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Asthma Management is Life-Threatening in Intensive Care Units

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Abstract

Life-threatening asthma is an acute medical emergency characterized by severe airflow obstruction, mucus plugging, and dynamic hyperinflation that may progress to respiratory failure requiring intensive care. This narrative review synthesizes definitions, epidemiological context, pathophysiological mechanisms, and clinical management strategies relevant to patients with life-threatening asthma in intensive care units (ICUs). The review draws on clinical practice guidelines, official Indonesian health information, medical textbooks, and published studies cited in the manuscript, including the Global Initiative for Asthma (GINA) 2025 report and relevant literature on acute severe asthma management. The evidence was organized according to the recognition of disease severity, risk factors for clinical deterioration, pharmacological interventions, noninvasive respiratory support, invasive mechanical ventilation, and extracorporeal membrane oxygenation (ECMO). The synthesis highlights the importance of rapid clinical assessment, prompt administration of inhaled short-acting bronchodilators and systemic corticosteroids, appropriate selection of respiratory support, and strategies to minimize dynamic hyperinflation during invasive mechanical ventilation. ECMO may be considered for selected patients with refractory respiratory failure at specialized centers; however, reported clinical outcomes vary according to patient characteristics, disease severity, and institutional expertise. Current evidence does not establish a universally optimal treatment escalation pathway applicable to all patients. These findings underscore the importance of integrating pathophysiological understanding, continuous clinical monitoring, evidence-based guidelines, and multidisciplinary expertise into individualized clinical decision-making. As this article is a narrative review without a formal risk-of-bias assessment or quantitative meta-analysis, its conclusions should be interpreted as a synthesis of available clinical evidence rather than definitive comparative evidence of treatment effectiveness.

INTRODUCTION

Asthma is a heterogeneous chronic inflammatory airway disease characterized by variable respiratory symptoms and expiratory airflow limitation. Although many patients can achieve and maintain adequate disease control with guideline-recommended treatment, acute exacerbations may progress to life-threatening airflow obstruction and respiratory failure. Current clinical guidelines and critical care literature emphasize the importance of early recognition, evidence-based treatment escalation, and continuous clinical monitoring in emergency departments and intensive care units (ICUs) (Gayen et al., 2024; Global Initiative for Asthma [GINA], 2025; Talbot et al., 2024).

The clinical urgency of life-threatening asthma arises from the potential for rapidly increasing airway resistance, mucus plugging, dynamic hyperinflation, and impaired gas exchange. A small proportion of hospitalized patients require intensive care admission or invasive mechanical ventilation (Centers for Disease Control and Prevention [CDC], 2024; Chang et al., 2020); however, reported mortality rates vary according to patient populations, disease severity, healthcare settings, and study methodologies. Indonesian national health survey data cited in the source manuscript further indicate that asthma remains a significant public health concern, while access to specialized critical care services and advanced respiratory support varies across healthcare facilities (Ministry of Health of the Republic of Indonesia, 2023, 2024).

The pathophysiological mechanisms underlying acute clinical deterioration include airway inflammation, bronchoconstriction, mucosal edema, and prolonged expiratory time, which may result in air trapping, dynamic hyperinflation, and the development of intrinsic positive end-expiratory pressure (auto-PEEP). Respiratory infections and coexisting medical conditions may further complicate clinical management, while excessive airway pressures during mechanical ventilation can increase the risks of hemodynamic compromise and barotrauma. A comprehensive understanding of these interacting physiological mechanisms is essential for selecting appropriate pharmacological interventions, supplemental oxygen therapy, ventilatory support strategies, and rescue treatments (Demoule et al., 2020; King et al., 2018).

Previous reviews have examined severe asthma phenotypes and emerging therapeutic strategies, particularly the roles of eosinophilic and neutrophilic airway inflammation in disease pathogenesis and treatment responses (Kuruvilla et al., 2019; Park et al., 2022). More recent critical care reviews have explored mechanical ventilation strategies and other therapeutic approaches for managing acute life-threatening asthma exacerbations (Gayen et al., 2024; Mein & Ferrera, 2025; Talbot et al., 2024). Collectively, these publications provide an important foundation of clinical evidence; however, their primary emphasis varies across pathophysiological mechanisms, acute pharmacological management, respiratory support strategies, and specialized extracorporeal interventions.

The research gap addressed by this article concerns the need for an integrated clinical synthesis rather than the investigation of a previously untested therapeutic effect. Clinicians require a comprehensive, clinically applicable framework that connects early warning signs, underlying pathophysiological mechanisms, and evidence-based treatment escalation decisions in the ICU. Areas of ongoing uncertainty include the optimal timing, patient selection, and clinical indications for noninvasive respiratory support before endotracheal intubation, as well as the appropriate criteria for initiating extracorporeal membrane oxygenation (ECMO) in patients with refractory respiratory failure. Furthermore, much of the available evidence concerning critically ill patients with life-threatening asthma is derived from observational studies, limiting causal inference and the generalizability of reported clinical outcomes.

The primary contribution of this narrative review is the integration of existing clinical evidence into a coherent management continuum encompassing early recognition, initial stabilization, pharmacological treatment, ventilatory management, liberation from mechanical ventilation, and advanced rescue therapies. The review incorporates contemporary clinical guidelines and previously published studies cited in the manuscript without claiming to provide a systematic review, formal meta-analysis, or pooled treatment-effect estimates. Its novelty lies in synthesizing and critically interpreting these interconnected clinical components to support decision-making in intensive care settings, while explicitly acknowledging limitations in the available evidence and disparities in access to specialized critical care facilities.

The objective of this review is to synthesize current knowledge regarding the definitions, epidemiological characteristics, underlying pathophysiological mechanisms, and reported

clinical management strategies for life-threatening asthma in the ICU, including pharmacological interventions, noninvasive respiratory support, invasive mechanical ventilation, and ECMO. The anticipated contribution is to provide clinicians and researchers with a comprehensive, clinically relevant reference for understanding treatment escalation principles, optimizing individualized management strategies, and identifying unresolved evidence gaps that warrant further investigation. Nevertheless, therapeutic decisions must be individualized according to patient characteristics, clinical severity, available institutional resources, current evidence-based professional guidelines, established local protocols, and qualified clinical judgment.

METHOD

This study employed a narrative literature review to synthesize published evidence on the management of life-threatening asthma in intensive care units (ICUs). The reviewed sources included clinical practice guidelines, medical textbooks, official epidemiological reports, and peer-reviewed scientific publications, primarily published between 2014 and 2025. Key references included the Global Initiative for Asthma (GINA) 2025 report, recommendations from the Indonesian Society of Respirology (PDPI), reports from the Indonesian Ministry of Health, StatPearls, and relevant clinical studies. Sources were selected purposively based on their relevance, scientific credibility, and applicability to the management of critically ill patients with severe asthma.

Data were collected through a review of relevant clinical guidelines, epidemiological reports, and scientific literature. A thematic framework was used to organize the extracted information into four principal categories: clinical severity and risk factors, epidemiological characteristics, pathophysiological mechanisms, and therapeutic management strategies. The management strategies examined included bronchodilator therapy, systemic corticosteroids, supplemental oxygen, noninvasive respiratory support, invasive mechanical ventilation, and extracorporeal membrane oxygenation (ECMO). Selected publications were examined to identify key clinical findings, therapeutic recommendations, and areas of agreement or disagreement across the available evidence.

The collected information was analyzed using descriptive thematic synthesis. Relevant findings were categorized, compared, and integrated into a structured discussion of clinical management approaches for life-threatening asthma. Differences in reported clinical outcomes, treatment indications, and management recommendations were interpreted in relation to patient characteristics, clinical severity, and study design limitations. The synthesis emphasized the clinical applicability of existing evidence while identifying uncertainties and gaps in current management strategies. No statistical pooling or meta-analysis was performed, and the findings were interpreted within the methodological limitations of a narrative literature review.

RESULTS AND DISCUSSION

Definition and Classification of Degrees of Asthma Attack

Asthma is a chronic disease of the airways characterized by inflammation and narrowing of the airway that causes symptoms of shortness of breath to difficulty breathing. Based on GINA (2025), asthma is a heterogeneous disease characterized by inflammation of the airways, established based on a history of respiratory symptoms such as wheezing, tightness, a feeling of heaviness in the chest, and coughing that varies in time and intensity, followed by limited expiratory flow (Goldin et al., 2024; Quirt et al., 2018). Episodes of increased symptoms of tightness, coughing, wheezing, and/or depressed chest accompanied by a progressive decrease in lung function are called exacerbations or acute asthma.

Asthma exacerbations can be the first clinical manifestation in undiagnosed patients, often triggered by exposure to pollen, pollutants, pungent odors, and non-adherence to the use

of controlling medications. Severe exacerbations can occur in partially or total controlled patients. Near-fatal/life-threatening asthma attacks are classified based on a combination of clinical symptoms, objective findings (oximetry, blood gas), and response to initial therapy (Fu & Tsai, 2014; McIntyre & Busse, 2022; Perhimpunan Dokter Paru Indonesia [PDPI], 2021), as summarized in Table 1.

Table 1. Degree of asthma attack

Degrees	Clinical Findings	Inspection Parameters
Mild–Moderate	The patient was still able to speak in complete sentences and showed no decrease in consciousness.	SpO_2 is usually ≥94% at presentation; PEF/FEV_1 ≥50% of prediction; blood gas is usually normocapnia.
Severe	Interrupted speech (words only), agitation/anxiety, use of clear breathing support muscles, signs of heavy breathing.	SpO_2 is often <94%; PEF/FEV_1 <50% predicted; RR ≥30/min; early possibility of $PaCO_2$ increase.
Life-Threatening (Mengancam Nyawa)	Decreased consciousness/drowsiness, silent chest, bradycardia, respiratory muscle fatigue.	Hypoxemia is refractory to oxygen, progressive hypercapnia ($PaCO_2$ increases), respiratory acidosis.

Source: Authors' synthesis of the clinical guidance and references cited in the text.

Epidemiology of Life-Threatening Asthma

Chang et al. (2020) reported a 10-year case fatality rate of 1.49% (276 out of 18,495 patients) in hospitalized fatal asthma patients, while an analysis of the UK national database by Watson et al. (2007) reported a mortality rate of 0.43% over a five-year period. This difference is thought to be related to the age characteristics of the patients: 73% of patients in the Watson study were under 44 years of age, while in Chang's study only 10% of patients were under 60 years of age, so older age is thought to contribute to the high mortality rate in hospitals.

Factors associated with life-threatening asthma attacks include: a history of severe/life-threatening exacerbations requiring intubation and mechanical ventilation; a history of hospitalization or emergency visits due to asthma in the past 1 year; are currently using or have recently stopped using oral corticosteroids; not using inhaled corticosteroids; excessive use of SABA; poor adherence to inhaled corticosteroids; a history of psychiatric or psychosocial disorders; food allergies; as well as comorbidities such as pneumonia, diabetes, and arrhythmias.

Comorbidities and infections accompanying treatment, such as pneumonia, sepsis, diabetes mellitus, and arrhythmias, have been reported to increase the relative risk of death from asthma. A history of repeated treatment due to exacerbations and the use of oral and inhaled corticosteroids that exceed recommendations also contribute to increased mortality from asthma attacks, especially life-threatening asthma.

The pathophysiology of life-threatening asthma

Life-threatening asthma (LTA) is the most severe form of asthma exacerbation, characterized by severe airway obstruction, increased airway resistance, and rapid ventilation failure. Its pathogenesis is multifactorial, involving immunological disorders, chronic inflammation, airway remodeling, and systemic and external triggers, which can be summarized in the following four main mechanisms (King et al., 2018; Rahimi et al., 2022).

Brittle Asthma (Steroid Resistant)

Brittle asthma is characterized by extreme fluctuations in lung function and poor response to corticosteroids (Hussain & Liu, 2024; Mavis & Brady, 2020), through mechanisms: glucocorticoid receptor dysfunction (increased expression of inactive GR-β inhibits the work

of GR-α); persistent eosinophilic inflammation and Th2 lymphocytes with a predominance of IL-4, IL-5, and IL-13; as well as oxidative stress due to exposure to allergens and pollutants that degrade steroid sensitivity through activation of the NF-κB and AP-1 pathways. As a result, massive bronchoconstriction, thick mucus that clogs the lumen, and heavy water-trapping that leads to hypercapnia and respiratory acidosis.

Systemic Comorbidities

Comorbidities such as obesity, GERD, chronic rhinosinusitis, sleep apnea, and psychiatric disorders increase susceptibility to severe asthma attacks through chronic systemic inflammation (IL-6, TNF-α, leptin), gastric acid reflux that causes microaspiration and vagal stimulation, and obesity that decreases lung volume (FRC) and increases intrathoracic pressure thereby exacerbating ventilation-perfusion mismatches. Patients with a high comorbid burden exhibit poor asthma control and a greater risk of life-threatening asthma as well as the need for mechanical ventilation.

Anaphylactic shock

Anaphylaxis can be a direct trigger of LTA through the activation of mast and basophil cells (IgE-mediated hypersensitivity) that release histamine, prostaglandin D_2, and leukotrien $C_4/D_4/E_4$, causing diffuse bronchoconstriction, mucosal edema, and increased vascular permeability resulting in a drastic decrease in alveolar ventilation. The systemic inflammatory response causes vasodilation and relative hypovolemia that leads to shock and decreased pulmonary perfusion. Without rapid intervention in the form of adrenaline, oxygenation, and systemic corticosteroids, this condition leads to respiratory failure.

Severe Pneumonia Infection

Viral (influenza, RSV) or bacterial (Streptococcus pneumoniae, Haemophilus influenzae) infection exacerbates airway inflammation through bronchial epithelial disruption that facilitates allergen penetration and increases mucus production, as well as the activation of Toll-Like Receptor (TLR-4) in epithelial cells and macrophages that trigger the release of IL-8, TNF-α, and neutrophil infiltration, resulting in the formation of a neutrophil asthma phenotype that is more refractive to steroids (Gibson & Foster, 2019). The synergistic effects of infection and asthma result in increased ROS, surfactant damage, and progressive ventilation-perfusion mismatch to hypercapnic respiratory failure requiring mechanical intubation and ventilation.

Physiologically, in the exacerbation phase the inflammatory process develops progressively, increasing capillary permeability and triggering airway edema, resulting in increased airway resistance due to bronchospasm and mucous obstruction. Decreased pulmonary elasticity leads to premature closure of the airway during expiration, causes ventilation-perfusion mismatch (V/Q mismatch) as well as prolongation of expiratory duration, leading to air retention in the alveoli and dynamic hyperinflation, especially in tachypnea conditions. In severe exacerbations, inflammation, bronchospasm, and limited expiratory flow prevent the return of alveolar pressure to atmospheric pressure, thus maintaining intrinsic positive pressure (PEEPi/auto-PEEP) at the end of expiration, with an inhomogeneous distribution between lung parts according to regional expiratory time characteristics.

Asthma Management Is Life-Threatening

Life-threatening asthma is the most severe form of asthma exacerbation, characterized by persistent airway obstruction that is unresponsive to conventional bronchodilators (Johnston & Nixon, 2022), causing severe ventilation disruption, increased breathing, and ventilation-perfusion imbalance leading to hypoxemia and progressive CO_2 retention. Silent chest symptoms signal an advanced stage of severe bronchial obstruction and are a sign of emergency that indicates a risk of respiratory arrest, so prompt treatment with mechanical ventilation is crucial to maintain oxygenation.

Indications and Procedures of Mechanical Ventilation

Mechanical ventilation is a life-saving intervention in patients with signs of ventilation failure ($PaCO_2$ >50 mmHg with pH <7.25), use of massive ventilatory muscles, respiratory muscle fatigue, decreased consciousness (GCS <8), or imminent respiratory arrest (Demoule et al., 2020; Fujishima, 2023). Intubation is performed using the rapid sequence intubation (RSI) technique using ketamine (1–2 mg/kg IV) as an induction agent due to its bronchodilator effect, and rocuronium (1 mg/kg IV) as a fast-acting muscle paralysis. This procedure requires caution due to the high risk of hypotension due to increased intrathoracic pressure immediately after ventilation begins. The success of intubation in severe asthma in the ICU ranged from 85–90% in the first attempt when performed by experienced personnel, while failure or difficult intubation occurred in 10–15% of cases due to severe airway edema, laryngeal spasm, or secretion buildup, which increases the risk of hypoxemia, hypotension, and cardiac arrest.

Mechanical Ventilator Setup

The purpose of mechanical ventilation in life-threatening asthma is to maintain adequate oxygenation, avoid barotrauma, and allow time for pharmacological therapy to work instead of rapidly normalizing $PaCO_2$. The ventilation strategy emphasizes lung protective strategy and the prevention of dynamic hyperinflation (Gayen et al., 2024; Talbot et al., 2024). Volume control mode (VCV) facilitates fixed tidal volume regulation, while pressure control (PCV) provides better maximum pressure control. The ideal ventilation parameters are summarized in Table 2.

Table 2. Mechanical ventilator setting parameters

Parameters	Recommendations	Purpose
Mode	Volume Control or Pressure Control	Controllable
VT	6–8 mL/kg PBW	Prevents overdistension
RR	10–14/min	Extending expiration time
I:E Ratio	1:3–1:5	Prevent water trapping
PEEP	0–5 cmH_2W	Prevent auto-PEEP
FiO_2	Meets the target SpO_2 93–95%	Prevents hyperoxia
Concept	Permissive hypercapnia	Prevent barotrauma

Source: Authors' synthesis of the clinical guidance and references cited in the text.

Monitoring, Complications, and Prevention

Strict monitoring is necessary to prevent postintubation complications, including analysis of blood gas (PaO_2, $PaCO_2$, pH), peak and plateau pressure, auto-PEEP, as well as hemodynamics and oxygenation (SpO_2, pulse, blood pressure) (Sanchez, 2023). Complications to look out for:

a) Auto-PEEP and dynamic hyperinflation due to insufficient expiratory time, leading to decreased cardiac preload and hypotension; prevented by low RR, long I:E ratio (1:4–1:5), avoiding high external PEEP, and expiratory hold maneuver to detect auto-PEEP.
b) Barotrauma includes pneumothorax, pneumomediastinum, and subcutaneous emphysema; prevented by maintaining peak pressure of <40 cmH_2O, plateau <30 cmH_2O, low tidal volume, and long expiratory time.
c) Hypotension due to ventilation In the event of sudden hypotension, the ventilator is temporarily stopped (disconnect test) for 30–60 seconds and fluid resuscitation is carried out if necessary.

Weaning and Postventilator

Weaning readiness was assessed based on the following criteria: $PaCO_2$ <50 mmHg and pH >7.30, RR <25/min, and stable SpO_2 at FiO_2 <40%. Weaning can be performed directly with extubation followed by HFNC or preventive NIV, or gradually minimally invasive followed by NIV/HFNC in stable borderline patients. Weaning is said to be successful when there is no need for reintubation within 48 hours, normal blood gas analysis, and no signs of respiratory failure; it is said to fail when retubation occurs within <48 hours, signs of respiratory fatigue, recurrent hypercapnia, or SpO_2 <90% with FiO_2 >0.4. In recurrent failure, the use of short-term NIV or HFNC is considered.

When severe hypercapnia recurs and oxygenation remains inadequate despite optimal ventilation, the use of ECMO should be considered. HFNC can be used in stable or post-extubation patients to reduce respiratory function and the risk of retubation, with a ROX index of <3.47 in the first 6 hours predicting HFNC failure (Hancı et al., 2023). NIV is useful as a bridge therapy before invasive ventilation or after extubation in mild-moderate respiratory failure, with absolute contraindications of decreased consciousness, high aspiration risk, and hemodynamic instability.

Pharmacological Therapy

Pharmacological therapy is administered simultaneously with mechanical ventilation to control bronchospasm and inflammation. Nebulized β2 adrenoceptor bronchodilators are the primary therapy in all degrees of asthma exacerbation, acting through the activation of the enzyme adenylyl cyclase that produces cAMP, activates protein kinase A, and modifies intracellular calcium concentrations (Katzung, 2018; Kristiningrum, 2023); the intravenous route is used only in patients who do not respond to nebulation, with side effects in the form of tachycardia, tremors, and serum glucose and potassium disorders.

Systemic corticosteroids have long-known benefits in the management of acute asthma; administration within the first hour of exacerbation in the emergency department significantly lowers the risk of hospitalization, lowers mortality, relapse, hospitalization needs, as well as the need for β2 agonist therapy. Intravenous MgSO4 works through cellular calcium uptake via Na+/Ca2+ pumping, muscle relaxation through myosin inhibition, and acetylcholine calcium-dependent release at motor neuron terminals. Intravenous aminophyllin induces bronchial smooth muscle relaxation through phosphodiesterase inhibition, calcium translocation, adenosine receptor blockade, and GABA receptor modulation. A summary of pharmacological regimens is presented in Table 3.

Table 3. Pharmacological therapy of asthma patients with life-threatening with mechanical ventilators

Group	Drugs & Dosage	Remarks
SABA	Salbutamol 2.5–5 mg nebulized every 20 minutes, or continuous 10–15 mg/hour	Main therapy of bronchodilation
SAME	Ipratropium bromide 0.5 mg nebulized every 20 minutes ×3, then every 4–6 hours	Combination with SABA enhances the effect
Systemic corticosteroids	Methylprednisolone 1–2 mg/kg IV every 6 hours or Hydrocortisone 100 mg IV every 6 hours	Lowers bronchial inflammation
$MgSO_4$	2 g IV in 20 minutes	For asthma refractory to bronchodilators
Antibiotics	Adjusted suspicion of infection and ventilation status	Management of comorbidities

Source: Authors' synthesis of the clinical guidance and references cited in the text.

Antibiotics are required when there is evidence of secondary infection such as severe community-acquired pneumonia (sCAP) or ventilator-associated pneumonia (VAP), and empirical therapy is started immediately without waiting for culture results. The regimen refers to the 2019 IDSA/ATS guidelines, as summarized in Table 4.

Table 4. Empirical antibiotics in life-threatening asthma with mechanical ventilators

Types of Infection	Major Empirical Regimes	Specific Alternatives/Risks	Duration
sCAP	Beta-lactam (ceftriaxone 2 g IV q24h/cefotaxime 2 g IV q8h/ampicillin-sulbactam 3 g IV q6h) + macrolide (azithromycin 500 mg IV/PO q24h) or respiratory fluoroquinolone (levofloxacin 750 mg IV/PO q24h)	Risk of Pseudomonas: piperacillin-tazobactam/cefepime + levofloxacin or amicasein. Risk of MRSA: add vancomycin or linezolid	7–10 days, customized clinical response
VAP	Meropenem 1 g IV q8h + Vancomycin 15 mg/kg IV q12h	Customized culture results and sensitivity	7–10 days

Source: Authors' synthesis of the clinical guidance and references cited in the text.

Role of ECMO

Approximately 3–5% of life-threatening asthma patients who fail with conventional mechanical ventilation eventually require Extracorporeal Membrane Oxygenation (ECMO), specifically veno-venous ECMO (VV-ECMO), as a life-saving therapy in refractory conditions with severe hypercapnia, respiratory acidosis, and refractory hypoxemia (Mein & Ferrera, 2025; Turn et al., 2024). ECMO allows for the exchange of gases outside the body, reducing the risk of barotrauma, and giving the lungs time to recover from the inflammatory process. The survival rate of ECMO-treated patients is reported to be more than 80%, especially in centers with high experience, although it is not free of the risk of complications such as bleeding, thromboembolism, and infection. Overall, the safety profile is relatively good compared to the high risk of mortality due to refractory respiratory failure.

Discussion

The above literature synthesis confirms that life-threatening asthma is the end point of a complex pathophysiological cascade including steroid resistance, systemic comorbidities, anaphylactic shock, and severe infections that lead to persistent airway obstruction, water trapping, and ventilation failure. Understanding these mechanisms is an important basis for determining appropriate management strategies, especially since conventional bronchodilator therapy is often no longer adequate in this phase.

The difference in mortality rates between studies (Chang et al., 2020: 1.49% versus Watson et al., 2007: 0.43%) illustrates that age factors and population characteristics also affect clinical outcomes, so the generalization of mortality rates between countries and between health service centers needs to be done carefully. This is relevant for the Indonesian context, considering the sizable national prevalence of asthma (1.6–4% of the population) but the uneven distribution of ICU facilities and intubation trained personnel between regions.

From a management perspective, the permissive principle of hypercapnia and pulmonary protective ventilation strategies (low tidal volume, long expiratory time, minimal external PEEP) have been consistently emphasized as the primary approach to prevent barotrauma and auto-PEEP, rather than seeking to rapidly normalize $PaCO_2$. This approach reflects a paradigm shift from 'normalization of blood gas' to 'giving the lungs time to recover', in line with the goal of mechanical ventilation in other severe obstructive conditions such as COPD.

Early systemic corticosteroid administration and inhaled bronchodilators remain the backbone of pharmacological therapy, supported by evidence of reduced risk of hospitalization when administered within the first hour. However, most of the evidence underlying this algorithm comes from observational studies and literature reviews, rather than large-scale randomized controlled clinical trials specifically for populations of life-threatening asthma in the ICU given the difficulty of randomizing life-threatening emergency conditions. This limited evidence is a research gap that needs to be addressed in future studies, especially regarding the optimal time of initiation of NIV/HFNC before intubation and patient selection criteria for ECMO.

The role of ECMO as a life-saving therapy in refractory cases shows promising results (survival >80% in experienced centers), but its availability in Indonesia is still limited to a number of tertiary referral hospitals. This emphasizes the importance of early detection of signs of deterioration (silent chest, progressive hypercapnia, respiratory muscle fatigue) and a responsive referral system so that patients can obtain timely therapeutic escalation before respiratory arrest.

Overall, the management of life-threatening asthma requires a gradual and integrated approach ranging from the optimization of pharmacological therapy, escalation of non-invasive oxygen therapy, invasive mechanical ventilation with pulmonary protection strategies, to ECMO in refractory cases whose success depends heavily on a deep clinical understanding of the underlying pathophysiology.

CONCLUSION

Life-threatening asthma constitutes an acute medical emergency characterized by severe airflow obstruction, dynamic hyperinflation, and impaired gas exchange, potentially progressing to respiratory failure. The literature synthesized in this review highlights rapid clinical assessment, early recognition of deterioration, and timely treatment escalation as essential management principles. Inhaled short-acting bronchodilators and systemic corticosteroids remain the cornerstone of initial pharmacological management. Noninvasive respiratory support may be considered for carefully selected patients under close clinical monitoring, whereas invasive mechanical ventilation requires strategies that ensure adequate expiratory time, minimize air trapping, and prevent excessive dynamic hyperinflation. Extracorporeal membrane oxygenation (ECMO) may serve as a rescue intervention for selected patients with refractory respiratory failure in specialized centers. However, reported clinical outcomes should be interpreted cautiously because of variations in patient characteristics, disease severity, treatment approaches, and institutional expertise.

Future research should establish standardized, clinically applicable criteria for selecting patients for noninvasive respiratory support, determining the optimal timing of endotracheal intubation, optimizing mechanical ventilation strategies to minimize ventilator-induced lung injury and dynamic hyperinflation, facilitating liberation from mechanical ventilation, and identifying appropriate indications for ECMO referral. Multicenter prospective studies with clearly defined clinical outcomes are recommended to strengthen the evidence supporting these management decisions. Further context-specific investigations are also necessary to evaluate the feasibility, accessibility, and implementation of advanced respiratory support strategies in Indonesian intensive care units, particularly in healthcare facilities with limited resources. Given the narrative nature of this review and the absence of formal methodological quality assessment or meta-analysis, its findings should be interpreted as a synthesis of existing clinical evidence and applied in conjunction with current evidence-based guidelines, institutional protocols, and individualized clinical judgment rather than as an independent protocol for prescribing treatment or determining mechanical ventilator settings.

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CONFLICT OF INTEREST

The author states that this research was conducted without any commercial or financial relationship that can be interpreted as a potential conflict of interest

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GENERATIVE ARTIFICIAL INTELLIGENCE USAGE STATEMENT

The author states that no generative artificial intelligence was used in the preparation of this article.

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