PERCUTANEOUS AXIAL PUMPS (LV IMPELLA)

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PRINCIPLE:
A percutaneous axial flow pump that uses an impeller to move blood from the LV to the proximal aorta. This augments aortic and coronary pressures.
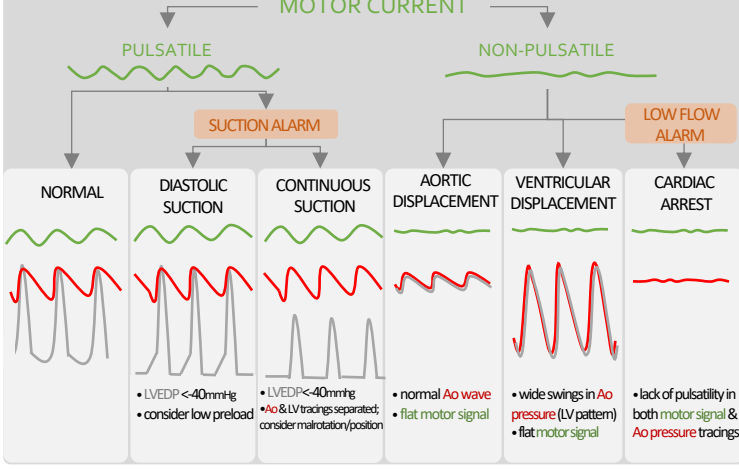- Forward flow depends on the model used (2.5, CP, LD, and 5.5) and the **Program Setting**. A **purge fluid** is added to avoid RBCs being drawn into the motor housing.
- An Impella can provide more hemodynamic support than IABP. It can either be used for support during high-risk PCI or for hemodynamic support in ICU patients with cardiogenic shock. It can also be a vent in peripheral VA ECMO

PHYSIOLOGY:
Physiologically, an Impella functions as a temporary percutaneous LVAD (see LVAD OnePager), that continuously unloads the LV. This both reduces the native CO (reducing cardiac work & myocardial O2 consumption) and provides additional CO via the pump. This provides higher CO with lower cardiac work. Impella is preload dependent & afterload sensitive. Unlike IABP, Impella does not require EKG/pressure triggering so it is more tolerant of arrythmias.

PLACEMENT:
Proper placement is essential. The device is typically placed under Fluoroscopic guidance ± TEE. POCUS/TTE are often used to verify placement. CXR can provide some info but does not show rotational malposition. Because the pump can become malpositioned, understanding & interpreting placement signals is necessary:

MOTOR CURRENT

PULSATILE — SUCTION ALARM
NON-PULSATILE — LOW FLOW ALARM

NORMAL	DIASTOLIC SUCTION	CONTINUOUS SUCTION	AORTIC DISPLACEMENT	VENTRICULAR DISPLACEMENT	CARDIAC ARREST
	• LVEDP <-40mmHg • consider low preload	• LVEDP<-40mmhg • Ao & LV tracings separated; consider malrotation/position	• normal Ao wave • flat motor signal	• wide swings in Ao pressure (LV pattern) • flat motor signal	• lack of pulsatility in both motor signal & Ao pressure tracings

COMPLICATIONS:
Bleeding (33%) frequent complication at insertion site. More common if heparin used as purge solution (there is also a risk of HIT); consider using bicarbonate or dextrose.
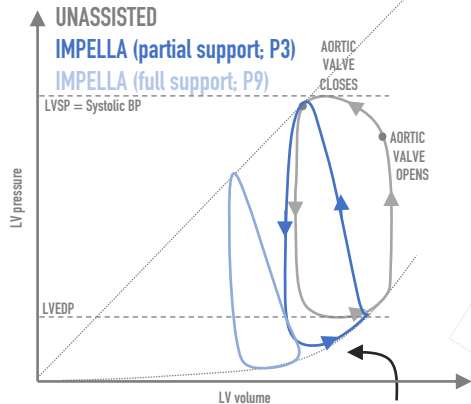**Hemolysis** (8%) may occur due to malpositioning or insufficient purge flow. Plasma free hemoglobin >40 mg/dL is most specific test. Reposition & ensure sufficient preload Severe cases can be treated with plasmapheresis or other therapies.
Limb ischemia – Obstruction of the femoral artery due to cannula without a re-prefusion canula (like ECMO); use NIR sensors on extremities to hasten diagnosis.
Suction events – inadequate LV filling or misplacement can cause suction to collapse the LV. This limits flow and can be arrhythmogenic; assess placement.
Cardiac Arrest – change to P2 (recommended) however can use higher program if confident about placement (see Cardiac Arrest on MCS OnePager)

UNASSISTED
IMPELLA (partial support; P3)
IMPELLA (full support; P9)
LVSP = Systolic BP
AORTIC VALVE CLOSES
AORTIC VALVE OPENS
LVEDP
LV pressure
LV volume

By continuously unloading the LV, an Impella reduces cardiac work. The degree of ventricular offloading depends on the level of support.

CONTRA-INDICATIONS:
- Severe AS/AI (unable to pass catheter)
- LV thrombus
- Prosthetic Ao valve
- Severe vascular disease (unable to place catheter)

PURGE SOLUTION
A continuous infusion prevents blood from entering the pump motor housing. Dextrose solutions may contain Heparin or bicarbonate as additives. The goal is to achieve sufficient **Purge Pressure** to prevent RBCs entry. Can adjust the **purge fluid** and **purge flow rate** to achieve this.
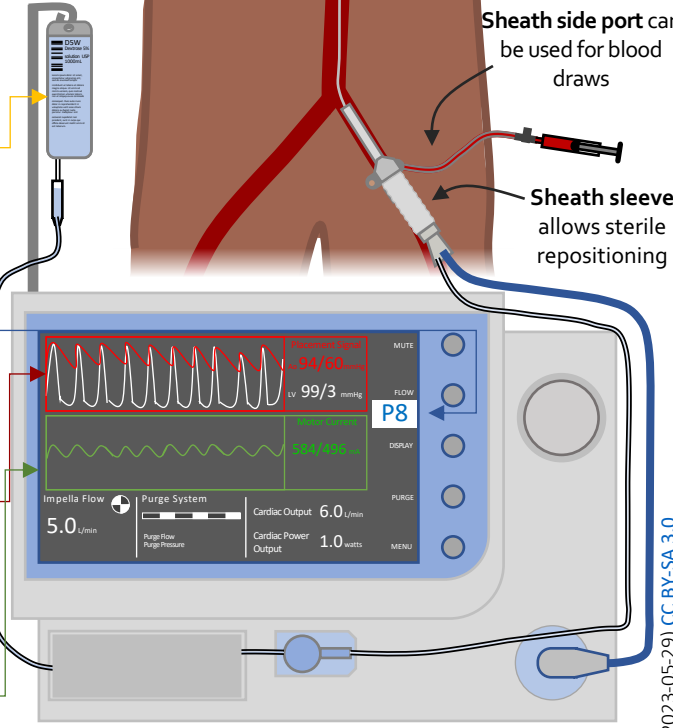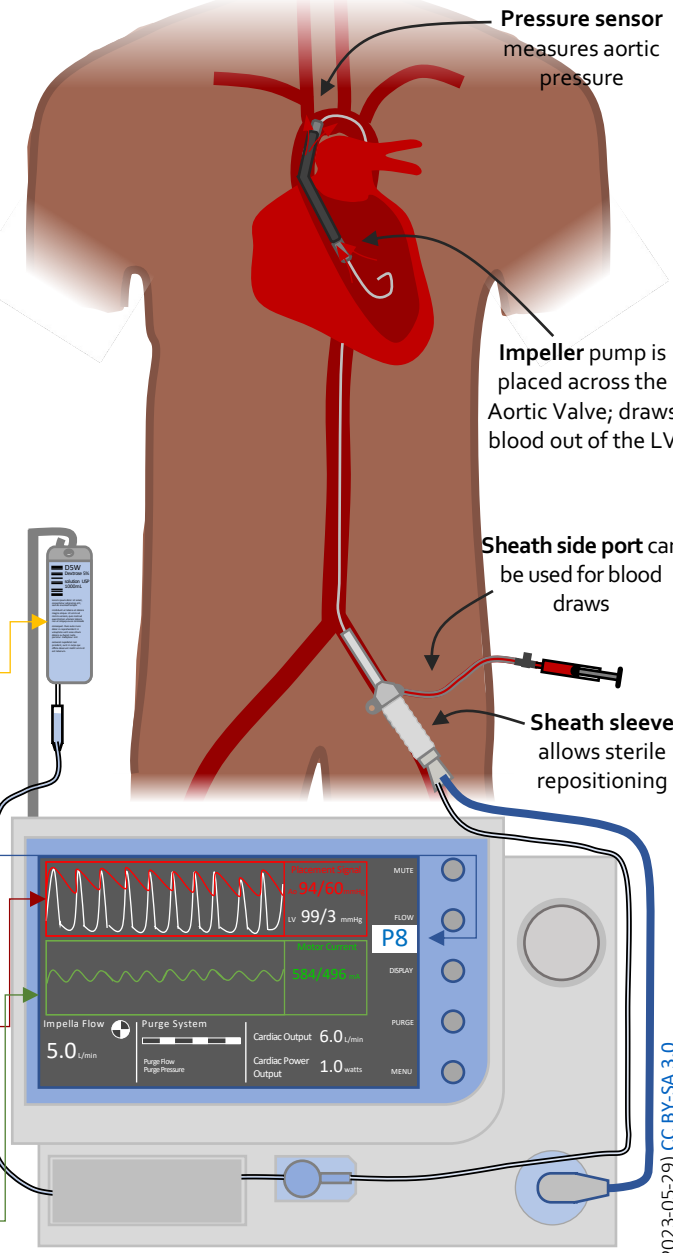
PROGRAM
Program level determines how fast the impeller rotates (RPMs), which is proportional to flow. Higher "**P level**" corresponds to greater hemodynamic support.

PLACEMENT SIGNALS
There are two pressure waveforms used as **placement signals**. The **Ao pressure** is optically transduced at the outflow (Ao) positions, the **inlet pressure** (LV) is not measured but is calculated using the motor current and Ao pressures.

MOTOR CURRENT
Motor current is proportional to pump torque and should increase with greater support (e.g. higher P-level). In patients with any native ventricular function, the **motor current** varies during the cardiac cycle.

Pressure sensor measures aortic pressure

Impeller pump is placed across the Aortic Valve; draws blood out of the LV

Sheath side port can be used for blood draws

Sheath sleeve allows sterile repositioning

Calculate Cardiac Output *estimates* the combined native and pump CO