CLINICAL SCENARIOS FOR MECHANICAL CIRCULATORY SUPPORT (MCS)

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I THE INTERMACS AND SCAI SHOCK CLASSIFICATIONS (THE TRIAGE GOLD STANDARDS)

- **The INTERMACS 7-Profile Classification (For Advanced NYHA Class IIIb–IV Heart Failure):** Stratifies advanced heart failure urgency and guides the selection between **Temporary (Short-Term) MCS** versus **Durable (Long-Term) Left Ventricular Assist Devices (LVAD)**:

INTERMACS Profile	Clinical Shorthand ("Catchphrase")	Hemodynamic & Clinical Definition	Recommended MCS / Timeline
Profile 1	**"Critical Cardiogenic Shock (Crash and Burn)"**	Life-threatening hypotension despite rapidly escalating inotropes/vasopressors and critical organ hypoperfusion (worsening acidosis/lactate, anuria; corresponds to **SCAI Stage D/E**)	**Immediate Temporary MCS** (**Impella, VA-ECMO, or ECPELLA**) within **minutes to hours** (do not implant durable LVAD directly in Profile 1 due to high mortality)
Profile 2	**"Progressive Decline (Sliding on Inotropes)"**	Dependent on continuous IV inotropes with **deteriorating renal function, hepatic congestion, nutrition, or volume status**	**Definitive intervention (Durable LVAD or Urgent Transplant) within a few days**
Profile 3	**"Stable but Inotrope-Dependent"**	Hemodynamically stable on mild-to-moderate IV inotropes (in hospital or home), but **repeated weaning attempts fail** due to hypotension, symptoms, or rising creatinine	**Elective Durable LVAD (HeartMate 3)** or Transplant within **a few weeks** (**Ideal Durable LVAD Window**)
Profile 4	**"Resting Symptoms at Home on Oral Therapy"**	Ambulatory on oral therapy but experiences daily resting/minimal-exertion congestion and **"frequent-flier" ER/hospital readmissions**	Evaluate for **Durable LVAD or Transplant within weeks to a few months**
Profile 5	**"Exertion Intolerant (Housebound)"**	Comfortable at rest, unable to engage in any activity, living predominantly within the house/bed-to-chair	Optimize GDMT/CRT; serial CPET and transplant/LVAD evaluation
Profile 6	**"Exertion Limited (Walking Wounded)"**	Minor-exertion fatigue within a few blocks, able to leave the house briefly	Medical optimization (Durable LVAD generally not indicated)
Profile 7	**"Advanced NYHA Class III"**	Clinically stable with reasonable activity level, history of recent decompensation	Medical management

II SCENARIO 1: ACUTE CARDIOGENIC SHOCK — "BRIDGE TO RECOVERY" OR "BRIDGE TO DECISION"

- **Clinical Settings: AMI-Related Cardiogenic Shock (AMI-CS)**, **Fulminant Myocarditis** (lymphocytic or giant cell), **Peripartum Cardiomyopathy**, **Takotsubo Syndrome**, or **Post-Cardiotomy Shock**.
- **Guideline Stance and Landmark Trial Shifts (ESC 2021/2023 HF & ACC/AHA 2022):**
  - **Downgrading of Routine IABP in AMI-CS (Class III — No Benefit):** Based on the **IABP-SHOCK II Trial** (*NEJM* 2012; n = 600), routine **Intra-Aortic Balloon Pump (IABP)** placement in AMI-CS **does not reduce 30-day, 1-year, or 6-year mortality**; in contemporary ESC guidelines, **IABP is reserved specifically for mechanical complications of AMI (Class IIa for acute mitral regurgitation or ventricular septal rupture)** or non-ischemic ADHF bridge.
  - **Microaxial Flow Pump (Impella CP) Survival Breakthrough — The DanGer Shock Trial (*NEJM* 2024):** Randomized 355 patients with **STEMI complicated by Cardiogenic Shock (SCAI Stage C/D/E, arterial lactate >=2.5 mmol/L, LVEF <45%, excluding comatose post-arrest patients)** to **Impella CP + Standard Care versus Standard Care Alone**. **Impella CP significantly reduced 180-day all-cause mortality from 58.5 percent to 45.8 percent (Absolute Risk Reduction 12.7%; HR 0.74; p = 0.04; NNT = 8)**—providing the **first randomized trial proof in 25 years (since the 1999 SHOCK Trial) that an active temporary MCS device reduces mortality in AMI-CS** (despite higher rates of limb ischemia and renal replacement therapy).
  - **Routine Early VA-ECMO in AMI-CS — The ECLS-SHOCK Trial (*NEJM* 2023):** Randomized 420 patients with AMI-CS (78% of whom had resuscitated cardiac arrest) to **early routine VA-ECMO versus medical therapy alone**; **routine VA-ECMO did NOT reduce 30-day mortality (47.8% vs. 49.0%; p = 0.81)** and doubled major bleeding and peripheral vascular complications. Consequently, **VA-ECMO** is reserved for **refractory biventricular arrest (ECPR), severe hypoxemic respiratory failure, or INTERMACS 1 crash-and-burn as a "Bridge to Decision"** (often requiring **LV venting via Impella ["ECPELLA"] or IABP** because retrograde aortic ECMO flow increases LV afterload and causes pulmonary edema/aortic root thrombosis).

III SCENARIO 2: HIGH-RISK PERCUTANEOUS CORONARY INTERVENTION ("PROTECTED PCI")

- **Clinical Setting:** Complex multivessel, unprotected Left Main, or last-remaining-vessel PCI (often requiring rotational atherectomy/IVL) in patients with **severe LV systolic dysfunction (LVEF <=30 to 35%)** who are turned down for CABG.
- **Evidence (BCIS-1 and PROTECT II Trials):** In **PROTECT II** (*Circulation* 2012), prophylactic **Impella 2.5** (providing 2.5 L/min active forward flow and direct LV unloading) vs. **IABP** in complex PCI with LVEF <=35% showed similar 30-day intent-to-treat MACE, but **significantly lower 90-day MACE in the per-protocol analysis (40.0% vs. 51.0%; p = 0.023)** by preventing intraprocedural hemodynamic collapse during prolonged balloon/atherectomy runs (ongoing **PROTECT IV** RCT is testing Impella CP/5.5 in CHIP).

IV SCENARIOS 3, 4 & 5: DURABLE LEFT VENTRICULAR ASSIST DEVICES (LVAD — HEARTMATE 3)

- **Abandonment of Historical "BTT vs. DT" Silos (MOMENTUM 3 Trial Paradigm):** While durable LVADs are implanted clinically as **Bridge to Transplant (BTT)** (for listed candidates deteriorating at INTERMACS 2–3), **Bridge to Candidacy (BTC)** (to reverse **"fixed" secondary pulmonary hypertension [PVR >5 WU]** or cardiorenal dysfunction so the patient can become transplant-eligible), or **Destination Therapy (DT)** (lifelong support in transplant-ineligible patients aged >70 years or with recent malignancy/obesity), the **MOMENTUM 3 Trial proved that clinical outcomes are identical across BTT, BTC, and DT categories**.
- **Eligibility Criteria for Durable LVAD (ESC 2021 / AHA-ACC 2022 Class I for Inotrope-Dependent; Class IIa for Ambulatory Advanced HF):** Persistent **NYHA Class IV** symptoms for >=60–90 days despite optimal GDMT/CRT, **LVEF <25%**, **Peak VO2 <12 mL/kg/min**, and at least one of: **inotrope/temporary MCS dependency (INTERMACS 2–3)**, **>=3 HF hospitalizations in 12 months**, or **progressive end-organ renal/hepatic dysfunction**—in the **absence of severe irreversible Right Ventricular Failure**.
- **Landmark Trial — MOMENTUM 3 (*NEJM* 2019 & 5-Year Extended Results, Mehra et al., *JAMA* 2022):**
- **Design:** Randomized 1,028 advanced HFrEF patients to the **HeartMate 3** (**fully magnetically levitated [Full MagLev] centrifugal-flow pump** with wide blood-flow gaps, frictionless rotor, and intrinsic artificial pulse every 2 seconds) versus the **HeartMate II** (mechanical-bearing axial-flow pump).
- **Results:** HeartMate 3 significantly improved the **2-year primary composite endpoint** (survival free of disabling stroke or reoperation to replace/remove a malfunctioning pump: **76.9% vs. 64.8%** in the final report), **virtually eliminated pump thrombosis (1.4% vs. 13.9%)**, halved stroke rates, and achieved a **5-year overall survival of 58.4 percent** (approaching the survival of marginal heart transplant recipients).
- **ARIES-HM3 Trial (*JAMA* 2023 — Aspirin-Free Antithrombotic Regimen):** Demonstrated that in patients with a **HeartMate 3 LVAD**, **eliminating Aspirin and treating with Warfarin (INR 2.0–3.0) alone** was non-inferior for thromboembolism (zero pump thrombosis) while **reducing non-surgical major bleeding (primarily GI bleeding from acquired von Willebrand syndrome and arteriovenous malformations) by 34 percent**.

MCS Device	Cannulation & Pump Mechanism	Max Flow (L/min)	Direct LV Unloading (Reduces LVEDP & MVO2)?	Primary Clinical Role
IABP	Femoral/axillary descending aorta; counterpulsation	**0.5 L/min**	Mild (reduces afterload)	**Mechanical AMI complications (acute MR/VSD — Class IIa)**; neutral in routine AMI-CS (**IABP-SHOCK II**)
Impella CP / 5.5	Retrograde transaortic (**LV to Ascending Aorta**); microaxial pump	**3.5–4.3 L/min (CP)**; **5.5–6.0 L/min (5.5)**	**Profound Direct LV Unloading**	**AMI-CS (DanGer Shock: 12.7% mortality ARR)**, Protected PCI (**PROTECT II**), or ECPELLA LV vent
TandemHeart	Transseptal (**Left Atrium to Iliofemoral Artery**); centrifugal	**4.0–5.0 L/min**	Indirect (unloads LA; usable with LV thrombus or mechanical aortic valve)	Severe LV shock when LV thrombus or mechanical AVR precludes Impella
VA-ECMO	**Right Atrium/Femoral Vein to Femoral Artery** + oxygenator	**4.0–7.0 L/min**	**NO (Increases LV Afterload** -> requires Impella/IABP vent)	**Biventricular crash-and-burn (INTERMACS 1), ECPR arrest, or RV failure with hypoxia**
HeartMate 3 LVAD	Surgical **LV Apex to Ascending Aorta**; Full MagLev centrifugal	**Up to 10 L/min**	**Complete Durable LV Unloading**	**BTT, BTC, & Destination Therapy** in INTERMACS 2–4 (**MOMENTUM 3 & ARIES-HM3**)

V PRACTICAL CONSIDERATIONS IN THE INDIAN CLINICAL CONTEXT

- **Resource-Stratified Temporary MCS Selection:** Because percutaneous **Impella** catheters and durable **HeartMate 3 LVADs** carry prohibitive out-of-pocket costs in India, **IABP + Inotropes** (in pre-shock / SCAI Stage B–C or acute mechanical complications) and **peripheral VA-ECMO** (managed by in-house cardiac surgery perfusion teams at a fraction of the disposable catheter cost of Impella) serve as the primary workhorses for acute **Bridge-to-Recovery** (e.g., fulminant viral/dengue myocarditis, aluminum phosphide poisoning, or post-cardiotomy shock) and **Bridge-to-Transplant**.

KEY REFERENCES

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