

GENERAL PRINCIPLES

INFECTION CONTROL

- Hand hygiene prior to and after all patient encounters and when changing PPE
- Use contact and droplet precautions for patients with confirmed/suspected COVID-19, including:
 - ◆ Surgical/medical mask
 - ◆ Eye protection
 - ◆ Gloves
 - ◆ Gowns
- N95 respirators should be used for all aerosol-generating procedures, including:
 - ◆ Endotracheal intubation
 - ◆ Deep suctioning
 - ◆ Nebulizer treatments
 - ◆ Bronchoscopy
 - ◆ Noninvasive ventilation
 - ◆ Chest compressions
 - ◆ Chest physiotherapy
- Patients should be placed in negative-pressure rooms, as able, and in geographic cohorts.
- Avoid unnecessary aerosolizing procedures, if possible.

INITIAL WORKUP

Symptoms (% of cases)

- Fever (44-94%)
- Cough (68-83%)
- Sore throat (14-61%)
- Shortness of breath (11-40%)
- Fatigue (23-38%)
- URI symptoms (5-25%)
- Myalgias (11-15%)
- Headache (8-14%)
- Confusion (9%)
- GI symptoms (3-17%)
- Anosmia

Labs suggestive of disease

- Lymphopenia
- Mild transaminitis (AST / ALT ~200s)
 - ◆ GGT elevated, AlkPhos elevations are rare
- Anemia
- Elevated D-dimer (in absence of known culprit thrombus/embolus)
- Elevated CK
- Elevated LDH

GENERAL PRINCIPLES

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- Low/normal procalcitonin, elevated in severe disease and/or superimposed bacterial infection
- Elevated inflammatory markers:
 - ◆ LDH, CRP, ESR, ferritin, IL-6

RISK FACTORS FOR MORE SEVERE DISEASE

Demographics

- Age > 55
 - ◆ Older age has higher OR for ARDS and death
- Male sex
- High BMI
- Long-term care facility inhabitant

Vital signs

- Initial SpO₂ <92% on RA
- Initial HR > 125 bpm
- Initial RR > 24 bpm

Comorbid conditions

- Asthma
- Coronary artery disease
- CKD
- Chronic lung disease
- Diabetes
- HTN
- Heart failure
- Immunocompromised/malignancy

Lab findings

- Low absolute lymphocyte count (<0.8)
- Elevated D-dimer (>1000)
- Elevated CRP (>10)
- Rising troponin

DISEASE COURSE

Duration of symptoms

- Fever - median 4-12 d
- Dyspnea - median 13 d
- Cough - median 19 d
 - ◆ Still present in 45% of survivors on discharge and 72% of nonsurvivors on death

Timing of complications

- Sepsis - median 9 d
- ARDS - median 12 d
- Acute cardiac injury - 15 d
- Acute kidney injury - 15 d
- Secondary infection - 18 d

GENERAL PRINCIPLES

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Suggested labs

- CBC w/diff
- BMP, Mg, Phos
- LFTs, Troponin & CPK, NT-proBNP
- LDH, CRP, D-dimer, procalcitonin
- PTT/INR, ferritin

ICU transfer potential

- Provider concern
- Shock (SBP<90, MAP<65)
- Respiratory distress (need for >6L O₂, rapid respiratory deterioration, significant WOB)
- Acidosis (pH <7.30, CO₂>50), lactate >2
- Deterioration in mental state

RESPIRATORY

RESPIRATORY ESCALATION

Target SpO₂: 92-96%, RR <25, Normal WOB

1. Nasal cannula: up to 6LPM
2. Venturi Mask: 9-12LPM with FiO₂ 30-60%
3. Trial HFNC if available: 100% to start at 20-30L/min up to 60L/min flow
 - ◆ Aerosolization potential, perform in negative pressure room
4. NIPPV: trial CPAP or BiPAP with mask & filter
 - ◆ High aerosolization potential, perform in negative pressure room
 - ◆ PEEP 5 to start up to 15-20

If mental status deteriorates, hypercarbia or acidosis develops, cardiac instability ensues, or patient has persistent profound hypoxia, tracheal intubation is likely next step.

Intubation

- Full PPE (N95 or PAPR, goggles/face shield, gown, gloves, hair cover)
- Set up vent with initial settings, viral filter in line, EtCO₂ inline, suction, post intubation sedation, vitals cycling q3-5'
- Preoxygenate using 100% oxygen through previously connected oxygen device
- Most experienced person by video laryngoscopy
- After intubation, inflate cuff, directly connect to vent w/ inline filter and EtCO₂ device to confirm placement. Secure ETT. Avoid auscultation, if possible.

DIAGNOSING ARDS

Criteria

New or worsening hypoxemia with bilateral opacities on imaging

Severity

- Mild: PaO₂/FiO₂ 200-300
- Moderate: PaO₂/FiO₂ 100-200
- Severe: PaO₂/FiO₂ <100

RESPIRATORY

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Utilize lung protective/ARDSnet recommendations

- Choose mode of ventilation (ACVC or ACPC)
- Vt: 4-6 mL/kg ideal body weight
- Choose RR (10-15 BPM) titrated to blood gas
- Titrate PEEP/FiO₂ to target PaO₂ > 55 mm Hg or SaO₂ 88-95%
- Consider higher PEEP based on severity of illness and BMI
 - ◆ BMI <35: PEEP 5
 - ◆ BMI >35: PEEP 10

ADJUSTING THE VENT

Assess patient response

- Patient RR; peak pressure; plateau pressure; ABG; SaO₂
- Goals: normal RR, pH 7.25-7.35, minute ventilation 6-7LPM, PaO₂ 55-80, SaO₂ 88-95%
- Plateau pressure goal ≤ 30 cm H₂O
 - ◆ If plateau pressure > 30, decrease Vt by 1 mL/kg steps until 4 mL/kg
 - ◆ If plateau pressure < 25 and Vt < 6 mL/kg, increased Vt until plateau pressure > 25 or Vt = 6 mL/kg

To improve oxygenation (SaO₂ and PaO₂):

Increase FiO₂ and/or PEEP per ARDSnet q15-30min to goal SaO₂

FiO ₂	30-40%	40-50%	50-70%	70-80%	90-100%
PEEP	5-8	8-10	10-12	12-14	14-24

To improve ventilation (RR, PCO₂ and EtCO₂):

- If pH 7.15 - 7.30, increase RR until pH > 7.30 or PaCO₂ < 25 (max set RR 35)
- If pH < 7.15, increase RR to 35
- If pH remains < 7.15, increase Vt by 1 mL/kg until pH > 7.15
- May give NaHCO₃
- If pH > 7.45, decrease RR

REFRACTORY HYPOXIA

- Assess fluid status and attempt diuresis if able.
- Deep sedation to RASS -5
- Consider neuromuscular blockade.
- Consider recruitment maneuvers if physiology deemed recruitable.
- Consider proning patient early if PaO₂/FiO₂ <150 12 hours into ventilation.



- Consider pulmonary vasodilators (iNO).
- Consider steroids.
- Consider ECMO consult if:
 - ◆ Persistent PaO₂ < 75 requiring FiO₂ > 0.75
 - ◆ Plateau pressure >30
 - ◆ Refractory hypercapnia and pH < 7.2
 - ◆ Absence of contraindications

RESPIRATORY

(CONTINUED)

Troubleshooting

- D** – dislodged/displaced ETT
- O** – obstructed (secretions, blood)
- P** – pneumothorax
- E** – equipment failure (attempt BMV)
- D** – dyssynchrony

SYSTEMS

CARDIOVASCULAR

Acute Cardiac Injury

- Upwards of 22% of patients 14 d into illness
- Seen as a rise in troponin >99th percentile

Cardiac Arrest

- Asystole 89%, PEA 4.4%, VF/VT 5.8%

Shock

- Acute onset of new/sustained hypotension (MAP <65, SBP <90) with signs of hypoperfusion (poor capillary refill, poor urine output, lactic acidosis, worsening mental status), or vasopressor requirement
- Consider etiology of shock.
 - ◆ Cardiogenic vs. septic vs. vasodilatory
- Empiric antibiotics within 1st hour
- Consider conservative fluid management strategy (withholding fluid bolus or giving smaller 250 mL – 500 mL boluses)
- Start norepinephrine as first agent.
 - ◆ Titrate every 3-5 minutes.
 - ◆ 2-20 mcg/min (max 100 mcg/min)
- Next line agents include vasopressin or epinephrine.
 - ◆ Epi 1-10 mcg/min
 - ◆ Vaso 0.01-0.04 units/min
- Dobutamine is considered if cardiac dysfunction playing a large role.

NEURO/SEDATION

Neuro

- High incidence of neurologic manifestations
- Dizziness, headache, impaired consciousness, hypogeusia, and hyposmia are most common.
- Stroke can occur.

Sedation

- Combination of analgesia and sedation should be employed.
- Daily sedation holidays if able/safe.
- Sedation should be targeted to facilitate improved oxygenation/ventilation.
- Scoring systems such as the RASS should be employed.

SYSTEMS

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Analgesic Medications

- Fentanyl 0-300 mcg/hr, 25-100 mcg q30min PRN
- Hydromorphone 0-4 mg/hr, 0-2 mg q1h PRN
- Morphine 0-10 mg/hr, 2-4 mg q1h PRN

Sedation Medications

- Propofol 0-80 mcg/kg/min, 10-50 mg q5min PRN
- Dexmedetomidine 0.2-1.4 mcg/kg/hr
- Midazolam 0-5mg/hr, 0.5-2 mg q2h PRN
- Ketamine 5-30 mcg/kg/min, 0.1-0.2 mg/kg q5min PRN

HEME/RENAL

Heme

- High incidence of thromboemboli and hypercoagulability
- Suggested prophylaxis of all patients if no contraindications
 - ◆ If CrCl > 30: enoxaparin 40 mg SC daily
 - ◆ If CrCl < 30 or AKI: heparin 5000 units SC TID
 - ◆ Hold if platelets <30,000 or bleeding, start TEDs and SCDs
 - ◆ If the patient is on direct oral anticoagulants or warfarin, consider switch to full dose anticoagulation.
 - ◆ Consider TPA or therapeutic anticoagulation if signs of emboli.
- DIC – high risk with median onset 4 d after hospitalization
 - ◆ If fibrinogen <150 → cryoprecipitate, FFP or fibrinogen concentrate
 - ◆ If platelets <30 → hold anticoagulation, consider platelet transfusion.
 - ◆ If bleeding → hold anticoagulation, consider FFP or 4F-PCC.

Renal

- AKI – high incidence (0.5-27%) due to ATN
 - ◆ Avoid nephrotoxic drugs.
 - ◆ Assess pre-renal vs intrinsic renal (FENa).
 - ◆ Dose medications based on CrCl.
- RRT – high incidence in ICUs (5-23%)
 - ◆ High mortality

THERAPIES

There is insufficient evidence to issue a recommendation on the use of specific agents. Agents should ideally be studied as part of a trial.

Medications

- Hydroxychloroquine 400 mg PO BID x1 d followed by 200 mg PO qd x4 d
 - ◆ Poor evidence but may be beneficial early.
 - ◆ NIH advises not to use with azithromycin.
- Remdesivir IV 200 mg x1 d then 100 mg IV qd x5 d or 10 d
 - ◆ Ongoing trials of efficacy
- Lopinavir/ritonavir 400 mg/100 mg PO q12h x10 d
 - ◆ Poor evidence with suggestion not to use

SYSTEMS

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- Methylprednisolone IV 60 mg/day or dexamethasone IV 10 mg/day
 - ◆ No clear evidence
 - ◆ Consider for ARDS, shock
- Tocilizumab IV 4-8 mg/kg x1 d
 - ◆ Poor evidence with trials ongoing
 - ◆ Consider use with evidence of cytokine storm syndrome.
- Convalescent plasma dosing uncertain
 - ◆ Minimal evidence