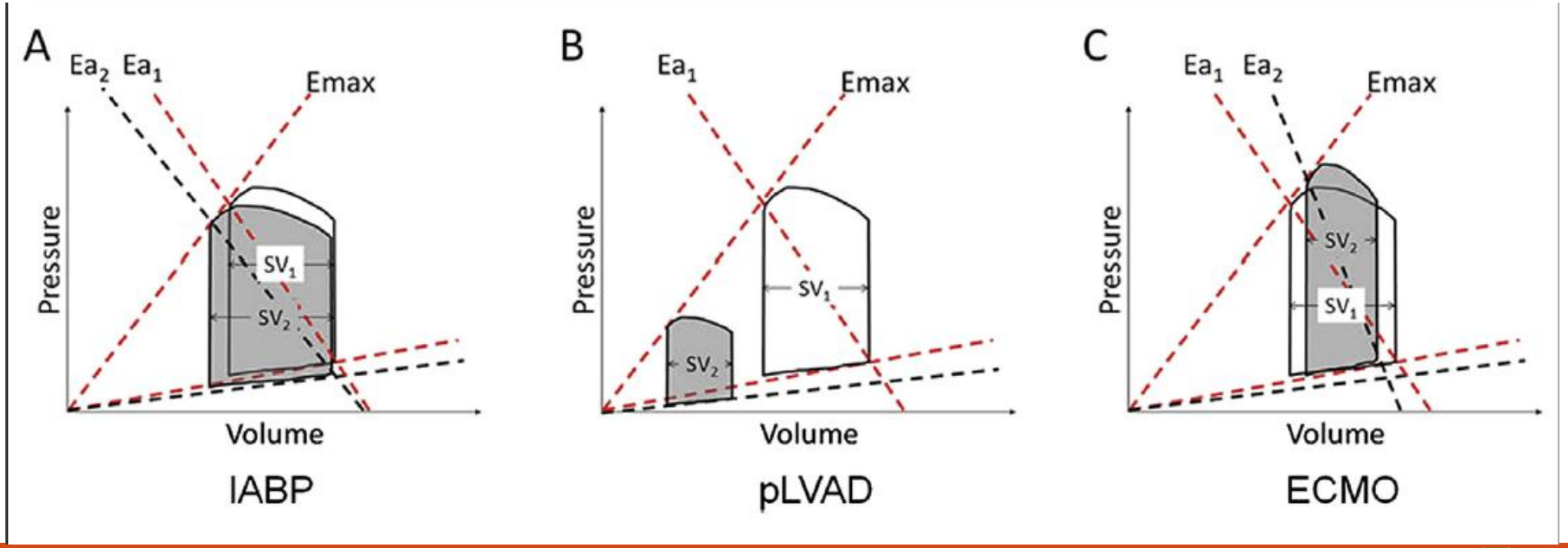
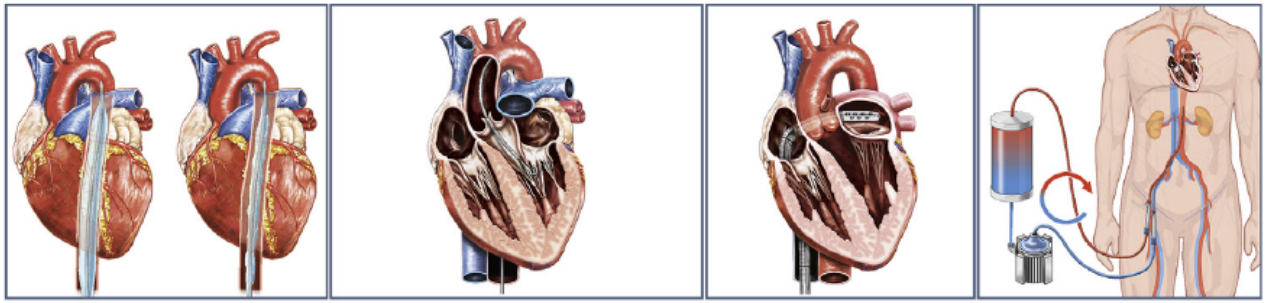
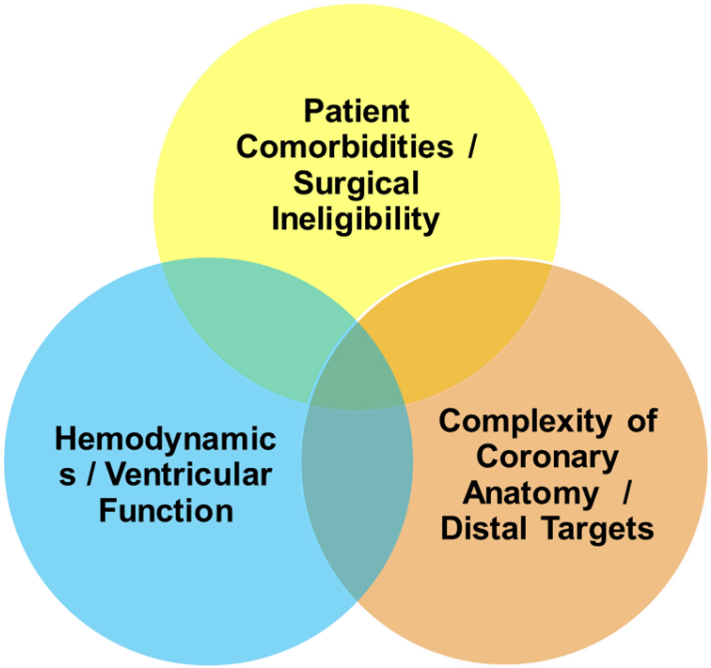


FIGURE 1 Comparison of MCS Devices



	IABP	IMPELLA	TANDEMHEART	VA-ECMO
Cardiac Flow	0.3-0.5 L/ min	1-5L/ min (Impella 2.5, Impella CP, Impella 5)	2.5-5 L/ min	3-7 L-min
Mechanism	Aorta	LV → AO	LA → AO	RA → AO
Maximum implant days	Weeks	7 days	14 days	Weeks
Sheath size	7-8 Fr	13-14 Fr Impella 5.0 - 21 Fr	15-17 Fr Arterial 21 Fr Venous	14-16 Fr Arterial 18-21 Fr Venous
Femoral Artery Size	>4 mm	Impella 2.5 & CP - 5-5.5 mm Impella 5 - 8 mm	8 mm	8 mm
Cardiac synchrony or stable rhythm	Yes	No	No	No
Afterload	↓	↓	↑	↑↑↑
MAP	↑	↑↑	↑↑	↑↑
Cardiac Flow	↑	↑↑	↑↑	↑↑
Cardiac Power	↑	↑↑	↑↑	↑↑
LVEDP	↓	↓↓	↓↓	↔
PCWP	↓	↓↓	↓↓	↔
LV Preload	---	↓↓	↓↓	↓
Coronary Perfusion	↑	↑	---	---
Myocardial oxygen demand	↓	↓↓	↔↓	↔

IABP indications



CLINICAL
Severe LV dysfunction (ejection fraction < 35%)
Decompensated heart failure (elevated LV end-diastolic pressure)
Arrhythmias (rapid atrial fibrillation, ventricular tachycardia)
COMORBIDITIES
Severe valvular disease
Severe lung disease
Chronic kidney disease (eGFR < 30 mL/min/1.73 m^2)
Acute coronary syndrome
ANATOMICAL/PROCEDURAL
Unprotected left main coronary intervention or equivalent
Three-vessel disease with complex, calcified lesions (high Syntax score or Type C lesions)
Retrograde chronic total occlusion

IABP – Results from the Benchmark Registry

16, 909 pts in 203 centers *(1996-6 to 2000-8)*

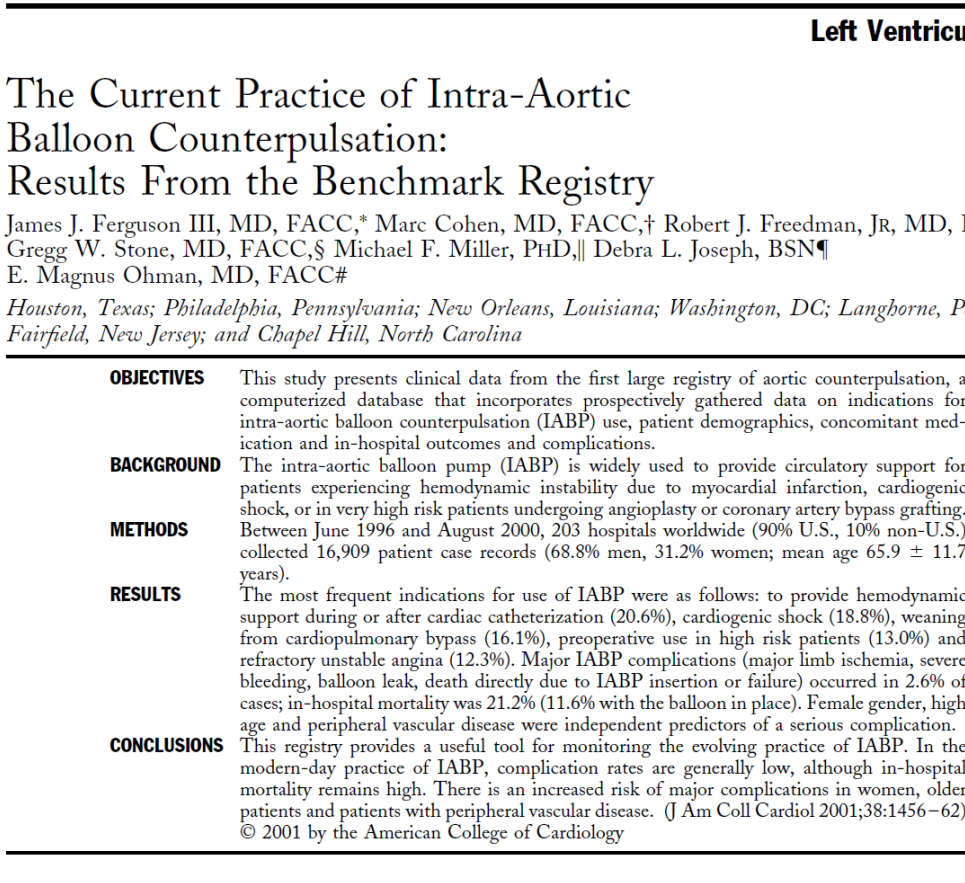
Indications:

- 20.6% high-risk cath/PCI
- 18.8% cardiogenic shock
- 16.1% weaning from CPB
- 13% preop CABG, high risk or unstable patients
- 12.3% refractory USA

Complications:

- 2.9% Limb ischemia
- 2.4% Access site bleeding
- 1% Balloon leak
- 0.05% Death attributable to IABP

Risk factors: PAOD, old age, female, small BSA



Left Ventricu

The Current Practice of Intra-Aortic Balloon Counterpulsation: Results From the Benchmark Registry

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OBJECTIVES This study presents clinical data from the first large registry of aortic counterpulsation, a computerized database that incorporates prospectively gathered data on indications for intra-aortic balloon counterpulsation (IABP) use, patient demographics, concomitant medication and in-hospital outcomes and complications.

BACKGROUND The intra-aortic balloon pump (IABP) is widely used to provide circulatory support for patients experiencing hemodynamic instability due to myocardial infarction, cardiogenic shock, or in very high risk patients undergoing angioplasty or coronary artery bypass grafting.

METHODS Between June 1996 and August 2000, 203 hospitals worldwide (90% U.S., 10% non-U.S.) collected 16,909 patient case records (68.8% men, 31.2% women; mean age 65.9 ± 11.7 years).

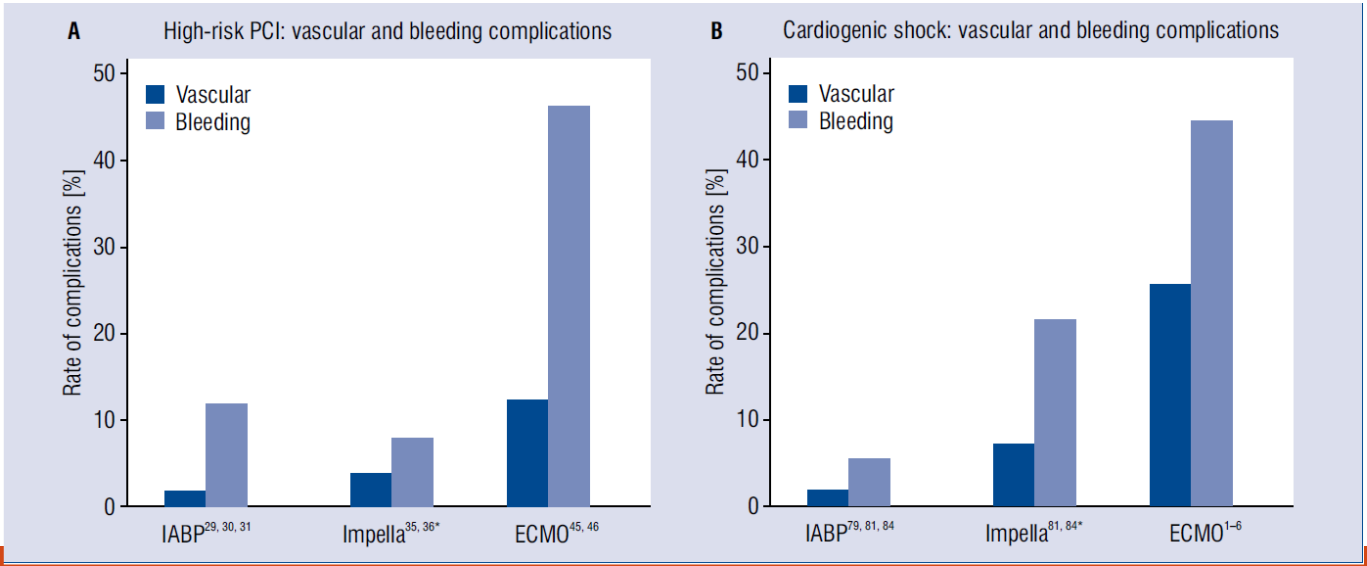
RESULTS The most frequent indications for use of IABP were as follows: to provide hemodynamic support during or after cardiac catheterization (20.6%), cardiogenic shock (18.8%), weaning from cardiopulmonary bypass (16.1%), preoperative use in high risk patients (13.0%) and refractory unstable angina (12.3%). Major IABP complications (major limb ischemia, severe bleeding, balloon leak, death directly due to IABP insertion or failure) occurred in 2.6% of cases; in-hospital mortality was 21.2% (11.6% with the balloon in place). Female gender, high age and peripheral vascular disease were independent predictors of a serious complication.

CONCLUSIONS This registry provides a useful tool for monitoring the evolving practice of IABP. In the modern-day practice of IABP, complication rates are generally low, although in-hospital mortality remains high. There is an increased risk of major complications in women, older patients and patients with peripheral vascular disease. (J Am Coll Cardiol 2001;38:1456–62)

Complications of different LV assist devices for high-risk PCI and cardiogenic shock

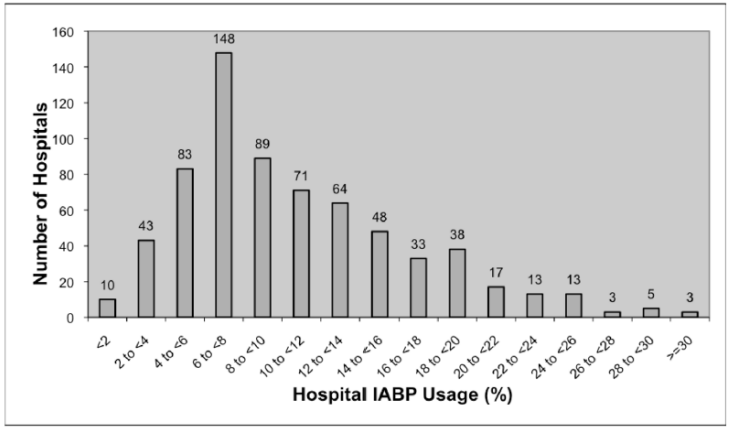
Table 1. IABP/Device-Related Complications in Recent Large Registry

Registry	Years	Number	All	Access Site Bleeding	Severe Bleed	Limb Ischemia*	Severe Limb Ischemia†	Infection	IABP Failure‡	Stroke	IABP-Related Death
Ferguson et al Benchmark registry[9]	1996–2000	16 909	7.0	2.4	0.8	2.9	0.9	NR	2.3	NR	0.05
Stone et al Benchmark registry[10]	1996–2001	5 495	8.1	4.3	1.4	2.3	0.5	0.1	2.3	0.1	0.05
Cohen et al Benchmark registry[11]	1996–2001	22 663	5.4	NR	0.9 (access site)	NR	0.9	NR	3.6	NR	0.05
Cohen et al Benchmark registry[12]	1997–2000	9 332	7.1	3.1	0.9	2.6	0.7	NR	NR	2.0	0.1
Urban et al Benchmark registry[13]	1997–2002	23 281	7.2	NR	0.9	NR	0.9	NR	1.2	NR	<0.1
Valente et al FLORENCE registry[14]	2004–2009	481	13.1	NR	6.9	3.1	NR	NR	NR	NR	NR



NCDR registry IABP data

- IABP were used in 18,990 (10.5%) 0f 181,599 high-risk PCI from 2005-01 to 2007-12
- Major indications: STEMI, Unprotected LM PCI, cardiogenic shock, LVEF < 30%



		Hospital IABP Usage			
		Quartile 1	Quartile 2	Quartile 3	Quartile 4
Overall	Unadjusted	Ref	1.17 (1.07–1.28)	1.26 (1.16–1.37)	1.36 (1.25–1.49)
	Adjustment: (1)	Ref	1.18 (1.08–1.28)	1.22 (1.12–1.33)	1.32 (1.21–1.44)
	Adjustment: (2)	Ref	1.10 (0.99–1.23)	1.04 (0.93–1.16)	1.07 (0.95–1.20)
	Adjustment: (3)	Ref	1.10 (0.98–1.23)	1.03 (0.92–1.15)	1.06 (0.94–1.19)
	Adjustment: (4)	Ref	1.11 (0.99–1.24)	1.03 (0.92–1.15)	1.06 (0.94–1.18)
Subgroups:					
STEMI	Adjustment: (4)	Ref	1.09 (0.96–1.23)	1.01 (0.90–1.14)	1.02 (0.90–1.15)
LVEF <30%	Adjustment: (4)	Ref	1.29 (1.09–1.54)	1.19 (1.00–1.42)	1.13 (0.94–1.35)
Unprotected Left Main	Adjustment: (4)	Ref	0.83 (0.53–1.32)	0.92 (0.59–1.42)	0.95 (0.60–1.50)
Cardiogenic Shock	Adjustment: (4)	Ref	1.19 (1.03–1.38)	0.99 (0.86–1.14)	1.06 (0.91–1.22)

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Intraaortic Balloon Support for Myocardial Infarction with Cardiogenic Shock

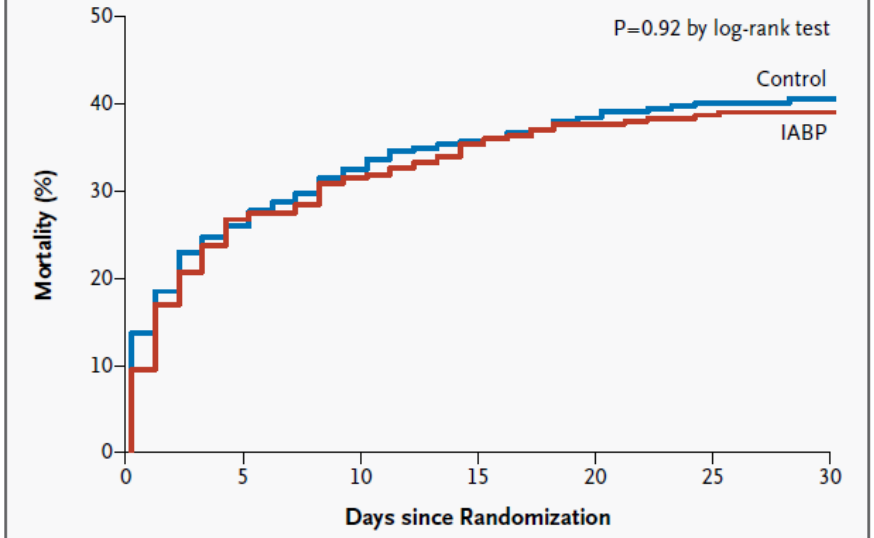


Figure 1. Time-to-Event Curves for the Primary End Point.
Time-to-event curves are shown through 30 days after randomization for the primary end point of all-cause mortality. Event rates represent Kaplan–Meier estimates.

Primary outcomes: death at 30 days

- IABP group (39.7%)
- Control group (41.3%)
- RR: 0.96, P = 0.69

No significant differences:

- Time to hemodynamic stabilization
- Length of stay in ICU
- Serum lactate levels
- Renal function

Crossover rate: 10%

86.6% IABP inserted after PCI

Elective versus provisional intra-aortic balloon pumping in high-risk percutaneous transluminal coronary angioplasty

Carlo Briguori, MD, PhD,[a] Cristiano Sarais, MD,[a] Paolo Pagnotta, MD,[a] Flavio Airoldi, MD,[a] Francesco Liistro, MD,[a] Fabio Sgura, MD,[a] Vassilis Spanos, MD,[a] Mauro Carlino, MD,[a] Matteo Montorfano, MD,[a] Carlo Di Mario, MD, PhD,[a,b] and Antonio Colombo, MD[a,b] *Milan, Italy*

- 133 patients with EF < 30% underwent PCI
- Elective IABP support (Group A, n=61) vs conventional PCI (Group B, n=72, ***11 (15%) requiring rescue IABP***)

	Group A (n = 61)	Group B (n = 72)	P
Intraprocedural events (%)			
Global	0	11 (15)	.001
VF/VT	0	1 (2.0)	.48
CPA	0	1 (2.0)	.48
Hypotension/shock	0	11 (15)	.001
Inhospital MACCEs (%)			
Global	3 (5)	7 (10)	.29
Death	1 (2)	3 (4)	.23
AMI	2 (3.2)	4 (5.5)	.30
CABG	0	0	1.0
Stroke	0	0	1.0
Vascular complications*	0	2 (3)	.25

- Prophylactic use of IABP support among high-risk PCI contributes to an uncomplicated and successful outcome

Role of Prophylactic Intra-Aortic Balloon Pump in High-Risk Patients Undergoing Percutaneous Coronary Intervention

Sundeep Mishra, MD, William W. Chu, MD, PhD, Rebecca Torguson, BS, Roswitha Wolfram, MD, Regina Deible, RN, William O. Suddath, MD, Augusto D. Pichard, MD, Lowell F. Satler, MD, Kenneth M. Kent, MD, PhD, and Ron Waksman, MD*

- 300 high risk pts, 69 had IABP inserted prophylactically
- 46 pts needed "rescue" IABP

Variable	P-IABP (n = 69)	R-IABP (n = 46)	p Value
In-hospital outcomes			
Death	0	10 (22%)	<0.01
Q-wave myocardial infarction	0	0	1.00
Non–Q-wave myocardial infarction	13 (20%)	26 (62%)	<0.01
Major complication	0	12 (26%)	<0.01
30-Day outcomes			
Death	2 (4%)	11 (27%)	<0.01
Q-wave myocardial infarction	0	3 (9%)	0.05
Death + Q-wave myocardial infarction	2 (4%)	13 (32%)	<0.01
Target lesion revascularization	0	0	—
Target vessel revascularization*	0	2 (6%)	0.13
Target lesion revascularization/major adverse cardiac events	2 (4%)	13 (32%)	<0.01
Stent thrombosis†	1 (1%)	0	1.00

- In patients who undergo high-risk PCI, prophylactic-IABP support have favorable outcomes compared with those who require rescue-IABP
- The criteria for prophylactic IABP may need further studies

Intra-aortic Balloon Counterpulsation and Infarct Size in Patients With Acute Anterior Myocardial Infarction Without Shock

The CRISP AMI Randomized Trial

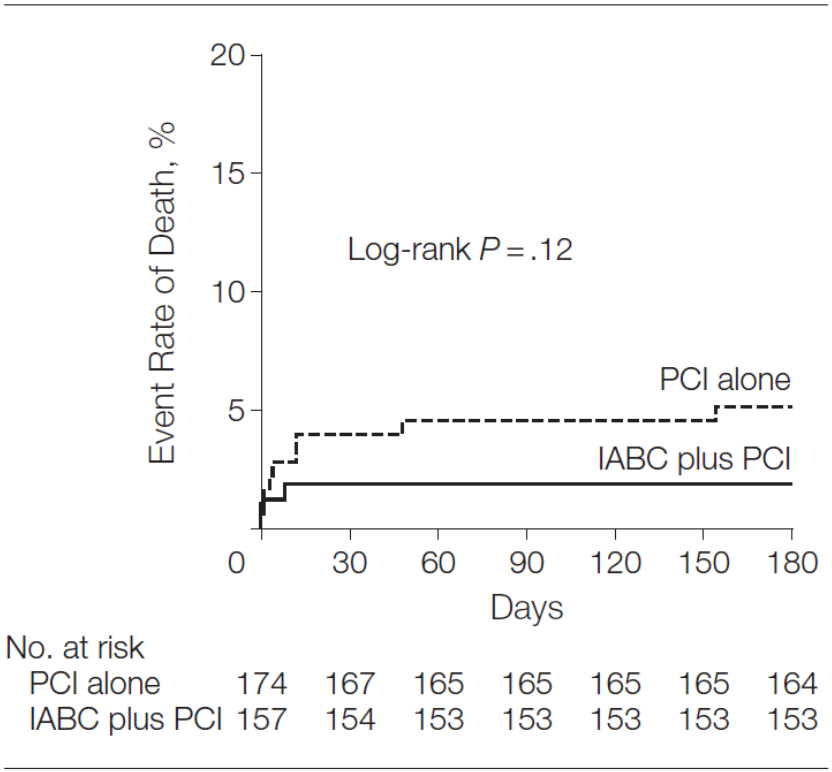
- IABP inserted prior to primary PCI and continued for at least 12 hours after PCI in patients with large anterior MI without cardiogenic shock
- IABP insertion delayed the D2B time (77 vs 68 min)

Table 3. Cardiac Magnetic Resonance Imaging (MRI) Findings

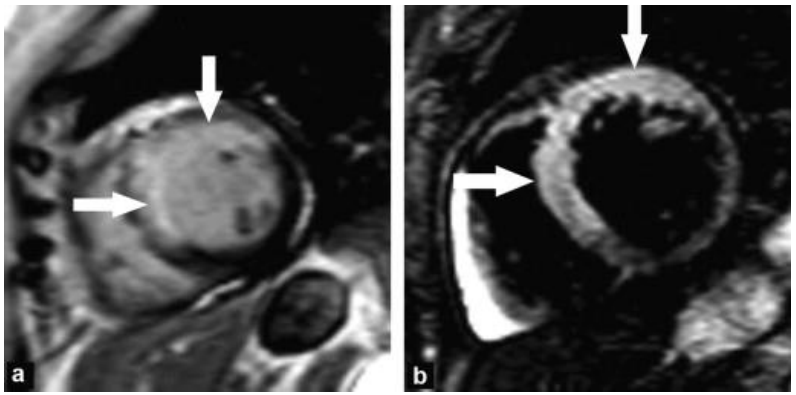
	Total (N = 337)	IABC Plus PCI (n = 161)	PCI Alone (n = 176)	*P* Value
Time from symptom onset to MRI, median (IQR), d	4.0 (3.0-5.0)	4.0 (3.0-5.0)	4.0 (3.0-4.0)	.20
Primary End Point				
Infarct size, % of left ventricular mass				
Per-protocol analysis, No. (%)	275 (81.6)	133 (82.6)	142 (80.7)	
Mean (95% CI)	39.8 (37.4-42.1)	42.1 (38.7-45.6)	37.5 (34.3-40.8)	.06
Median (IQR)	38.8 (26.0-52.2)	42.8 (27.2-54.7)	36.2 (25.9-49.4)	
Multiple imputation analysis				
Mean (95% CI)	39.7 (37.3-42.1)	42.1 (38.6-45.6)	37.6 (34.3-40.9)	.07
Median (IQR)	39.0 (26.0-52.3)	42.5 (27.1-55.9)	36.4 (24.9-49.9)	
Proximal left anterior descending and TIMI flow score of 0 or 1				
Per-protocol analysis, No. (%)	192 (57.0)	93 (57.8)	99 (56.3)	
Mean (95% CI)	44.4 (41.7-47.1)	46.7 (42.8-50.6)	42.3 (38.6-45.9)	.11
Median (IQR)	42.1 (30.3-54.7)	45.1 (32.7-60.8)	38.6 (29.6-51.6)	
Multiple imputation analysis				
Mean (95% CI)	44.4 (41.7-47.1)	46.8 (42.9-50.8)	42.1 (38.4-45.7)	.08
Median (IQR)	42.5 (30.3-55.9)	45.3 (32.3-61.6)	39.2 (29.5-51.9)	

Intra-aortic Balloon Counterpulsation and Infarct Size in Patients With Acute Anterior Myocardial Infarction Without Shock

The CRISP AMI Randomized Trial



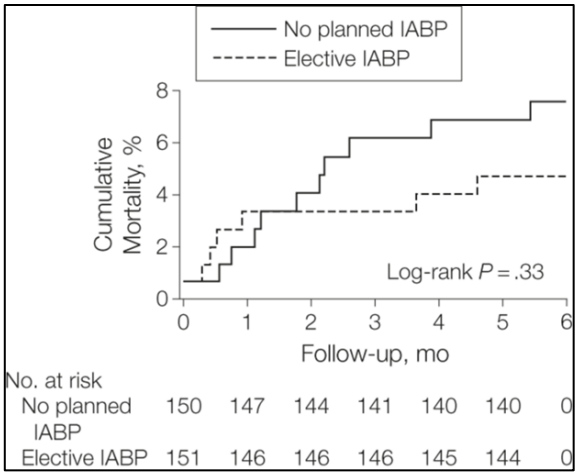
- Crossover rate: 8.5% (15 patients due to shock)
- IABP plus primary PCI compared with PCI alone did not result in reduced infarct size



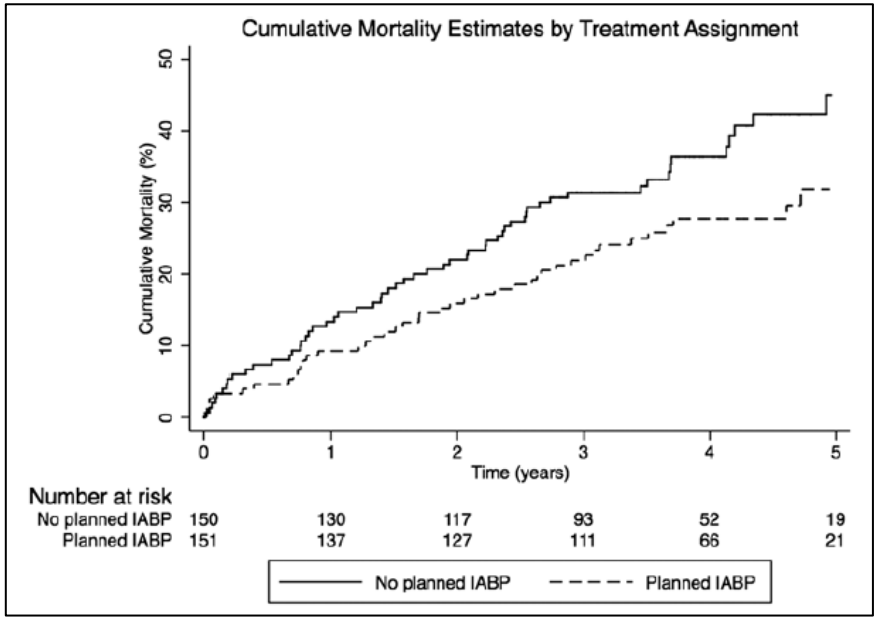
IABP for high-risk PCI (BCIS-1)

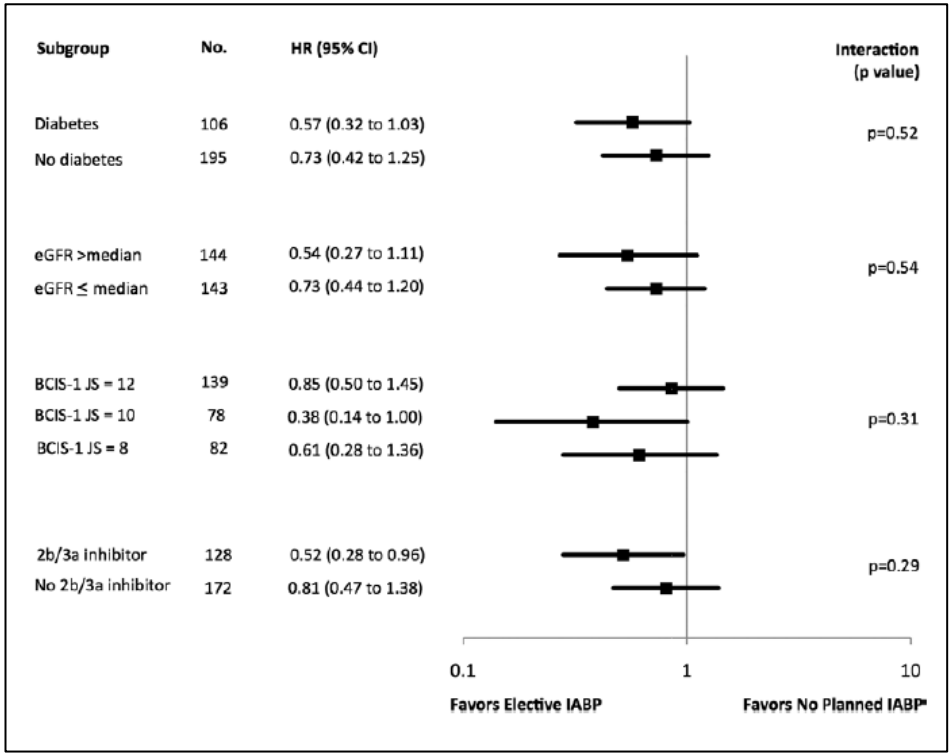
- Patients (n=301) with severe left ventricular dysfunction (EF<30%) and extensive coronary disease (Jeopardy Score 8/12)
- Primary endpoints: MACCE: death, AMI, CVA, or further revascularization at 28 days
- Rescue IABP in 18 patients (crossover rate 12%)

Variable	No. (%) Elective IABP (n = 151)	No. (%) No Planned IABP (n = 150)	OR (95% CI)[a]	*P* Value
Primary end point				
MACCE[b]	23 (15.2)	24 (16.0)	0.94 (0.51-1.76)	.85
MI	19 (12.6)	20 (13.3)	0.93 (0.48-1.83)	.85
Death	3 (2.0)	1 (0.7)	3.02 (0.31-29.37)	.34
CVA	2 (1.3)	0		
Further revascularization	1 (0.7)	4 (2.7)	0.24 (0.03-2.20)	.21
Secondary end points				
6-mo mortality	7 (4.6)	11 (7.4)[c]	0.61 (0.24-1.62)	.32
Bleeding				
All	29 (19.2)	17 (11.3)	1.86 (0.93-3.79)	.06
Major	5 (3.3)	6 (4.0)	0.83 (0.20-3.36)	.77
Minor	24 (15.9)	11 (7.3)	2.39 (1.07-5.61)	.02
Procedural complications	2 (1.3)	16 (10.7)	0.11 (0.01-0.49)	<.001
Access-site complications	5 (3.3)	0		.06[d]



IABP for high-risk PCI
Long-term mortality data from BCIS-1





P = 0.039

Circulation 2013;127:207-212

Guideline recommendations for IABP

PVAD	Clinical setting	Guidelines	Recommendation class	Level of evidence	Recommendation
MECHANICAL SUPPORT	ST-segment elevation myocardial infarction	STEMI ESC 2017			Mechanical circulatory support may be considered as a rescue therapy in order to stabilize the patients and preserve organ perfusion (oxygenation) as a bridge to recovery of myocardial function, cardiac transplantation, or even left ventricle assist device destination therapy on an individual basis
	High-risk patients*	PCI ACCF/ /AHA/SCAI 2011	IIb	C	Elective insertion of an appropriate hemodynamic support device as an adjunct to PCI may be reasonable in carefully selected high-risk patients

PVAD	Clinical setting	Guidelines	Recommenda-tion class	Level of evidence	Recommendation
IABP	Post MI CS	STEMI ACC/AHA 2013	IIa	B	Patients who do not quickly stabilize with pharmacological therapy
	Post MI CS	HF ESC 2016 STEMI ESC 2017 SCA NSTE ESC 2015	IIa	C	CS due to mechanical complications of MI
	CS	HF ESC 2016 STEMI ESC 2017 SCA NSTE ESC 2015	III	B	Routine use of IABP is not recommended

Take home message

- IABP is inexpensive, safe, easy to use, and readily available in catheterization laboratories
- IABP may be a first-line mechanical support device and are useful in stabilizing patients during the CHIP PCI procedure and post-MI cardiogenic shock
- Prophylactic use of an IABP in CHIP PCI patients may be superior to a “rescue” strategy, although routine use is no more recommended. More studies may be needed especially for the patient selection for prophylactic IABP usage