JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Acute Respiratory Failure (CPG ID: 06)

This CPG describes the associated risk factors, diagnosis, and management of Acute Respiratory Distress Syndrome (ARDS) in combat casualties in the forward deployed environment and the resources available for safe Aeromedical transport of these patients.

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BACKGROUND

Patients with multiple injuries are known to develop lung injury[1] which can result in long-term disability or even death.[2] A recent review of combat casualty deaths following admission to a hospital demonstrated that 8% of potentially preventable deaths are from multi-organ failure which includes ARDS.[3] The purpose of this guideline is to review the diagnostic criteria for ARDS, to describe the frequency of this problem in combat casualties, and to recommend a series of management strategies to permit safe aeromedical evacuation of these patients.

Respiratory failure has been observed in combat casualties for over a century. Some degree of ARDS occurs in between 26% and 33% of combat casualties.[1,4,5] In a review of the DoD Trauma Registry (DoDTR), 152 patients with ARDS were identified over a 7 year period.[6] Independent risk factors for ARDS included female sex, shock or tachycardia on presentation, and severe injury (Military Injury Severity Score (mISS) ≥25). Patients with ARDS had a significantly increased risk of death as compared to intubated controls (12.8% vs. 5.9%, Odds Ratio 1.99, 95% confidence interval [1.12, 3.52], p=0.02). Further analysis of this population identified that increased crystalloid infusion and Fresh Frozen Plasma (FFP) transfusion independently predicted ARDS.[7]

DEFINITIONS

- ARDS develops as a result of both direct and indirect injury to the lungs. Common causes of ARDS following a direct injury include pneumonia or gastric aspiration. In combat casualties, direct insults such as pulmonary contusion, inhalation injury, and fat emboli may lead to ARDS. ARDS from indirect lung injury can occur in patients who receive multiple transfusions, who develop septic shock, or in those with severe acute pancreatitis.

- Cardiac failure or fluid overload must be ruled out when considering the diagnosis of ARDS. Several other disease processes can also mimic ARDS. Patients with these conditions will benefit from lung-protective ventilator management but may require disease-specific interventions as well. Examples include Acute Eosinophilic Pneumonia (AEP), Acute Interstitial Pneumonitis (AIP), Bronchiolitis Obliterans Organizing Pneumonia (BOOP), and Diffuse Alveolar Hemorrhage (DAH).[8]

- The definition of ARDS was updated in 2012. The new Berlin definition of ARDS reflects a range of severity from mild to moderate to severe, defines "acute onset" as within one week and specifies the need for Positive End Expiratory Pressure (PEEP) ≥5 cm H_2O.[9] The original American-European Consensus Conference (AECC) definition of ARDS which also included Acute Lung Injury (ALI)[10] is less practical; so this CPG will refer to the new Berlin definition. Timing of ARDS must occur within one week of a known clinical insult described above, or must be in the context of new or worsening respiratory symptoms. On chest imaging (CXR or CT scan), bilateral opacities must be present which are not fully explained by pulmonary edema, effusions/hemothorax, lobar collapse, or pulmonary nodules. If the above criteria are met, the degree of hypoxemia with a PEEP or Continuous Positive Airway Pressure (CPAP) of at least 5 cm H_2O determines the severity of ARDS.

    1. **Mild ARDS** = PaO_2 to FiO_2 ratio (P:F) of > 200 and ≤ 300.
    2. **Moderate ARDS** = P:F of >100 and ≤ 200.
    3. **Severe ARDS** = P:F of ≤ 100.

- The diagnosis of ARDS is typically made in patients who have respiratory failure that requires intubation and mechanical ventilation.

DIAGNOSIS

Patients suspected of having ARDS on the basis of CXR findings and ventilator settings should have their diagnosis confirmed by following the below guidance.

1. Verify that the patient is likely to have respiratory failure from either a direct or indirect pulmonary injury or the need for mechanical ventilation support.
2. Consider diagnoses which can mimic ARDS as described above.
3. Obtain a good quality anteroposterior upright CXR and look for diffuse infiltrates. Consider a chest CT if this imaging modality is available and the patient is stable for transport to CT.
4. If cardiogenic pulmonary edema and/or fluid overload cannot be fully excluded as the cause of or a contributing factor to the patient's respiratory failure, consider placing a central venous pressure catheter and obtain a trans-thoracic echocardiogram if possible.[11,12]
5. Place the patient on volume- or pressure-control ventilation.
    a. Tidal volume (V_T) approximately 6-8 mL/kg using Predicted Body Weight (PBW), see ARDSNet Card in Appendix B) targeting a plateau pressure (P_{PLAT}) ≤ 30 cm H_2O or if using a pressure control mode of ventilation, set the inspiratory pressure to 30-35 cm H_2O and then decrease it gradually to achieve a V_T of 6-8 mL/kg.
    b. Set the respiratory rate between 6 and 35 and adjust to achieve a pH≥7.3.
    c. Set PEEP (minimum 5 cm H_2O) and FiO_2 according to the ARDSNet table[23] to achieve a SpO_2 of 88-95% (PaO_2 of 55-80 mmHg). Allow the patient's gas exchange to equilibrate for 30 minutes and then draw an ABG to calculate the patient's P:F ratio.

If ARDS is confirmed, document the grade (mild, moderate, severe) in the patient's record with the diagnostic criteria used. A recent study further demonstrated that Age-Adjusted Oxygenation Index (AOI) accurately predicts prognosis in patients with ARDS.[13] Traditionally, the Oxygenation Index (OI) is calculated as where MAP is mean airway pressure. This study relied on the ARDSNet database which recorded P_{PLAT} rather than MAP; so the AOI was calculated as $(\frac{100\times P_{PLAT}}{P:F}) + Age$. These authors found that an AOI of 80-99 in the first four days of ARDS was associated with 50% mortality.

Pediatric trauma patients are also at risk for development of ARDS.[14] While there are many similarities in the pathophysiology of ARDS in adults and children, recent literature has supported a slightly different approach with the diagnostic criteria used in pediatric ARDS.[15,16] Similar to the Berlin criteria for adults, ARDS in children requires respiratory failure not explained by cardiac failure or volume overload. However, instead of utilization of a P:F ratio, recent recommendations have been made to utilize OI to grade severity of ARDS in the pediatric population. As above, OI can be calculated as $(\frac{100\times MAP}{P:F})$. Mild ARDS can be defined as an OI of 4 to <8, moderate ARDS defined as an OI of 8 to <16 and severe ARDS defined as an OI ≥16.[15,16]

MANAGEMENT

The management of patients with ARDS should safely support gas exchange without further injuring the patient's lungs.[17] In fact, using a lung-protective ventilator strategy in *all* intubated patients appears to improve clinical outcomes.[18–20] Providers must also recognize that there are also some limitations imposed by the transport ventilators and that the patient's PaO_2 will always decrease during aeromedical transport.[21,22]

In patients with ARDS, the goal is to limit barotrauma (P_{PLAT}≤30 cm H_2O or peak inspiratory pressure, PIP≤35 cm H_2O if PPLAT cannot be measured), volutrauma (V_T 6-8 mL/kg PBW) and atelectrauma (moderate to high PEEP).[17] Goals should include an SpO_2≥88-95% and a pH≥7.3 (in traumatic brain injury, this pH goal should be met with the $PaCO_2$ maintained at 35-40 mm Hg).

Early consultation with an intensivist is encouraged for all patients with moderate to severe ARDS. Military physician-to-physician consultation can be obtained by contacting Landstuhl Regional Medical Center (LRMC) at DSN 314-486-7141 or San Antonio Military Medical Center (SAMMC) at DSN 312-429-BURN (2876).

For Role 3 patient management, see Appendix A.

VENTILATOR AND GAS EXCHANGE MANAGEMENT

Lung-Protective Ventilation Settings

Once ARDS has been diagnosed, the patient should be placed on lung-protective ventilation settings according to the ARDSNet ventilator management card.[23] The patient's PBW is determined by measuring the patient's height and then using the appropriate sex-based calculation. Note there are two different PEEP tables, one with a lower PEEP and higher FiO_2 and the other with a higher PEEP and lower FiO_2. Either is acceptable, but meta-analysis suggests a trend towards improved survival using the high PEEP table in patients with moderate to severe ARDS by modern criteria.[24] In all cases, the "driving pressure" (P_{PLAT} – PEEP) should be minimized to optimize the patient's chances of survival.[25] During the initial management, a V_T of 8 mL/kg may be used, but this should be decreased to 6 mL/kg within 2-4 hours. If the P_{PLAT} remains above 30 cm H_2O, the tidal volume can be further reduced to 4 mL/kg so long as there is evidence of adequate oxygen delivery to peripheral tissues (normal lactate and base deficit).[26] Other modes of ventilation besides volume-assist-control can be used, but this should be at the discretion of an intensivist experienced in the management of ARDS.

Rescue Oxygenation Therapies

Advanced therapies for ARDS patients are limited in an austere environment. Low-level recruitment maneuvers performed by holding 40 cm H_2O pressure for 40 seconds can be performed by the patient's provider, but the team should be prepared to manage unstable hemodynamics due to decreased venous return. Other measures such as inhaled Nitric Oxide (iNO) or inhaled prostacyclin (Flolan) are not typically available in Role 3 facilities. Advanced rescue ventilator modes such as inverse ratio ventilation or Airway Pressure Release Ventilation (APRV) should be utilized under the supervision of an experienced intensivist.

Extracorporeal Life Support

Early consideration for Veno-Venous Extracorporeal Life Support (vvECLS) is vital in patients who are failing attempts at lung-protective ventilation.[27] If gas exchange and perfusion goals are not met after 12 hours of lung-protective ventilation and the patient has been paralyzed and proned, then extracorporeal support should be considered. Additionally, transport of patients who are supported with vvECLS may be safer and easier if an extracorporeal transport team is available. (See *Transport of ARDS patients* below).

Indications for initiating Extracorporeal Membrane Oxygenation (ECMO) for respiratory failure include:

1. P:F ration <100 or plateau pressures > 30cm H_2O despite optimal ventilator management.
2. Respiratory acidosis with pCO_2>70 and a pH <7.25 despite optimal ventilator management.
3. Initiation of ARDS rescue therapies (PEEP>15, prone positioning, High Frequency Oscillation (HFOC), iNO, prolonged paralysis)
4. Respiratory failure associated with significant barotrauma needed for ventilator support.

ECMO consultation is available 24 hours a day and can be coordinated through the Institute of Surgical Research (ISR) Burn Unit (210-222-BURN). Due to the dramatic sequelae of acute respiratory failure and the time required to generate a potential ECMO transport team, **early notification is paramount**. Early consultation with the ECMO team is essential, even if it is **prior to 12 hours of respiratory failure.**

NEUROMUSCULAR BLOCKADE

If a patient has severe or rapidly worsening ARDS, a short course (48 hours) of neuromuscular blockade may facilitate continued use of Lung Protective Ventilation (LPV) while eliminating such problems as ventilator dyssynchrony.[28] This strategy carries a survival benefit in patients with confirmed ARDS when used early in the course of disease (within 48 hours). Cisatricurium (Nimbex®) minimizes the risk of ICU-related neuropathy or myelopathy, as compared to other neuromuscular blockers, and does not require dose adjustment in renal or hepatic insufficiency. Thus, cisatricurium is the preferred neuromuscular blocking agent in patients with ARDS.[29, 30]

PRONE POSITIONING

If the patient's disease is primarily in the lower lobes (based on CXR or CT findings), a trial of prone positioning for 2–6 hours should be performed.[31] If the patient's gas exchange improves, continue the proning therapy. A recent study of patients with moderate to severe ARDS (P:F <150) demonstrated a mortality benefit to proning for 16 hours/day.[32] This is best done by an experienced team able to avoid tube/line dislodgment during the proning maneuver, and may not be practical in the deployed or austere setting. The EKG electrodes are placed on the patient's back and the eyes are taped shut. This approach is best implemented in the setting of a proning protocol which includes indications and contraindications, a pre-proning checklist, and a description of nursing care of the proned patient.

FLUID MANAGEMENT

Patients with ARDS in the setting of a positive fluid balance have an increased mortality.[33] Thus, early and aggressive limitation of unnecessary volume infusion is encouraged by eliminating any "maintenance IV fluid," maximally concentrating all necessary drips, and converting IV medications to enteral. If the patient's hemodynamics can tolerate diuresis, this should be pushed aggressively.[34] In the setting of hemodynamic compromise, attempts should be made to minimize volume and be judicious with any trials of diuresis. Some Role 3 facilities are equipped with Continuous Renal Replacement Therapy (CRRT) which can also be used to eliminate excess intravascular volume in the setting of poor renal function under the direction of an intensivist or nephrologist experienced in this therapy (See JTS *Hyperkalemia and Dialysis in the Deployed Setting* CPG[35]). If the patient is hypoproteinemic (i.e. total protein < 6 g/dL), albumin 25 g IV every 8 hours (100 mL 25% albumin) combined with diuresis for 3-5 days has been demonstrated to improve oxygenation and diuresis in two prospective randomized studies in patients with ARDS. The goals of therapy include a CVP < 4 mmHg with evidence of effective circulation by exam (warm, no mottling and capillary refill < 2 s) and adequate urine output (≥ 0.5 mL/kg/hr).[12]

BLOOD PRODUCT TRANSFUSIONS

Blood products carry a risk of initiating or exacerbating respiratory failure.[36-39] In a recent study of the DoDTR, moderate numbers of Red Blood Cell (RBC) transfusions (2-14) increased the risk of ARDS. Furthermore, each unit of additional plasma transfused increased the risk of ARDS in intubated combat casualties by 7%.[36] Similar findings have also been demonstrated in the civilian trauma population.[39] Thus, it is imperative to balance the benefits of Damage Control Resuscitation (DCR) against the risk of ARDS. If the patient is bleeding and needs blood volume replaced, blood products should not be withheld. Furthermore, in patients with severe ARDS refractory to maximal ventilator support, transfusion of additional RBCs may be necessary to sustain adequate oxygen delivery. On the other hand, a patient who is no longer bleeding who has asymptomatic anemia[40] or a

mildly elevated International Normalized Ratio (INR) with a normal thromboelastogram or rotational thromboelastogram likely does not need additional blood products.

CORTICOSTEROID ADMINISTRATION

Intravenous steroids have generally shown no benefit in the initial treatment of ARDS.[41] However, initiation of low to moderate-dose corticosteroids in highly-select patients can improve pulmonary mechanics and reduce ventilator and ICU days without increasing complications including infections and neuropathy/myelopathy.[42,43] This select population consists primarily of those with "late-phase" or "prolonged" ARDS, defined as duration of ≥7 days. The ARDSNet Late Steroid Rescue Study Trial demonstrated a potential benefit of steroids in the subgroup of patients with ARDS duration between 7-13 days, but potential harm of steroids when administered to patients who were at ≥14 days of duration. In patients without contraindications, the recommended regimen is methylprednisolone 2 mg/kg IV x1 followed by an infusion of 2 mg/kg/day (can be divided into every 6 hour doses) for 14 days (or for the duration of intubation, whichever is shorter). The infusion can then be tapered over 7-21 days based on clinical judgment. If steroids have not been initiated within two weeks of an ARDS diagnosis, they should be avoided due to an increased mortality with delayed therapy.[44] Of note, AEP can masquerade as ARDS and has been described in deployed military members who recently started smoking.[45] AEP is highly sensitive to steroid therapy; so it is very important to correctly diagnose AEP from the more common ARDS.

NUTRITION AND VENOUS THROMBOEMBOLISM PROPHYLAXIS

Patients with ARDS receive nutritional support (See JTS *Nutritional Support Using Enteral and Parenteral Methods* CPG).[46] Enteral feeds are preferred if the gastrointestinal system is functional. Consideration should be given to positioning a naso-jejunal feeding tube for this purpose; a naso-gastric feeding tube can also be used if a feeding tube cannot be advanced through the pylorus. Stress ulcer prophylaxis is recommended in critically ill intubated patients, and all patients with ARDS should be considered for chemical Venous Thromboembolism (VTE) prophylaxis once adequate hemostasis has been achieved.

SEDATION MANAGEMENT AND PHYSICAL THERAPY

The major long-term morbidity of ARDS is neurologic and/or musculoskeletal disability related to prolonged inactivity.[29,30] Consequently, at the earliest possible time, patients should undergo a daily awakening trial ("sedation holiday")[47] and should be started on an aggressive program of early mobilization. This consists of a staged approach even while intubated, beginning with passive range of motion (performed multiple times daily by providers, nurses, therapists, co-workers, and family) and then progressing to sitting up at the side of the bed, moving from bed to chair, and ambulating with assistance.[48, 49]

ARDS IN PEDIATRIC PATIENTS

Ventilator management of ARDS in children is similar to their adult counterparts with a goal to limit ventilator-induced lung injury. Additionally, adjunctive and rescue measures are also similar in pediatric ARDS patients.[16]

TRANSPORT OF ARDS PATIENTS

CRITICAL CARE AIR TRANSPORT TEAM (CCATT) CAPABILITIES

Intubated U.S. military patients are routinely transported out of theater by the Critical Care Air Transport Team (CCATT).[50–52] From October 2001 to May 2006, these made up 1,265 of 1,995 (63%) of all CCATT patients.[53] The decision to transport a patient with ARDS should be made jointly with the theater CCATT Director and the validating flight surgeon, the on-site CCATT physician, and the Role 3 Chief of Trauma and/or ICU Director.

Considerations should include the severity of the patient's respiratory failure, the trajectory of that respiratory failure (improving or worsening), and the experience of the team.[22]

U.S. Air Force CCATT has both the Impact 731™ (Zoll Medical Corporation., Chelmford, MA) ventilator and the LTV 1000™ (CareFusion., Yorba Linda, California) ventilator for use in transport.[54] The Impact 731 operates in volume control, pressure control, SIMV, and CPAP with and without pressure support. Up to 100% O_2 can be applied as can PEEP of up to 25 cm H_2O. Flow rates range from 0 to 100 L/min at 40 cm H_2O. Peak inspiratory pressures range from 10 to 80 cm H_2O. Inverse ratio ventilation is not possible with the Impact 731.

ADVANCED CRITICAL CARE EVACUATION TEAM (ACCET) CAPABILITIES

In 2012, SAMMC established an ECLS team and now offers long-range transport of patients with severe ARDS with or without ECLS. The team consists of a medical/pulmonary critical care physician, a surgical intensivist, an ICU nurse, and a respiratory therapist. Advanced therapies used by this team include high frequency percussive ventilator (Percussionaire VDR-4), inhaled prostacyclin (Flolan), and ECLS for the management of patients with moderate to severe ARDS who could not otherwise be safely transported.[55–58]

Indications for requesting an ACCET for transport to the U.S. include the following:

- PaO_2: FiO_2 < 100 .
- Inhalation injury.
- FiO_2 > 0.7 or pH < 7.25 on lung-protective ventilation.
- PEEP > 15 cm H_2O w/ PPLAT > 30 cm H_2O.
- Severe brain injury with $PaCO_2$ > 40 mmHg on a transport ventilator.
- Cardiogenic shock refractory to maximal medical therapy.
- Anatomic derangement (e.g., Bronchopleural fistula, pneumonectomy).
- Use of advanced ventilator modes such as APRV.
- Acute Pulmonary Embolism (PE) with cardiac arrest or with persistent hypoxemia.
- Multi-system organ failure (e.g., ARDS + Renal Failure).

ACCET team members are specifically trained in the indications for and the use of these modalities which have all been appropriately vetted through the combat casualty care and transport communities.

- High-frequency percussive ventilation can be helpful in cases of purulent pneumonia or inhalation injury by mobilizing secretions while affording safe gas exchange.[59]

- ECLS is used for adult respiratory failure with good outcomes as demonstrated in recent series using modern equipment.[60-62] Most adult ECLS is Veno-Venous which can be performed through either single site internal jugular (IJ) vein cannulation, combined IJ/femoral vein (FV) or dual-FV cannulation. Systemic heparin should be administered once surgical bleeding has been controlled. This approach has been used safely in trauma patients both in the U.S. and in Germany, including patients with Traumatic Brain Injury (TBI).[62–65]

- ACCET transports should be initiated by the local Chief of Trauma and/or ICU Director by contacting U.S. Transportation Command (TRANSCOM) through the normal intertheater evacuation procedure. This will facilitate timely activation of the appropriate team. Physician-to-physician consultation can also be obtained by contacting LRMC at DSN 314-486-7141 or SAMMC at DSN 312-429-BURN (2876). Early consultation and ECLS team activation are always encouraged.

- From Nov 2005 – Mar 2007, 524 intubated patients were transported via CCATT. Of these, five were moved by the LRMC ALRT which had been called on a total of 11 patients. Of the five ALRT patients requiring advanced support modes, four survived to hospital discharge.[66] Furthermore, of 10 U.S. combat casualties transported on either Pumpless Extracorporeal Lung Assist (PECLA) or ECLS, nine survived to hospital discharge.[55] These data underscore the importance of utilizing available resources for transporting these tenuous patients to definitive care.

OUTCOMES

In a general civilian population, the in-hospital mortality in patients with ARDS remains upwards of 40%[67] and the 5-year mortality is approximately 60%.[68] For trauma patients, ARDS increases morbidity[69] and may increase mortality as well,[70] although there is some inconsistency in the current civilian literature.[71] However, ARDS is an independent risk factor for death in combat casualties as noted above. To mitigate this risk, early LPV should be implemented along with minimizing unnecessary IV infusions, eliminating unnecessary blood product transfusions, and implementation of an aggressive physical therapy regimen if possible. Early activation of the ACCET evacuation system should also be considered.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All patients who receive mechanical ventilation

INTENT (EXPECTED OUTCOMES)

1. Patients with Acute Respiratory Distress Syndrome (ARDS) are treated with lung protective ventilation.
2. Advanced airway support team consultation occurs within 4 hours when criteria are met (ex. PaO2:FiO2 < 100, FiO2> 70%, PEEP > 15 cmH2O with Pplat > 30 cm H2O, severe TBI with PaCO2 > 40 mmHg, etc).

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients diagnosed with ARDS who receive initial tidal volume 6-8 mL/kg.
2. Number and percentage of patients who have advance airway support team consultation within 4 hours when criteria are met (ex. PaO2:FiO2 < 100, FiO2> 70%, PEEP > 15 cmH2O with Pplat > 30 cm H2O, severe TBI with PaCO2 > 40 mmHg, etc) and patient is eligible for evacuation (US or coalition casualties).

DATA SOURCE

- Patient Record.
- Department of Defense Trauma Registry (DoDTR).

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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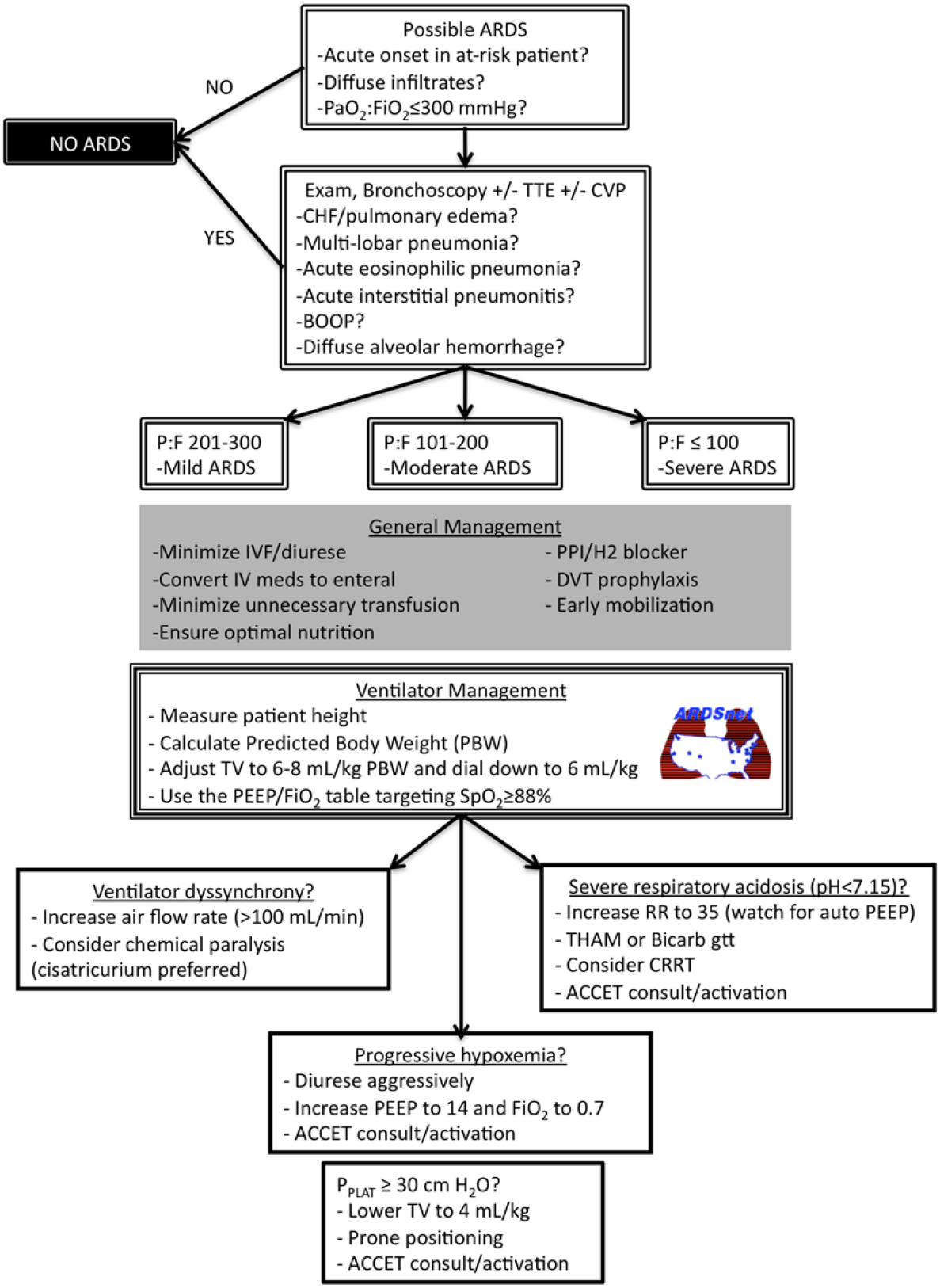
APPENDIX A: DIAGNOSIS AND MANAGEMENT OF ARDS



APPENDIX B: ARDSNET VENTILATOR MANAGEMENT FOR PATIENTS WITH ARDS[23]

NIH NHLBI ARDS Clinical Network
Mechanical Ventilation Protocol Summary

INCLUSION CRITERIA: Acute onset of

1. $PaO_2/FiO_2 \leq 300$ (corrected for altitude)
2. Bilateral (patchy, diffuse, or homogeneous) infiltrates consistent with pulmonary edema
3. No clinical evidence of left atrial hypertension

PART I: VENTILATOR SETUP AND ADJUSTMENT

1. Calculate predicted body weight (PBW)
   Males = 50 + 2.3 [height (inches) - 60]
   Females = 45.5 + 2.3 [height (inches) -60]
2. Select any ventilator mode
3. Set ventilator settings to achieve initial V_T = 8 ml/kg PBW
4. Reduce V_T by 1 ml/kg at intervals ≤ 2 hours until V_T = 6ml/kg PBW.
5. Set initial rate to approximate baseline minute ventilation (not > 35 bpm).
6. Adjust V_T and RR to achieve pH and plateau pressure goals below.

OXYGENATION GOAL: PaO_2 55-80 mmHg or SpO_2 88-95%
Use a minimum PEEP of 5 cm H_2O. Consider use of incremental FiO_2/PEEP combinations such as shown below (not required) to achieve goal.

Lower PEEP/higher FiO2

FiO_2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7
PEEP	5	5	8	8	10	10	10	12

FiO_2	0.7	0.8	0.9	0.9	0.9	1.0
PEEP	14	14	14	16	18	18-24

Higher PEEP/lower FiO2

FiO_2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5
PEEP	5	8	10	12	14	14	16	16

FiO_2	0.5	0.5-0.8	0.8	0.9	1.0	1.0
PEEP	18	20	22	22	22	24

PLATEAU PRESSURE GOAL: ≤ 30 cm H_2O
Check Pplat (0.5 second inspiratory pause), at least q 4h and after each change in PEEP or V_T.
If Pplat > 30 cm H_2O: decrease V_T by 1ml/kg steps (minimum = 4 ml/kg).
If Pplat < 25 cm H_2O and V_T< 6 ml/kg, increase V_T by 1 ml/kg until Pplat > 25 cm H_2O or V_T = 6 ml/kg.
If Pplat < 30 and breath stacking or dys-synchrony occurs: may increase V_T in 1ml/kg increments to 7 or 8 ml/kg if Pplat remains ≤ 30 cm H_2O.

pH GOAL: 7.30-7.45
Acidosis Management: (pH < 7.30)
If pH 7.15-7.30: Increase RR until pH > 7.30 or $PaCO_2$ < 25 (Maximum set RR = 35).
.
If pH < 7.15: Increase RR to 35.
If pH remains < 7.15, V_T may be increased in 1 ml/kg steps until pH > 7.15 (Pplat target of 30 may be exceeded).
May give $NaHCO_3$
Alkalosis Management: (pH > 7.45) Decrease vent rate if possible.

I: E RATIO GOAL: Recommend that duration of inspiration be ≤ duration of expiration.

PART II: WEANING

A. Conduct a SPONTANEOUS BREATHING TRIAL daily when:

1. $FiO_2 \leq 0.40$ and PEEP ≤ 8 OR $FiO_2 \leq 0.50$ and PEEP ≤ 5.
2. PEEP and FiO_2 ≤ values of previous day.
3. Patient has acceptable spontaneous breathing efforts. (May decrease vent rate by 50% for 5 minutes to detect effort.)
4. Systolic BP ≥ 90 mmHg without vasopressor support.
5. No neuromuscular blocking agents or blockade.

B. SPONTANEOUS BREATHING TRIAL (SBT):
If all above criteria are met and subject has been in the study for at least 12 hours, initiate a trial of UP TO 120 minutes of spontaneous breathing with FiO2 ≤ 0.5 and PEEP ≤ 5:

1. Place on T-piece, trach collar, or CPAP ≤ 5 cm H_2O with PS ≤ 5
2. Assess for tolerance as below for up to two hours.
   a. $SpO_2 \geq 90$: and/or $PaO_2 \geq 60$ mmHg
   b. Spontaneous $V_T \geq 4$ ml/kg PBW
   c. RR ≤ 35/min
   d. pH ≥ 7.3
   e. No respiratory distress (distress= 2 or more)
      - HR > 120% of baseline
      - Marked accessory muscle use
      - Abdominal paradox
      - Diaphoresis
      - Marked dyspnea
3. If tolerated for at least 30 minutes, consider extubation.
4. If not tolerated resume pre-weaning settings.

Definition of UNASSISTED BREATHING
(Different from the spontaneous breathing criteria as PS is not allowed)

1. Extubated with face mask, nasal prong oxygen, or room air, OR
2. T-tube breathing, OR
3. Tracheostomy mask breathing, OR
4. CPAP less than or equal to 5 cm H_20 **without pressure support or IMV assistance.**

APPENDIX C: PRONE POSITIONING IN PATIENTS WITH ARDS

PREPARATION:

1. Check for contraindications.
   - Facial or pelvic fractures
   - Anterior torso wounds or burns
   - Spinal instability
   - Increased ICP
2. Confirm ETT placement with recent CXR.
3. Ensure that ETT and all invasive lines/monitors (chest tubes, IVs, central lines) are secured.
4. Consider how patient's head, neck, shoulder girdle will be supported.
5. Stop tube feedings, evacuate stomach, cap/clamp feeding and gastric tubes.
6. Prepare airway suctioning equipment.
7. Prepare all IV tubing, catheters, etc., for prone connections.
   - Assure sufficient tubing length
   - Relocate drainage bags to opposite side of bed
   - Move chest tube drains to between legs
   - Reposition IV tubing to patient's head on opposite side of bed

TURNING

1. Place personnel on both sides and head of bed.
2. Increase FiO_2 to 1.0, and note TV, minute ventilation, peak/plateau pressures.
3. Place new draw sheet, put patient into lateral decubitus position.
4. Remove EKG leads and patches. Suction airway, oropharynx, nares as necessary.
5. Continue to proning, and reposition patient in center of bed.
6. Turn patient's face toward ventilator. Ensure airway is not kinked and has not migrated.
7. Support face/shoulders appropriately; ensure no contact of padding with eyes/orbits.
8. Position patient's arms for comfort. Avoid arm extension that might cause brachial plexopathy.
9. Auscultate chest for mainstem intubation; reassess TV and minute ventilation.
10. Reconnect and adjust all tubing, check functions.
11. Reattach ECG patches and leads to back.
12. Tilt patient in reverse Trendelenburg. Intermittent slight (200) lateral repositioning every two hours, if possible.
13. Document skin assessment on weight-bearing surfaces every shift.

APPENDIX D: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e., "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.