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# Repeated Endotracheal Epinephrine Associated With Rapid Improvement in Ventilatory Mechanics During Near-Fatal Refractory Status Asthmaticus: A Case Report

## Authors' Contribution:

Study Design A  
Data Collection B  
Statistical Analysis C  
Data Interpretation D  
Manuscript Preparation E  
Literature Search F  
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**Patient:** Female, 19-year-old  
**Final Diagnosis:** Status asthmaticus  
**Symptoms:** Respiratory distress  
**Clinical Procedure:** —  
**Specialty:** Critical Care Medicine

**Objective:** Unusual clinical course

**Background:** Near-fatal status asthmaticus remains a life-threatening condition in which evidence guiding management beyond conventional therapies is limited. When effective ventilation cannot be achieved despite invasive mechanical ventilation and standard medical treatment, therapeutic options become increasingly uncertain.

**Case Report:** An 18-year-old woman with a history of asthma developed near-fatal refractory status asthmaticus requiring endotracheal intubation and intensive care admission. Despite invasive mechanical ventilation, continuous nebulized salbutamol, systemic corticosteroids, intravenous magnesium sulfate, and sedation, profound hypercapnic and hypoxemic respiratory failure persisted (pH 6.94, PaCO<sub>2</sub> 106 mm Hg, and PaO<sub>2</sub> 49 mm Hg at an FiO<sub>2</sub> of 1.0), with critically reduced tidal volumes and markedly elevated airway pressures. Endotracheal epinephrine was administered as a rescue intervention and this was followed by rapid improvement in ventilatory mechanics, oxygenation, and gas exchange. PaO<sub>2</sub> subsequently increased to 64 mm Hg at an FiO<sub>2</sub> of 0.60, corresponding to an improvement in the PaO<sub>2</sub>/FiO<sub>2</sub> ratio from 49 to approximately 107. Recurrent ventilatory deterioration developed on 2 occasions and was again followed by prompt improvement after repeated endotracheal epinephrine administration. The patient ultimately recovered, was successfully liberated from invasive mechanical ventilation, and was discharged without neurological sequelae.

**Conclusions:** In this patient with near-fatal refractory status asthmaticus, repeated endotracheal epinephrine administration was temporally associated with rapid improvements in ventilatory function during episodes of recurrent deterioration. Because multiple concurrent therapies were administered, causality cannot be established. This observation should be regarded as hypothesis-generating and may warrant further investigation in carefully selected patients with extreme refractory disease after standard therapies have been optimized.

**Keywords:** Status Asthmaticus • Ventilation • Epinephrine • Salvage Therapy  
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## Introduction

Near-fatal status asthmaticus represents the most severe form of acute asthma exacerbation and remains associated with substantial morbidity and mortality despite major advances in asthma management [1]. Although only a minority of patients require intensive care admission and invasive mechanical ventilation, these patients constitute a particularly vulnerable population in whom rapid deterioration may culminate in life-threatening respiratory failure. Recent international statements have emphasized that major evidence gaps persist in the management of severe asthma exacerbations, particularly when conventional therapies fail to achieve clinical stabilization [2].

Current treatment strategies for severe asthma exacerbations include inhaled short-acting  $\beta_2$ -agonists, systemic corticosteroids, oxygen supplementation, and intravenous magnesium sulfate [1]. Invasive mechanical ventilation is considered supportive therapy while pharmacologic interventions take effect, and does not directly reverse the underlying airway obstruction. However, guidance becomes limited when patients continue to deteriorate despite optimization of conventional therapy and invasive mechanical ventilation. Several salvage interventions, including ketamine, inhaled anesthetics, extracorporeal carbon dioxide removal (ECCO<sub>2</sub>R), and extracorporeal membrane oxygenation (ECMO), have been described in this setting, although the supporting evidence is derived largely from case reports, observational studies, and expert opinion [3].

We report the case of an 18-year-old woman with near-fatal refractory status asthmaticus who progressed toward respiratory collapse despite invasive mechanical ventilation and optimization of conventional therapies. During the subsequent course, endotracheal epinephrine was used as a rescue intervention in the setting of recurrent deterioration. The purpose of this report is not to establish therapeutic efficacy, but to describe this observation and generate hypotheses regarding the potential role of endotracheal epinephrine as a rescue intervention in carefully selected patients with refractory status asthmaticus when standard measures fail.

## Case Report

An 18-year-old woman with a known history of asthma presented to the emergency department with progressive dyspnea and severe respiratory distress. On arrival, she had sinus tachycardia at 116 beats/min, a blood pressure of 130/70 mm Hg, a respiratory rate of 36 breaths/min, and an oxygen saturation of 82% despite receiving oxygen at 10 to 15 L/min through a non-rebreather mask. According to the available history, she had remained largely asymptomatic for the preceding

4 to 5 years and had experienced no intervening asthma exacerbations. She had discontinued maintenance therapy, but the name and dose of her previous inhaler and the exact date of discontinuation could not be determined. No recent asthma follow-up or Asthma Control Test score was available. She described a 2 to 3-day prodromal illness clinically compatible with a viral respiratory infection; however, this was not microbiologically confirmed, and no definite infectious, allergic, environmental, medication-related, or other precipitating factor could be established.

Initial treatment in the emergency department included repeated bronchodilator therapy and intravenous methylprednisolone. Despite these interventions, her respiratory distress progressively worsened and was accompanied by declining mental status. The exact pre-intubation Glasgow Coma Scale score was not documented. Owing to impending respiratory failure, rapid sequence intubation was performed using rocuronium 30 mg as the neuromuscular blocking agent. No cardiopulmonary arrest occurred, and cardiopulmonary resuscitation was not required. Toxicological screening was not performed during the acute clinical evaluation. The patient was subsequently transferred to the intensive care unit (ICU) for further management of severe status asthmaticus.

On arrival in the ICU, after intubation and initiation of sedation, her Glasgow Coma Scale score was 4T (E1M3VT). She was markedly cyanotic, with a heart rate of 136 beats/min, a blood pressure of 142/83 mm Hg, a respiratory rate of 44 breaths/min, and an oxygen saturation of 79% despite mechanical ventilation with an FiO<sub>2</sub> of 1.0. During transfer from the transport stretcher to the ICU bed, the ventilator settings were rapidly adjusted. Adaptive support ventilation (ASV) was selected to facilitate rapid algorithm-guided adjustment of respiratory rate, inspiratory and expiratory times, and pressure delivery without delaying treatment through repeated manual modification of individual parameters. Ventilation was initiated with an FiO<sub>2</sub> of 1.0, a positive end-expiratory pressure (PEEP) of 8 cm H<sub>2</sub>O, and a target minute ventilation of 120%, which was progressively increased to 200% because of persistent ventilatory failure.

An arterial blood gas analysis obtained immediately after ICU admission while the patient was receiving an FiO<sub>2</sub> of 1.0 demonstrated profound acidemia and extreme hypercapnia, with a pH of 6.94, PaCO<sub>2</sub> of 106 mm Hg, PaO<sub>2</sub> of 49 mm Hg, standard bicarbonate of 21 mmol/L, and lactate of 1.7 mmol/L. The PaO<sub>2</sub>/FiO<sub>2</sub> ratio was 49. In an effort to achieve adequate tidal volumes, the upper pressure limit was progressively increased to 60 cm H<sub>2</sub>O. Nevertheless, effective ventilation could not be established. Exhaled tidal volumes remained critically low at approximately 120 to 160 mL despite peak airway pressures exceeding 50 cm H<sub>2</sub>O.

Ventilator waveforms demonstrated persistent expiratory flow at the onset of the subsequent breath, consistent with incomplete exhalation, intrinsic PEEP, and dynamic hyperinflation. Intrinsic PEEP was assessed qualitatively from the expiratory flow-time waveform; a reliable numerical auto-PEEP measurement could not be obtained during these episodes.

Nebulized salbutamol was administered as 4 consecutive 2.5-mg doses, for a total dose of 10 mg, during the emergency rescue period. The precise overall duration of administration was not separately documented. The patient received intravenous methylprednisolone 80 mg in the emergency department, followed by an additional 80 mg after ICU admission. Intravenous magnesium sulfate 2 g was administered over approximately 10 to 15 minutes. Initial sedation and analgesia were provided with continuous intravenous infusions of midazolam at 0.1 mg/kg/h and fentanyl at 1 µg/kg/h, respectively.

On auscultation, diffuse coarse wheezing was audible throughout both inspiration and expiration over all lung fields; a silent chest was not present. The intensity and quality of the breath sounds were striking and resembled a “creaking door” phenomenon, consistent with severe generalized airflow obstruction.

Immediately reversible causes of ineffective ventilation were assessed during the rapidly evolving deterioration. Endotracheal suctioning yielded no significant secretions, and replacement of the endotracheal tube produced no improvement, arguing against tube obstruction or malposition. Bronchoscopy could not be performed because the deterioration progressed over only a few minutes and immediate restoration of ventilation took priority. Anaphylaxis was considered unlikely because there were no cutaneous or mucosal manifestations, no identifiable allergic trigger, and no hypotension or other evidence of circulatory compromise.

Despite invasive mechanical ventilation and concurrently administered standard therapies, effective ventilation could not be established. Endotracheal epinephrine was therefore administered as a rescue intervention. Epinephrine 1 mg was diluted with normal saline to a total volume of 10 mL, yielding a final concentration of 0.1 mg/mL (1: 10 000), and was instilled through the endotracheal tube.

Propofol, aminophylline, inhaled anesthetics, inhaled corticosteroids, and alternative routes of epinephrine were not administered before the first endotracheal epinephrine administration. Because the patient’s deterioration progressed over only a few minutes, sequential trials of these nonstandard adjunctive therapies were not feasible. Neither ECMO nor ECCO<sub>2</sub>R was available at our institution, and initiation of either modality would have required interhospital transfer, which was not feasible during the acute rescue period.

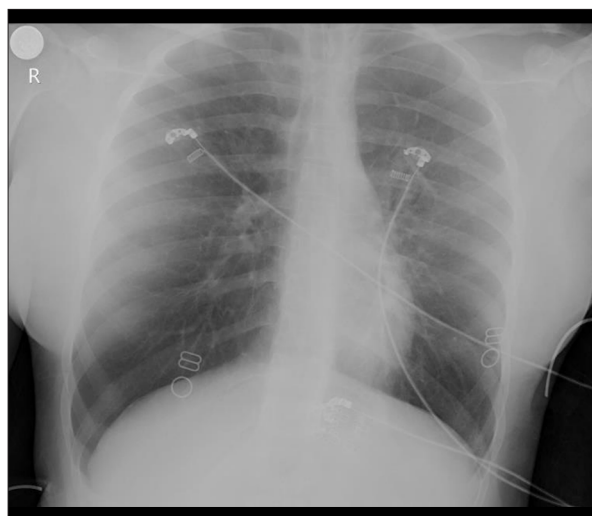


**Figure 1.** Portable chest radiograph obtained to evaluate respiratory deterioration. No focal parenchymal infiltrate, pneumothorax, or lobar atelectasis was identified. No alternative radiographic explanation for the profound ventilatory failure was found.

A prompt physiological improvement was observed within seconds after the initial endotracheal epinephrine administration. Respiratory rate and peak airway pressures decreased, oxygenation improved, and effective ventilation was restored. An arterial blood gas analysis obtained during this interval while the patient was receiving an FiO<sub>2</sub> of 0.60 showed improvement in pH to 7.09, PaCO<sub>2</sub> to 69.8 mm Hg, and PaO<sub>2</sub> to 61 mm Hg. Standard bicarbonate was 22 mmol/L, lactate was 1.5 mmol/L, and the PaO<sub>2</sub>/FiO<sub>2</sub> ratio was approximately 102.

The temporary stabilization allowed review of the available radiological results. Chest radiography and thoracic computed tomography demonstrated no focal parenchymal infiltrate, pneumothorax, lobar collapse, or evident emphysematous change (**Figures 1, 2**). The thoracic computed tomography examination was not performed using a pulmonary angiography protocol; therefore, pulmonary embolism could not be definitively excluded. However, there were no bilateral pulmonary opacities or other parenchymal findings suggestive of pulmonary edema or acute respiratory distress syndrome.

Unfortunately, the initial response proved to be transient. Within approximately 3 to 5 minutes, peak airway pressures again increased and ventilatory performance progressively deteriorated. Before complete recurrence of the initial ventilatory failure, a second dose of endotracheal epinephrine was administered when declining tidal volumes and worsening ventilator mechanics became evident. This intervention was again followed by rapid improvement.

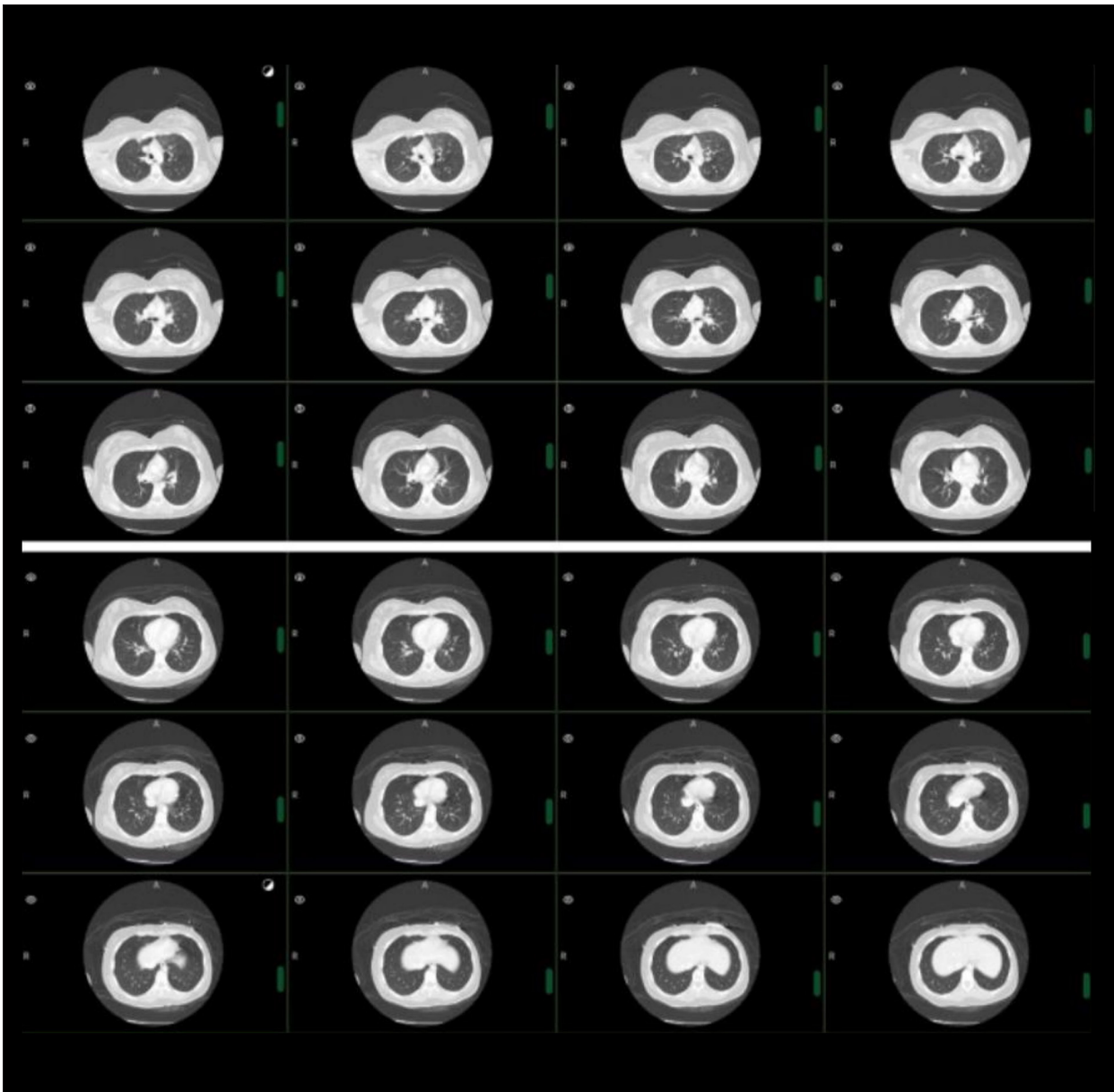


**Figure 2.** Axial thoracic computed tomography images obtained to evaluate respiratory deterioration. The examination showed no focal parenchymal infiltrate, pneumothorax, lobar collapse, or evident emphysematous change. No alternative radiological explanation for the profound ventilatory failure was identified.

During the rescue phase, the initial sedation regimen consisting of midazolam and fentanyl was modified to a combination of midazolam and ketamine. The second response appeared more sustained. Nevertheless, progressive deterioration recurred approximately 5 to 10 minutes later. Recorded ventilator parameters during this third episode documented recurrent ventilatory deterioration despite ongoing intensive therapy. Recognizing this pattern of deterioration, a third administration of endotracheal epinephrine was performed and once again resulted in prompt restoration of effective ventilation. Subsequent ventilator measurements demonstrated an increase in tidal volume

to approximately 500 mL, accompanied by decreases in respiratory rate and peak airway pressure. Ventilator settings and recorded respiratory parameters extracted from screenshots obtained before and after the third endotracheal epinephrine administration are summarized in **Table 1**.

Across these 3 episodes, repeated endotracheal epinephrine administration was temporally associated with rapid and reproducible improvements in ventilatory mechanics, oxygenation, and gas exchange. Continuous cardiac monitoring demonstrated sinus tachycardia throughout the rescue period.

**Table 1.** Ventilator settings and recorded respiratory parameters before and after the third endotracheal epinephrine administration.

| Parameter                                                   | Before administration | After administration |
|-------------------------------------------------------------|-----------------------|----------------------|
| Ventilation mode                                            | ASV                   | ASV                  |
| <b>Settings</b>                                             |                       |                      |
| Target minute ventilation (%)                               | 120                   | 120                  |
| Set PEEP (cm H <sub>2</sub> O)                              | 8                     | 8                    |
| Set FiO <sub>2</sub> (%)                                    | 60                    | 60                   |
| <b>Recorded parameters</b>                                  |                       |                      |
| Peak airway pressure (cm H <sub>2</sub> O)                  | 45                    | 38                   |
| Device-displayed plateau pressure (cm H <sub>2</sub> O)     | 45                    | Not displayed        |
| Device-displayed auto-PEEP (cm H <sub>2</sub> O)            | 2.1                   | Not displayed        |
| Exhaled tidal volume (mL)                                   | 277                   | 553                  |
| Inspiratory flow (L/min)                                    | 41.1                  | Not displayed        |
| Expiratory flow (L/min)                                     | 37.2                  | Not displayed        |
| Inspiratory resistance (cm H <sub>2</sub> O-s/L)            | 43                    | Not displayed        |
| Expiratory resistance (cm H <sub>2</sub> O-s/L)             | 30                    | Not displayed        |
| Device-displayed static compliance (mL/cm H <sub>2</sub> O) | 18.8                  | Not displayed        |
| Total respiratory rate (breaths/min)                        | 32                    | 15                   |
| Inspiratory time (s)                                        | 0.49                  | Not displayed        |
| Expiratory time (s)                                         | 1.38                  | Not displayed        |
| Inspiratory-to-expiratory ratio                             | 1: 2.8                | Not displayed        |
| Inspiratory time constant (s)                               | 0.80                  | Not displayed        |
| Expiratory time constant (s)                                | 0.51                  | Not displayed        |
| Rapid shallow breathing index (breaths/min/L)               | 116                   | Not displayed        |
| P0.1 (cm H <sub>2</sub> O)                                  | —                     | Not displayed        |
| Inspiratory work of breathing (J/L)                         | —                     | Not displayed        |

ASV, adaptive support ventilation; PEEP, positive end-expiratory pressure.

No atrial fibrillation, other arrhythmia, hypertension, or apparent ischemic ST-segment change was observed. A 12-lead electrocardiogram was not obtained during the rapidly evolving acute phase.

As described for the first episode, epinephrine 1 mg was diluted with normal saline to a total volume of 10 mL and rapidly instilled as a bolus directly through the endotracheal tube while mechanical ventilation was continued. The same dose, volume, and administration technique were used for all 3 administrations.

Following the third endotracheal epinephrine administration, transient hypotension developed and was treated with an intravenous epinephrine infusion of less than 0.1 µg/kg/min. Blood

pressure subsequently stabilized at 109/57 mm Hg, with a heart rate of 112 beats/min. No further episodes of recurrent ventilatory deterioration were observed thereafter. Subsequent arterial blood gas analysis demonstrated continued improvement of the ventilatory failure, FiO<sub>2</sub> of 0.60, the pH increased further to 7.15, PaCO<sub>2</sub> decreased to 58.8 mm Hg, and PaO<sub>2</sub> increased to 64 mm Hg; standard bicarbonate was 21 mmol/L, lactate was 1.5 mmol/L, and the PaO<sub>2</sub>/FiO<sub>2</sub> ratio was approximately 107. Lactate remained within the normal range throughout these measurements, with no biochemical evidence of β<sub>2</sub>-agonist- or epinephrine-associated hyperlactatemia. The patient was successfully extubated on hospital day 3. She remained in the ICU for continued monitoring and was transferred to the general ward on hospital day 5. She was discharged home on hospital day 10 without neurological sequelae. No pneumothorax,

**Table 2.** Chronological summary of clinical deterioration, interventions, and immediate responses.

| Time or event                                                        | Clinical findings                                                                                                                                                                                                                                                                                                                                                                                                                                    | Interventions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Immediate response                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ICU admission and initial reassessment                               | Visible cyanosis; irregular tachypneic breathing; pH 6.94, PaCO <sub>2</sub> 106 mm Hg, PaO <sub>2</sub> 49 mm Hg, standard HCO <sub>3</sub> <sup>-</sup> 21 mmol/L, lactate 1.7 mmol/L, and PaO <sub>2</sub> /FiO <sub>2</sub> ratio 49; exhaled tidal volume approximately 120-160 mL despite peak airway pressure > 50 cm H <sub>2</sub> O; ventilator findings consistent with incomplete exhalation, intrinsic PEEP, and dynamic hyperinflation | ASV with FiO <sub>2</sub> 1.0 and PEEP 8 cm H <sub>2</sub> O; target minute ventilation increased from 120% to 200%; upper pressure limit increased to 60 cm H <sub>2</sub> O; 4 consecutive 2.5 mg doses of nebulized salbutamol (total 10 mg); intravenous methylprednisolone 80 mg in the emergency department followed by an additional 80 mg in the ICU; intravenous magnesium sulfate 2 g over approximately 10-15 min; midazolam 0.1 mg/kg/h and fentanyl 1 µg/kg/h; endotracheal suctioning | No meaningful improvement; effective ventilation could not be established                                                                                                                                                                                                                                                                                                                                                |
| Persistent failure of ventilation before first rescue administration | Persistently low tidal volumes and markedly elevated airway pressures despite the above interventions                                                                                                                                                                                                                                                                                                                                                | Endotracheal tube exchange produced no improvement. The first endotracheal epinephrine dose was subsequently administered (1 mg diluted with normal saline to a total volume of 10 mL)                                                                                                                                                                                                                                                                                                              | Improvement within seconds, with decreased respiratory rate and peak airway pressure and restoration of effective ventilation. Arterial blood gas analysis obtained during this interval showed pH 7.09, PaCO <sub>2</sub> 69.8 mm Hg, PaO <sub>2</sub> 61 mm Hg at an FiO <sub>2</sub> of 0.60, standard bicarbonate 22 mmol/L, lactate 1.5 mmol/L, and a PaO <sub>2</sub> /FiO <sub>2</sub> ratio of approximately 102 |
| Approximately 3-5 min after the first administration                 | Recurrent reduction in tidal volume, worsening ventilatory mechanics                                                                                                                                                                                                                                                                                                                                                                                 | Second endotracheal epinephrine administration; ketamine infusion initiated at 80 mg/h without a loading bolus                                                                                                                                                                                                                                                                                                                                                                                      | Prompt improvement in ventilatory mechanics; the response was more sustained than after the first administration                                                                                                                                                                                                                                                                                                         |
| Approximately 5-10 min after the second administration               | Further recurrence of tachypnea, reduced tidal volume, elevated peak airway pressure, despite ongoing treatment and ketamine-based sedation                                                                                                                                                                                                                                                                                                          | Third endotracheal epinephrine administration                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Prompt restoration of effective ventilation; tidal volume increased to approximately 500 mL, with decreases in respiratory rate and peak airway pressure                                                                                                                                                                                                                                                                 |
| Stabilization period after the third administration                  | Hypotension developed after improvement in ventilatory mechanics; no further episodes of recurrent ventilatory deterioration were documented                                                                                                                                                                                                                                                                                                         | Intravenous epinephrine infusion initiated                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Sustained improvement in ventilation; subsequent arterial blood gas analysis showed pH 7.15, PaCO <sub>2</sub> 58.8 mm Hg, PaO <sub>2</sub> 64 mm Hg, standard HCO <sub>3</sub> <sup>-</sup> 21 mmol/L, lactate 1.5 mmol/L, and PaO <sub>2</sub> /FiO <sub>2</sub> ratio 107. Blood pressure subsequently stabilized at 109/57 mm Hg, with a heart rate of 112 beats/min                                                 |

ICU, intensive care unit; PEEP, positive end-expiratory pressure; ASV, adaptive support ventilation.

ventilator-associated pneumonia, hospital-acquired infection, or other major in-hospital complication occurred.

The patient received intravenous methylprednisolone 80 mg in the emergency department and an additional 80 mg after ICU admission; treatment was subsequently continued at 80 mg/day for 3 days and then 40 mg/day, for a total duration of 7 days. The chronological sequence of clinical deterioration, interventions, and immediate responses is summarized in **Table 2**.

## Discussion

Near-fatal status asthmaticus represents the most severe end of the spectrum of acute asthma exacerbations and remains associated with substantial morbidity and mortality despite advances in asthma management. The European Respiratory Society/European Academy of Allergy and Clinical Immunology (ERS/EACI) statement on severe asthma exacerbations emphasized that important evidence gaps persist in the management of life-threatening attacks, particularly in patients requiring invasive mechanical ventilation [2]. Although endotracheal intubation is generally regarded as providing a therapeutic window during which pharmacological treatments can take effect, this assumption may not always hold true in clinical practice.

Our patient illustrates a scenario in which the anticipated protective window afforded by invasive mechanical ventilation failed to materialize. Despite airway control, optimization of ventilator settings, continuous nebulized  $\beta_2$ -agonist therapy, systemic corticosteroids, intravenous magnesium sulfate, sedation, and exclusion of endotracheal tube-related causes through tube exchange, effective ventilation could not initially be achieved. Profound acidemia (pH 6.94), extreme hypercapnia ( $\text{PaCO}_2$  106 mm Hg), severe cyanosis, critically reduced tidal volumes, and markedly elevated airway pressures indicated imminent physiological collapse despite what would generally be considered definitive supportive therapy.

Importantly, mechanical ventilation itself does not reverse bronchospasm but merely supports gas exchange while medical therapies exert their effects. Contemporary reviews emphasize that invasive ventilation in severe asthma requires careful balancing of permissive hypercapnia, dynamic hyperinflation, and barotrauma risk. However, the literature provides limited guidance regarding the management of patients in whom adequate ventilation cannot be established despite optimization of conventional therapies. Rescue strategies such as ketamine, inhaled anesthetics, ECCO<sub>2</sub>R, and ECMO have been described, but recommendations regarding their timing, sequencing, and patient selection rely predominantly on observational studies, case reports, and expert opinion [3,4].

The principal observation of this report was the repeated temporal association between endotracheal epinephrine administration and reproducible physiological improvement. The first administration was followed within seconds by restoration of effective ventilation, improvement in oxygenation, reduction in peak airway pressures, and objective improvement in arterial blood gas parameters. Importantly, this response was transient and followed by recurrent ventilatory deterioration. Subsequent administrations were undertaken in response to evolving deterioration in ventilator mechanics and were again associated with rapid improvement. Although the pattern was not perfectly symmetrical, the repeated sequence of deterioration followed by prompt restoration of ventilation strengthens the temporal association between endotracheal epinephrine administration and the observed physiological changes.

The mechanisms underlying this response remain speculative. Epinephrine exerts potent  $\beta$ -adrenergic effects leading to airway smooth muscle relaxation and bronchodilation. Simultaneously,  $\alpha$ -adrenergic vasoconstrictive effects may reduce airway mucosal edema, potentially improving airway caliber [5]. These mechanisms may be particularly relevant in patients with profound airflow limitation, in whom delivery of inhaled therapies to distal airways is compromised by critically low tidal volumes and severe bronchospasm. In such circumstances, endotracheal administration could theoretically achieve more effective local drug delivery than nebulized therapy alone.

Potential systemic adverse effects of epinephrine include tachycardia, hypertension, arrhythmias, myocardial ischemia, and hyperlactatemia. In our patient, sinus tachycardia was already present before endotracheal epinephrine administration, and no new arrhythmia, hypertension, apparent ischemic change, or lactate elevation was observed during continuous monitoring. Transient hypotension occurred after the third administration, although its causal relationship to endotracheal epinephrine cannot be established.

Ketamine was incorporated into the sedation strategy during the rescue phase and may have contributed to subsequent stabilization through its bronchodilatory and sympathomimetic properties [6]. The temporal relationship between endotracheal epinephrine administration and the observed physiological improvements was notable; however, the relative contribution of endotracheal epinephrine, ketamine, and other ongoing therapies cannot be determined from a single-case observation.

Published experience with endotracheal epinephrine for severe bronchospasm remains extremely limited. A recent BMJ Case Reports publication described successful use of endotracheal epinephrine in refractory post-intubation bronchospasm [7]. However, several important distinctions should be considered when comparing that report with the present case. The

present case differs from the previously reported case in that the near-fatal asthma exacerbation and progressive respiratory failure preceded intubation, whereas the earlier report described bronchospasm developing after airway instrumentation. In our patient, profound hypercapnic ventilatory failure persisted after intubation despite ongoing conventional treatment.

The severity of this presentation is further highlighted by comparison with reports describing extracorporeal rescue therapies for refractory status asthmaticus. ECCO<sub>2</sub>R and ECMO have been successfully employed in patients with persistent hypercapnic respiratory failure despite maximal medical therapy [8,9]. Our patient exhibited several features that might prompt consideration of extracorporeal support, including severe acidemia, extreme hypercapnia, ineffective ventilation despite high airway pressures, and evolving hemodynamic instability. However, repeated endotracheal epinephrine administration was temporally associated with improvement in ventilatory function, and extracorporeal rescue therapies were ultimately not required. Whether endotracheal epinephrine could serve as a temporizing bridge before ECMO or ECCO<sub>2</sub>R in selected patients remains entirely speculative and warrants further investigation.

This report has several limitations. As a single-patient observation, it cannot establish efficacy or causality. Continuous salbutamol, systemic corticosteroids, magnesium sulfate, ventilator adjustments, and ketamine were administered concurrently; therefore, the independent contribution of endotracheal epinephrine cannot be determined. Furthermore, pulmonary deposition and systemic absorption after endotracheal administration were not measured, and the efficacy, systemic safety, optimal dose, dosing interval, administration technique, and appropriate patient selection remain unknown. The findings should therefore be interpreted solely as hypothesis-generating.

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## Conclusions

This case describes near-fatal refractory status asthmaticus in which effective ventilation could not initially be achieved despite invasive mechanical ventilation and optimization of conventional therapies. Repeated endotracheal epinephrine administration was temporally associated with reproducible improvements in ventilatory mechanics and gas exchange during episodes of recurrent deterioration. Because this observation derives from a single patient and multiple concurrent therapies were administered, causality cannot be established. The findings should therefore be regarded as hypothesis-generating and applicable only to highly selected patients with extreme refractory disease after standard therapies and immediately reversible causes of ventilatory failure have been addressed. Further investigation is required before any therapeutic conclusions can be drawn.

## Institution Where Work Was Done

Prof. Dr. A. İlhan Özdemir State Hospital, Giresun, Türkiye.

## Consent for Publication

Written informed consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief upon reasonable request.

## Declaration of Figures' Authenticity

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