Right Heart Failure and Pulmonary Hypertension

RV physiology, recognition, PH groups, ICU causes, drugs, intubation risk and mechanical support

WHY THE RIGHT VENTRICLE FAILS

- Afterload-sensitive: RV stroke volume falls sharply as mean PA pressure rises from 10 to 30 mm Hg (Ventetuolo 2014).
- Interdependence: a dilated RV pushes the septum left (D-shaped LV) and underfills the LV.
- Perfusion: the RV is perfused in systole and diastole; as RV pressure nears aortic, systolic flow stops and hypotension starts an ischemic spiral.

RECOGNIZING RV FAILURE

Echo cut-offs ASE 2025; CVP:PAWP 0.63 in Kormos 2010 (LVAD). Septum flat in systole: pressure overload; diastole only: volume overload.

CLUE	RV FAILURE LOOKS LIKE
Pressures	CVP near or above PAWP (ratio over about 0.6)
Trend	CVP rising while CI, SvO_2 and urine output fall
PA pressure	May fall as the RV fails: not improvement
Bedside	Hypotension, JVD, clear lungs, TR murmur, edema
Organs	Rising lactate, creatinine and bilirubin
Echo size	RV/LV over 1, basal RV 41 mm or more, flat septum
Echo function	TAPSE ≤17 mm, S′ ≤9.5 cm/s, FAC ≤35%
McConnell sign	Mid free wall akinetic, apex spared: PE (also RV infarct)

PULMONARY HYPERTENSION (ESC/ERS 2022)

Kept by the 7th World Symposium (2024). 1 WU = 80 dyn·s/cm^5.

TYPE	RIGHT-HEART CATHETER
PH	Mean PA pressure over 20 mm Hg (was 25 or more)
Pre-capillary	PAWP 15 or less and PVR over 2 Wood units
Isolated post-capillary	PAWP over 15, PVR 2 WU or less
Combined	PAWP over 15 and PVR over 2 WU

GROUP	EXAMPLES	ICU POINT
1 PAH	Idiopathic, methamphetamine, scleroderma, HIV, portal HTN	Keep home PAH drugs; PH team adjusts
2 Left heart	HFrEF, HFpEF, valve disease; most common	Treat the LV; no PAH drugs
3 Lung or hypoxia	COPD, ILD, sleep apnea, hypoventilation	Oxygen; treat the lung
4 PA obstruction	Chronic thromboembolic PH	Lifelong anticoagulation
5 Multifactorial	Sickle cell, sarcoidosis, dialysis	Treat the driver

ICU CAUSES AND THE SPECIFIC FIX

ARDS risk thresholds: Mekontso Dessap 2016.

CAUSE	KEY ACTION
Acute PE	Anticoagulate; reperfuse if hypotension persists (AHA/ACC 2026)
ARDS, high PEEP	Driving pressure under 18, $PaCO_2$ under 48, prone
RV infarct	Fluid if CVP low; no nitrates; keep AV synchrony
After LVAD	Inotrope, iNO, no high pump speed; early RVAD
Cardiac surgery	Inotrope, inhaled NO; exclude tamponade
Sepsis	Stop fluid once CVP is high and the RV dilated
Decompensated PAH	Treat the trigger: infection, AF, missed drug

MANAGEMENT PRIORITIES

1. Treat the cause.
2. Preload: most decompensated patients are overloaded: IV loop diuretic; CRRT if refractory. Fluid only for a low CVP, 500 mL or less (ESC 2019 PE).
3. PVR: SpO_2 over 90–92% (WSPH 2024; Ventetuolo 2014), normal $PaCO_2$ and pH, normothermia, lowest PEEP that keeps lungs open.
4. Pressure: norepinephrine, then vasopressin; MAP 65 or more (WSPH 2024: 70–75), aortic above PA pressure.
5. Contractility: dobutamine or milrinone, usually with a pressor.
6. Rhythm: restore sinus rhythm fast; pace heart block; no β-blockers or CCBs.
7. Support: Impella RP Flex, ProtekDuo or RVAD before organs fail; VA-ECMO bypasses the lungs (preferred in severe pre-capillary PH, WSPH 2024).

Inhaled agents are off-label in adults; wean in steps over hours (abrupt stop: rebound PH).

DRUG	TYPICAL ADULT DOSE	NOTE
Norepinephrine	Start 2–12 mcg/min, titrate	First pressor; restores RV perfusion
Vasopressin	0.03 units/min, fixed	Raises SVR more than PVR
Dobutamine	2.5–5 mcg/kg/min	WSPH 2024: not above 5–7.5 in PH
Milrinone	0.125–0.375 mcg/kg/min, no load	Lowers PVR and SVR; renal dosing
Inhaled NO	20 ppm typical	MetHb at 4–8 h; NO_2; edema if LV fails
Inhaled epoprostenol	10–50 ng/kg/min (ideal weight)	Continuous nebulizer; cheaper than NO
Phenylephrine	Avoid alone	Raises PVR

INTUBATION AND HOME PROSTACYCLIN

- Intubation can arrest a failing RV: induction drops SVR, positive pressure raises PVR and cuts venous return, apnea adds hypoxemia and CO_2.
- Avoid if possible: HFNC or NIV; awake VA-ECMO in some PH centers.
- If needed: arterial line, norepinephrine running, push-dose pressor and inhaled vasodilator ready, best operator.
- Etomidate or reduced-dose ketamine; avoid propofol boluses; keep apnea short.
- After: tidal volume about 6 mL/kg, plateau under 30, modest PEEP (ESC 2019 PE).

SAFETY Never interrupt chronic IV epoprostenol (half-life 6 minutes or less) or treprostinil (about 4 h; labels): no stopping, flushing, bolusing, blood draws or other drugs in the line. If it fails, restart through a peripheral IV within minutes and call the PH team; rebound PH can kill.

Sources (25) are listed with links at icubasics.com/sheets/rv-failure-ph.html. For education and exam preparation only. Not medical advice; follow current guidelines and your institution's protocols. ICU Basics is an independent study aid not affiliated with any certifying body.