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SUPPLEMENTAL DATA

STOP algorithm for bedside mechanical ventilation: Standardized, evidence-based management of critically ill patients

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Full article is available at the following link: STOP algorithm for bedside mechanical ventilation: Standardized, evidence-based management of critically ill patients

Stepwise approach of STOP Algorithm

Step 1 - Assessment of Vital Signs and Ventilator Alarms:

In the first step of the STOP algorithm, the focus is on addressing immediate life-threatening conditions if the vital signs are abnormal, defined as heart rate exceeding 130 bpm, mean arterial pressure (MAP) below 65 mmHg, peripheral oxygen saturation (SpO_2) under 90%, or respiratory rate above 35 breaths per minute, and/or the ventilator is alarming. The step is divided into distinct pathways, each addressing specific abnormalities following the CERTAIN approach, a systematic and evidence-based framework to the initial resuscitation and ongoing care of acutely and critically ill patients to prioritize key actions [38]. A well-accepted mnemonic, DOPE (Displacement, Obstruction, Pneumothorax, Equipment failure) for ventilator troubleshooting is integrated into CERTAIN framework as well [39] . Clinicians begin by assessing vital signs—such as heart rate, mean arterial pressure, peripheral oxygen saturation (SpO_2), and respiratory rate—and ventilator alarms. If any abnormality or alarm is present, the algorithm guides the clinician through structured assessments and interventions.

The categories "**U** - (POCUS – Point of Care Ultrasound)" and "**L** - (Laboratory/Diagnostic Tests)" prompt clinicians to consider additional imaging and laboratory studies, ensuring a comprehensive approach to patient evaluation if further investigation is needed. This step aims to identify and resolve immediate threats quickly and systematically, setting the foundation for a structured ventilator management approach.

Step 2 – Assessment of adequate ventilation:

The second step focuses on evaluating adequate ventilation, defined as minute ventilation > 5 L/min and/or tidal volume ≥ 200 mL in controlled modes. If the tidal volume (Vt) and/or minute ventilation is low, the consensus recommendation is to switch even transiently to volume control mode to allow accurate subsequent airway pressure measurements [40, 41].

Step 3 - Peak Pressure (Ppeak) Assessment: If ventilation is not adequate, there are three potential issues to consider: (1) a leak, (2) improper ventilator settings (such as low respiratory rate or low tidal volume), or (3) airway obstruction. In cases of a leak or setting maladjustment, the peak pressure (Ppeak) is typically normal or low. However, if an airway obstruction is present, Ppeak is often elevated, necessitating further assessment of the plateau pressure (Pplat) for differential diagnosis [42, 43].

Step 4 - Plateau Pressure (Pplat) Measurement:

The fourth step involves assessing the Pplat, which provides insights into lung compliance and the potential for alveolar over-distension. A plateau pressure ≥ 30 cmH_2O was considered indicative of reduced lung compliance and increased risk of VILI. When both peak and Pplat are elevated, it suggests compliance issues within the lungs. In contrast, if Ppeak is high but Pplat remains normal, this indicates that the issue lies with airway resistance rather than lung compliance. This distinction will guide the clinicians to appropriately address the underlying problem [30, 43].

Step 5 - Evaluation of the Risk of Ventilator Induced Lung Injury:

The fifth step of the STOP algorithm focuses on lung protection strategies to reduce the risk of VILI. Key components include maintaining low tidal volumes, ideally around 6 ml/kg of predicted body weight, to prevent over-distension and minimize barotrauma. Additionally, optimizing PEEP, keeping the Pplat under 30 cmH2O, and maintaining a driving pressure (Pplat - PEEP) below 15 cmH2O are emphasized as essential measures [27,30,44].

Assessment of inspiratory effort is particularly important in patients receiving spontaneous ventilation, as excessive effort can contribute to patient self-inflicted lung injury (P-SILI). Two bedside indices commonly available on modern ventilators can assist with this evaluation: (1) Pressure Muscle Index (PMI = Ppeak − Pplat), which reflects patient-generated inspiratory effort during assisted breaths. (2) P0.1, the airway occlusion pressure measured at 0.1 seconds, which quantifies neural respiratory drive. Elevated effort is suggested by P0.1 > 3.5–4 cmH_2O or PMI > 10–12 cmH_2O, thresholds associated with heightened respiratory drive and increased risk of P-SILI. Measurements should be interpreted cautiously in the presence of circuit leaks, asynchronous breathing, very strong spontaneous efforts, heavy sedation, or ventilator modes that modify pressure delivery, as these factors may reduce measurement reliability. Persistent elevation warrants reassessment of ventilatory support, including consideration of increased assistance or transition to controlled modes.

Step 6 - Evaluation of the Risk for Oxygen Toxicity:

The sixth step addresses concerns regarding oxygen toxicity. Prolonged exposure to high concentrations of oxygen can lead to oxygen toxicity, especially in patients requiring mechanical ventilation. Oxygen toxicity was considered when FiO_2 remained > 0.6 for a prolonged duration. Continuous monitoring of oxygen saturation levels and adjusting inspired oxygen fraction (FiO2) accordingly are essential components of this step. Implementing protocols to minimize oxygen exposure is crucial for preventing pulmonary complications in critically ill patients [45, 46].

Step 7 - Identifying Patient-Ventilator Asynchrony:

The seventh step focuses on recognizing patient-ventilator asynchrony, a phenomenon that can significantly affect patient comfort and ventilation effectiveness. Proper assessment involves evaluating the patient's respiratory effort in relation to the ventilator's delivered breaths. The STOP protocol includes strategies for identifying and correcting asynchrony, which can improve patient-ventilator interaction and overall outcomes. Minimizing asynchrony has been shown to enhance patient comfort and reduce the duration of mechanical ventilation [47–49].

Step 8 - Assessment of Readiness for Spontaneous Awakening and Breathing Trials:

The final step of the STOP algorithm evaluates whether the patient is ready for spontaneous awakening and breathing trials (SAT and SBT). Readiness for SAT/SBT generally required $FiO_2 \leq 0.50$, PEEP $\leq$ 5–8 cmH_2O, $SpO_2 \geq$ 88–90%, hemodynamic stability without escalating vasopressor support, and no evidence of active myocardial ischemia or elevated intracranial pressure. This assessment includes considering the patient's level of sedation, neurological status, and respiratory drive. By incorporating validated criteria for spontaneous awakening and breathing trials (SAT and SBT) readiness, such as the patient's ability to follow commands and maintain adequate oxygenation on minimal support, the STOP algorithm enhances the likelihood of successful extubation and reduces the duration of mechanical ventilation [50–52].

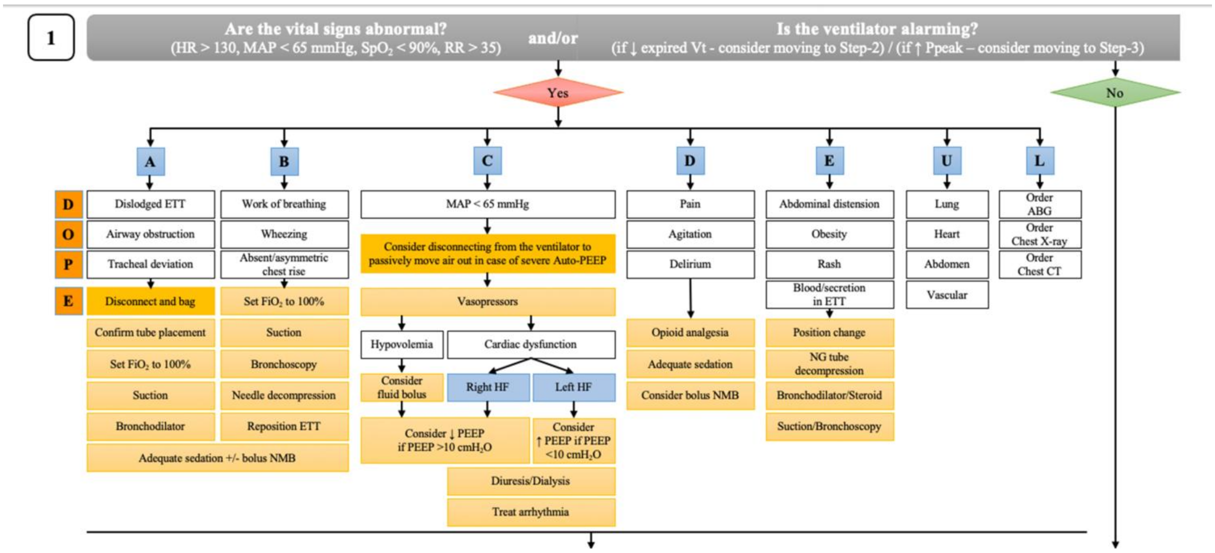

Figure S1. Flowchart for assessment of life-threatening conditions requiring immediate actions (Step 1). Step 1 involves a bedside screening process designed to swiftly identify and address immediately reversible, life-threatening causes of ventilator alarms or abnormal vital signs. This step integrates a focused assessment with prompt corrective actions and targeted diagnostics. Abbreviations: A: Airway; B: Breathing; C: Circulation; D: Disability; E: Exposure; U: POCUS (Point-of-care ultrasound); L: Lab/diagnostic tests; D: Displacement; O: Obstruction; P: Pneumothorax; E: Equipment failure; ABG: Arterial blood gas; CT: Computed tomography; ETT: Endotracheal tube; FiO_2: Fraction of inspired oxygen; HR: Heart rate; MAP: Mean arterial pressure; NMB: Neuromuscular blockade; NG: Nasogastric; PEEP: Positive end-expiratory pressure; Ppeak: Peak inspiratory pressure; SpO_2: Peripheral capillary oxygen saturation; Vt: Tidal volume.

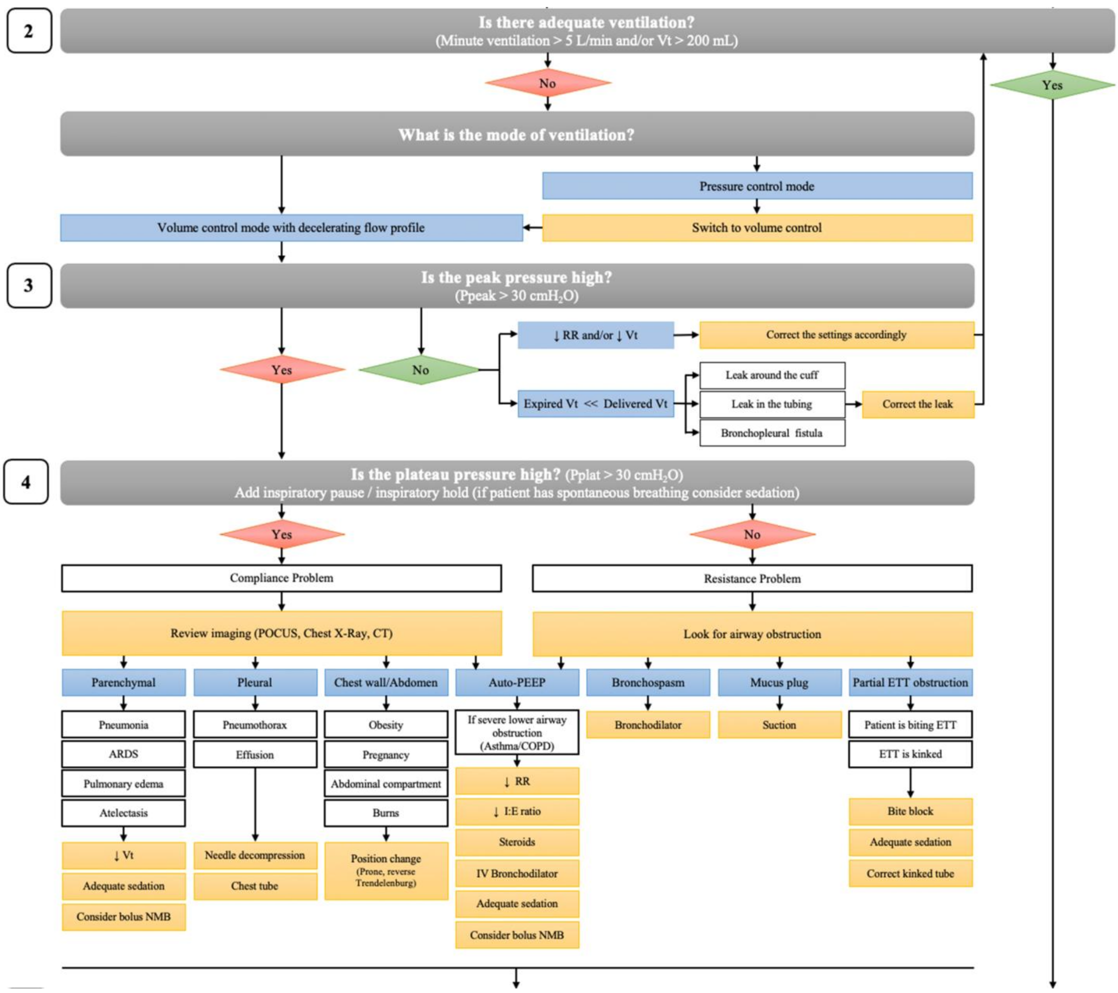

Figure S2. Flowchart for assessment of adequate ventilation for immediate troubleshooting (Steps 2–4). This flowchart outlines the rapid bedside evaluation of inadequate ventilation, defined as MV exceeding 5 L/min and/or tidal volume (Vt) exceeding 200 mL. Key steps include mode adjustment, assessment of elevated peak pressure (Ppeak > 30 cmH$_2$O) with checks for leaks and settings, and differentiation of compliance versus airway resistance issues based on plateau pressure (Pplat > 30 cmH$_2$O) to guide targeted interventions. Abbreviations: ARDS: Acute respiratory distress syndrome; CT: Computed tomography; ETT: Endotracheal tube; I:E: Inspiration: expiration; NMB: Neuromuscular blockade; PEEP: Positive end-expiratory pressure; Ppeak: Peak inspiratory pressure; Pplat: Plateau pressure; POCUS: Point-of-care ultrasound; RR: Respiratory rate; Vt: Tidal volume.

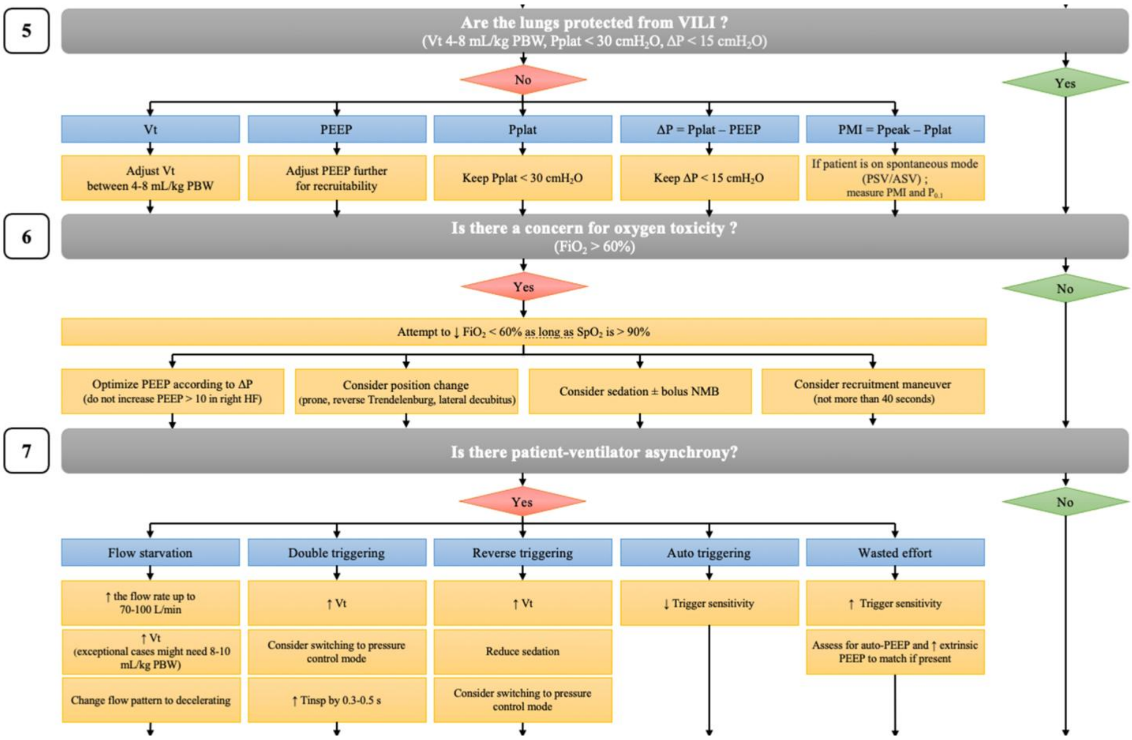

Figure S3. Flowchart for minimizing the risk of lung injury (Steps 5–7). A systematic approach to reducing ventilator-associated lung injury through the optimization of essential ventilatory parameters, the restriction of excessive oxygen exposure, and the identification and management of patient–ventilator asynchrony. Abbreviations: ASV: Adaptive support ventilation; FiO$_2$: Fraction of inspired oxygen; HF: Heart failure; NMB: Neuromuscular blockade; $P_{0.1}$: Airway occlusion pressure at 0.1 seconds; PBW: Predicted body weight; PEEP: Positive end-expiratory pressure; PMI: Pressure muscle index; Pplat: Plateau pressure; PSV: Pressure support ventilation; SpO$_2$: Peripheral capillary oxygen saturation; Tinsp: Inspiratory time; VILI: Ventilator-induced lung injury; Vt: Tidal volume; ΔP: Driving pressure.

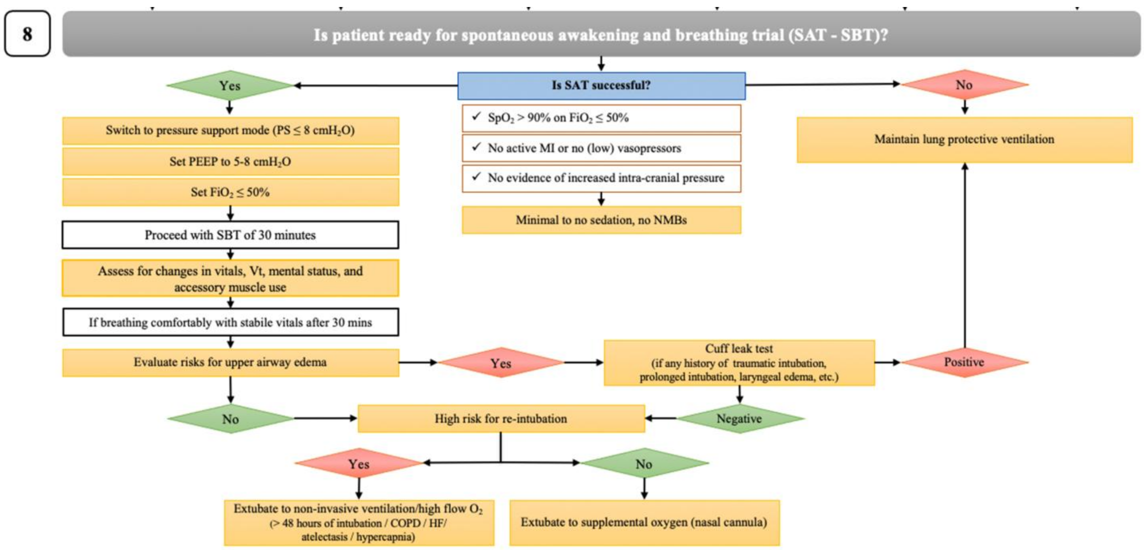

Figure S4. Flowchart for assessing readiness for spontaneous awakening and breathing trials (Step 8). This flowchart outlines a systematic approach for the initiation and interpretation of SAT and SBT. It incorporates predefined criteria for physiological stability, standardized procedures for conducting SBTs, screening for upper-airway edema—including cuff-leak testing when appropriate—and recommendations for post-extubation respiratory support. Abbreviations: COPD: Chronic obstructive pulmonary disease; FiO_2: Fraction of inspired oxygen; HF: Heart failure; MI: Myocardial infarction; NMB: Neuromuscular blockade; PEEP: Positive end-expiratory pressure; PS: Pressure support; SAT: Spontaneous awakening trial; SBT: Spontaneous breathing trial; SpO_2: Peripheral capillary oxygen saturation; Vt: Tidal volume.