ICR-PE-019

Pulmonary · critical care

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CRITICAL CARE ORDER SET

Pulmonary Embolism

ICU management of acute PE. Risk-stratify by hemodynamics and RV strain, anticoagulate immediately unless contraindicated, and reserve systemic thrombolysis for massive PE with shock. Support the failing RV cautiously — avoid over-resuscitation — engage the PERT early, and keep reversal and bleeding orders one click away. Adapt every dose to your institutional protocol and the patient in front of you.

PATIENT	MRN	WEIGHT (KG) / CRCL	RISK CLASS
ALLERGIES	**BLEEDING RISK / LAST PROCEDURE**	**ORDERING CLINICIAN**	**CODE STATUS**

01 Admission & level of care

- [ ] Admit to: **ICU / Medical ICU** · Condition: **Critical**
- [ ] Diagnosis: acute PE — specify **submassive vs massive**, provoked vs unprovoked, ± DVT

MONITORING

- [ ] Continuous cardiac monitoring & pulse oximetry
- [ ] Noninvasive BP **q15 min × 1 h**, then **q1 h** (or arterial line if indicated)
- [ ] Neuro checks **q1–2 h** if thrombolysis given or considered
- [ ] Strict intake/output; Foley catheter if hemodynamically unstable or oliguric

02 Vital parameters & nursing

TARGETS **SpO_2 ≥ 92%** (individualize in chronic CO_2 retainers) · **MAP ≥ 65 mmHg** (or per baseline)

- [ ] Head of bed ≥ `30°`
- [ ] Daily weight
- [ ] Activity: bed rest initially; reassess daily for mobilization

03 Oxygen / ventilatory support

Tiered — order by presentation.

Supplemental oxygen

- [ ] Nasal cannula `2–6 L/min`, titrate to SpO_2 ≥ 92%
- [ ] If persistent hypoxemia: simple mask `6–10 L/min` or nonrebreather `10–15 L/min`

High-flow nasal cannula (HFNC)

- [ ] Start `40–60 L/min`, FiO_2 `0.6–1.0`; titrate to SpO_2 ≥ 92% & RR < 30

Noninvasive ventilation — concomitant COPD/CHF, not shocked

- [ ] BiPAP / CPAP per RT protocol

Intubation / invasive ventilation — impending failure

CAUTION Intubation can precipitate RV collapse — optimize first, have **vasopressors ready**, avoid hypotension & high mean airway pressures.

- [ ] Lung-protective if ARDS physiology: TV `6 mL/kg IBW` (4–8), PEEP per ARDSnet, plateau `< 30 cm H₂O`

04 Hemodynamic support

FLUIDS — CAUTIOUS

- [ ] Balanced crystalloid (LR / Plasma-Lyte) **`250–500 mL IV over 15–30 min`** PRN MAP < 65 and no overt RV volume overload

> **RV PITFALL** Reassess clinically and by bedside echo / IVC; **avoid large-volume resuscitation** — over-filling worsens RV failure.

VASOPRESSORS & INOTROPES

1 Norepinephrine · first-line

- [ ] Start **`0.05–0.1 mcg/kg/min`** IV; titrate by 0.02–0.05 mcg/kg/min q5–10 min to MAP ≥ 65 (range up to ~1 mcg/kg/min)

2 Vasopressin · adjunct

- [ ] **`0.03 units/min`** IV fixed dose if norepinephrine > 0.2–0.3 mcg/kg/min and MAP still < target

3 Dobutamine · RV failure with low cardiac output despite adequate MAP

- [ ] Start **`2.5–5 mcg/kg/min`**, titrate to **`20 mcg/kg/min`** to hemodynamics; often needs concurrent vasopressor (avoid hypotension)

05 Anticoagulation — core therapy

> **CHOOSE** By hemodynamic status, renal function, weight, bleeding risk, and procedural plans. In ICU PE, **IV unfractionated heparin** is used most often.

A Unfractionated heparin (UFH) IV

- [ ] Bolus **`80 units/kg IV`** (max 10,000 units) — omit / reduce in high bleeding risk or just post-thrombolysis
- [ ] Infusion **`18 units/kg/h IV`** continuous; adjust per institutional heparin nomogram

MONITORING

- [ ] aPTT target `1.5–2.5 × control`, or anti-Xa `0.3–0.7 IU/mL` — at 6 h, after each change, then ≥ daily once stable

B **LMWH — enoxaparin** · stable, good renal function, no urgent procedures

- [ ] Standard `1 mg/kg SC q12h` · renal (CrCl < 30): `1 mg/kg SC q24h`
- [ ] CBC / platelets daily; anti-Xa 4 h post-3rd dose in weight extremes, pregnancy, renal dysfunction (goal 0.6–1.0 IU/mL for q12h)

C **DOACs** · defer until stable, procedures cleared, leaving ICU

- [ ] **Apixaban** `10 mg PO BID × 7 days`, then `5 mg PO BID`
- [ ] **Rivaroxaban** `15 mg PO BID × 21 days`, then `20 mg PO daily` with food

06 Systemic thrombolysis

INDICATION **Massive PE with shock**; consider in select submassive with RV strain. Only if no major contraindications (Section 13) and per institutional protocol.

ALTEPLASE (TPA) — DOSE OPTIONS

Standard regimen · most common in US

- [ ] `100 mg IV over 2 h` — often without concurrent UFH during infusion; restart UFH when aPTT < 2× normal & bleeding risk acceptable

Half-dose · off-label, bleeding concern / intermediate-high risk

- [ ] `50 mg IV over 2 h` (or 10 mg bolus + 40 mg over 2 h) — evidence mixed, follow local protocol

Bolus · cardiac arrest / peri-arrest massive PE

- [ ] `50 mg IV bolus over 2 min`; may repeat 50 mg once after 15–30 min if no ROSC & high suspicion

POST-THROMBOLYSIS MONITORING

- [ ] ICU-level care; neuro & bleeding checks **q1 h × 24 h**
- [ ] Hold invasive procedures ≥ 24 h if possible; no anticoag/antiplatelet ≥ 24 h unless strongly indicated & attending-approved
- [ ] Labs: CBC, PT/INR, aPTT, fibrinogen at 2–4 h post-infusion, then **q6–8 h × 24 h**; resume UFH once aPTT near-normal & no bleeding

07 Catheter-directed / surgical options

CONSULTS

- [ ] **Pulmonary Embolism Response Team (PERT)**
- [ ] IR / interventional cardiology for catheter-directed thrombolysis / thrombectomy
- [ ] Cardiothoracic surgery for surgical embolectomy (massive PE, not lysis candidate or failed lysis)

IF PROCEDURE PLANNED — PRE-PROCEDURE HOLDS

- [ ] NPO (except meds) from now
- [ ] Hold per proceduralist — UFH drip off **4–6 h** pre-procedure; enoxaparin hold **24 h** (longer if renal dysfunction)

08 Laboratory studies

ON ADMISSION

- [ ] CBC with differential
- [ ] PT/INR, aPTT, fibrinogen
- [ ] ABG or VBG (if hypoxemic / acidotic)
- [ ] Type & screen (or cross if high bleeding / lysis risk)
- [ ] CMP + Ca, Mg, phosphate, LFTs
- [ ] hs-troponin and BNP / NT-proBNP
- [ ] Pregnancy test (childbearing potential)
- [ ] D-dimer only if multifactorial workup (not needed if PE confirmed)

Daily

- [ ] CBC · CMP · PT/INR, aPTT (or per UFH protocol)

As indicated

- [ ] Anti-Xa levels; defer thrombophilia workup to outpatient / ward (off acute-phase AC)

09 Imaging & diagnostics

BASELINE

- [ ] CT pulmonary angiography (if not already done)
- [ ] Lower-extremity venous duplex if DVT not yet documented & will influence approach

CARDIAC / RV ASSESSMENT

- [ ] Transthoracic echo — RV size/function, RV/LV ratio, PA pressures, pericardial effusion, PFO
- [ ] Repeat echo in **24–72 h** if initial RV dysfunction & ongoing hemodynamic concern
- [ ] Repeat CTPA not routine — reserve for deterioration or failure to improve

10 Sedation, analgesia & prophylaxis

ANALGESIA — AVOID RESPIRATORY DEPRESSION

- [ ] Acetaminophen **650–1000 mg PO/NG/IV q6h** PRN (max 3–4 g/day; reduce in liver disease)
- [ ] If opioids needed: low-dose IV fentanyl / hydromorphone PRN dyspnea/pain with monitoring

SEDATION — IF INTUBATED

- [ ] Propofol — start **5–10 mcg/kg/min**, titrate by 5–10 q5–10 min (range 5–50), goal RASS −1 to 0
- [ ] Alternative: dexmedetomidine **0.2–1.4 mcg/kg/h**

VTE PROPHYLAXIS — UNAFFECTED LIMBS

- [ ] SCDs to non-affected extremities while awake / able to tolerate

NOTE Therapeutic anticoagulation for PE (Section 5) covers prophylaxis — no separate pharmacologic prophylaxis needed.

11 Reversal / bleeding management

Set as PRN / STAT "powerplan" components.

If on UFH — protamine sulfate

- [ ] `1 mg per 100 units heparin` given in last 2–3 h (max 50 mg); IV over 10 min, monitor for hypotension / anaphylactoid reaction

Massive bleeding / suspected ICH after thrombolysis

- [ ] **Stop alteplase & all anticoagulants**; STAT CT head without contrast
- [ ] Activate massive transfusion protocol if indicated

TRANSFUSE

- [ ] Cryoprecipitate `10 units` (or 1–2 units/10 kg) if fibrinogen < 150 mg/dL
- [ ] Platelets if < 100,000/μL or recent antiplatelet therapy
- [ ] Packed RBCs to maintain Hgb ≥ 7–8 g/dL (higher if CAD / active ischemia)
- [ ] Consider tranexamic / aminocaproic acid per neurosurgery / hematology (off-label, institutional)

12 Transition / long-term anticoagulation

TRANSITION TO ORAL ANTICOAGULATION

- [ ] Start DOAC or warfarin once stable, off thrombolytics, bleeding risk acceptable
- [ ] If warfarin: `5 mg PO daily` (2–3 mg if elderly / malnourished / liver disease) with UFH/LMWH overlap ≥ 5 days & until INR 2.0–3.0 for ≥ 24 h

DURATION OF THERAPY

- [ ] Provoked (transient): generally `3 months`
- [ ] Unprovoked / persistent: ≥ `6–12 mo` or indefinite, individualized

FOLLOW-UP REFERRALS

- [ ] Hematology (unprovoked / recurrent / thrombophilia)
- [ ] Pulmonology / PE clinic
- [ ] Cardiology if significant RV dysfunction / pulmonary HTN

13 Contraindications & safety prompts

REVIEW BEFORE THROMBOLYSIS / ANTICOAGULATION DECISIONS

- [ ] Contraindications to thrombolysis — ICH, recent stroke, recent major surgery, uncontrolled HTN, etc.
- [ ] Recent procedures / planned surgeries
- [ ] Concurrent antiplatelet therapy
- [ ] Pregnancy / postpartum status

EDUCATIONAL USE ONLY

Not a substitute for clinical judgement. Verify doses, allergies, renal function, and contraindications. Adapt all agents, targets, and thresholds to your institutional protocols, formulary, and the individual patient.

Spreading knowledge
Improving outcomes