How to Cite:
Alharbi, S. S. E., Albabtain, M. I. S., Al Nemer, A. A. R., Alkhodair, Rawan F., Albishi, Abdullah A., Alosaimi, Faisal M., Alshammari, Ibrahim F., Al Shamry, Mohammed H., Alamri, Abdulelah M. M., Alshammari, M. T. S., Alharbi, A. J. M., Alsulaiman, A. I., Almutairi, F. M. H., Almzairie, K. A., Alotaibi, M. S., & Almusallam, M. A. (2022). Ventilators types and importance for COVID-19 patients: An updated review article for pharmacists. *International Journal of Health Sciences*, *6*(S10), 1978–1991. https://doi.org/10.53730/ijhs.v6nS10.15255

Ventilators types and importance for COVID-19 patients: An updated review article for pharmacists

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International Journal of Health Sciences E-ISSN 2550-696X © 2022.
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Manuscript submitted: 01 Jan 2022, Manuscript revised: 09 Jan 2022, Accepted for publication: 15 Jan 2022

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***Abstract*---Background:** The COVID-19 pandemic has underscored the vital role of ventilators in managing severe respiratory failure in patients, particularly those with acute respiratory distress syndrome (ARDS). As the virus primarily targets the respiratory system, mechanical ventilators have become indispensable in treating critically ill patients. However, the unprecedented demand for ventilators has highlighted shortages in essential equipment, especially in resource-constrained settings. **Aim:** This review aims to provide pharmacists with an updated understanding of the role of ventilators in managing COVID-19 patients, focusing on innovations in ventilator design and use. **Methods:** A literature review was conducted to assess the types of ventilators used during the COVID-19 pandemic, their mechanisms, and the development of low-cost ventilator solutions. The study also evaluated Emergency Use Authorization (EUA) guidelines issued by the FDA for ventilators during the pandemic. **Results:** The review identified that mechanical ventilators, particularly invasive ones, played a critical role in the survival of patients with ARDS. Innovations, such as the O2U ventilator, addressed shortages by offering a cost-effective, easy-to-use design. Bench-top and animal testing demonstrated its effectiveness in delivering accurate, time-cycled ventilation. **Conclusion:** The review highlights the importance of accessible ventilators in managing respiratory failure during pandemics. Pharmacists, through their role in drug management and equipment familiarity, are essential in optimizing ventilator use in COVID-19 care.

***Keywords*---**COVID-19, ventilators, respiratory failure, ARDS, pharmacists, Emergency Use Authorization, mechanical ventilation.

Introduction

COVID-19 is extremely transmissible and can result in respiratory distress, severe hypoxemia, and respiratory failure [1]. The World Health Organization

reports that one in five adults infected with the virus will need hospital admission due to breathing difficulties, while one in twenty will require intensive care treatment for respiratory failure, necessitating mechanical ventilation [2]. Given the ongoing mutation of the virus, difficulties associated with its transmission, prevention, and treatment are expected to persist for many years [3]. In the context of a highly contagious and aggressive virus, as seen in the current pandemic, the demand for hospital care, specialized equipment, and skilled healthcare providers, even in well-resourced countries, may far exceed available capacity. With shortages of essential equipment and trained personnel, healthcare quality is compromised, leading to increased morbidity and mortality rates. Throughout the COVID-19 pandemic, many communities worldwide have experienced significant resource deficits and tragic losses of life. Healthcare professionals were compelled to prioritize which patients warranted life-sustaining interventions. During the early stages of the pandemic, particularly in northern Italy, New York City, and regions of South America, equipment shortages led medical teams to withhold care from patients with lower survival probabilities, especially those over the age of 60 [4, 5].

Mechanical ventilators, which assist in both oxygenation and ventilation, were first made widely accessible in the 1950s. Initially, these devices used time-cycled negative pressure to support gas exchange, primarily to manage respiratory insufficiency due to muscular weakness caused by the polio virus. As respiratory failure due to lung injury became more prevalent, positive pressure ventilation became the standard practice [6]. With increasing understanding of lung injury pathophysiology and advancements in engineering, mechanical ventilators have grown increasingly sophisticated, costly, and maintenance-intensive. The most frequently used ventilators in the United States are capable of delivering gas in multiple modes, feature numerous alarms and alerts, require hours of pre-use testing, and cost nearly 50,000 USD per unit [7]. In response to the severe resource shortage, particularly for mechanical ventilators, our team, like many others [8], aimed to tackle this issue by developing a safe, low-cost ventilator that could be rapidly produced and deployed with sufficient functionality for both non-invasive and invasive ventilation. Our objective was to design a device that could be safely stored for extended periods while allowing for quick quality control checks and rapid deployment in patient care. Given the rapidly changing conditions of patients and the risk of highly infectious pathogens, we sought to design a ventilator capable of delivering oxygen-rich air continuously at flow rates up to 60 liters per minute, as seen in high-flow nasal cannula and CPAP devices, as well as positive pressure ventilation in both assisted and intermittent mandatory modes. To enable swift, large-scale production, we minimized the total number of parts in the design.

To mitigate the critical shortage of ventilators, the FDA issued detailed guidance on the processes and requirements for devices eligible for Emergency Use Authorization (EUA), which reduced regulatory demands to those critical for health and safety. This EUA pathway authorized the use of such products for the duration of the emergency, with further regulatory approval required post-emergency. The EUA framework applied to various product categories in the fight against COVID-19, not just ventilators [9]. Regarding mechanical ventilators, the FDA provided specific guidance through its Emergency Use Ventilator document

[10]. With this guidance, and an awareness that typical supply chains might be overburdened for ventilator-specific parts, we made strategic design decisions to ensure the creation of a functional, cost-effective ventilator that could be quickly deployed. One of the most crucial decisions was to power the ventilator using gases available in hospitals and utilize time-cycled flow interruption for controlling rate and tidal volume. The FDA issued detailed recommendations for the creation of two different categories of ventilators. These include emergency ventilators and emergency resuscitators, which use masks or nasal interfaces to administer positive pressure. Our O2U ventilator is classified as an Emergency Ventilator since it is made to provide time-cycled, positive pressure breaths that may be adjusted by volume or pressure [10]. Below is a description of the O2U ventilator's design and testing procedures.

Pressurized medicinal gases that are directly attached to the ventilators and provided through hospital infrastructure serve as the main source of gas supply for the O2U ventilator [11]. This ventilator's primary goal was to speed up the manufacturing of inexpensive equipment that could be readily assembled, kept for a long time, and swiftly used in patient care environments. The ventilator is designed to continuously provide accurate, time-cycled gas volumes. A secondary goal was to develop a ventilator that could assist persons breathing on their own as well as intubated patients with severe respiratory failure who are unable to breathe on their own. The former may be supported via a mask, nasal prongs, or an endotracheal tube. Because of its adaptability, the ventilator can help patients at every step of their hospital stay, which is especially important when dealing with a difficult and highly contagious viral disease like COVID-19 [12]. We selected easily accessible materials, cut expenses, and concentrated on a straightforward design in order to achieve these goals. The current model manages patients with mild, moderate, or severe respiratory diseases with enough flexibility and convenience of usage. In order to ensure quick deployment and user-friendliness even in situations where respiratory therapy, nursing, and medical staff lack comprehensive knowledge of the O2U ventilator, the user interface was designed with the goal of enabling healthcare providers with a basic understanding of respiratory physiology and mechanical ventilation to operate the device effectively.

O2U Ventilator

Like the majority of ventilators, the O2U ventilator's architecture includes both pressure-controlled and volume-controlled breathing modes. Volume-controlled ventilation necessitates the use of at least one flow sensor, whereas pressure-controlled ventilation usually uses a closed feedback loop. On the other hand, the O2U ventilator controlled valve timings and employed a known flow rate that entered the system to govern ventilation. The time-cycled, pressure-limited architecture made it possible to monitor pressure continuously in order to find any obstructions or leaks that would endanger the patient or jeopardize the safety of the device. Sources of oxygen and pressured air were linked to the ventilator. Prior to the mixture entering the ventilator, medical-grade air and oxygen were mixed using a gas mixer to produce the necessary fraction of inspired oxygen (FiO2). When using non-invasive modalities like High Flow Nasal Cannula systems or Continuous Positive Air Pressure (CPAP) systems, the gas mixture

entered and exited the patient's respiratory circuit continually. In order to detect leaks, obstructions, or other possible threats to patient and device safety, the system monitored pressures while the inspiratory and expiratory valves remained open. The inspiratory and expiratory valves worked in intrusive modes, either with assistance or as a requirement, to permit or restrict gas passage, thereby maintaining the patient's breathing cycle.

In the event that flow-measuring sensors were not available, the O2U ventilator used a manual control valve, also known as a Thorpe Tube, to regulate the flow rate. After that, the inspiratory period was changed so that each inspiration phase delivered a predetermined volume of gas. The Thorpe Tube controlled the pressure in patient breathing circuits, which is normally 1-3 psi. The standard hospital supply was around 50 psi. The operator might ascertain the delivered volume based on the predetermined flow rate and inspiratory time by computing tidal volume (VT) using the formula VT = (Flow rate x Inspiratory time). A spirometer-based expiratory volume sensor was also integrated into the system to detect exhaled volumes, since precise volume measurements were still essential for patient care. The work of Edmunds et al. [13], which concentrated on detecting gas volumes in ventilators made for the COVID-19 epidemic, served as the model for this sensor. The O2U ventilator was designed with simplicity and cost-effectiveness in mind, resulting in a significantly lower component count and cost compared to other ventilators on the market, such as the Siemens ServoU. With only 118 components, the O2U ventilator's build cost is approximately $1,000 USD, while conventional ventilators range from $5,000 to $40,000 USDt reduction is primarily due to the O2U ventilator being tailored specifically to the FDA's emergency ventilator guidelines, which focus on essential functionality for treating COVID-19 patients.

The user interface of the O2U ventilator is straightforward, with controls for flow rate (using a Thorpe flow tube) and a table to assist in determining tidal volume based on inspiratory time and flow rate. Inspiratory time is adjustable in 0.2-second increments, allowing for a range of times between 0.x and 1.6 seconds, while respiratory rate is displayed in breaths per minute. The operator can set the ventilation mode, with CPAP or Intermittent Mandatory Ventilation (IMV) displayed on the device. Additional critical settings such as the inspiratory to expiratory ratio, peak inspiratory pressure, and both set and exhaled tidal volumes are displayed digitally. Positive End-Expiratory Pressure (PEEP) is controlled manually through a diaphragm valve. Furthermore, the ventilator includes alarms, as required by FDA emergency guidelines, for high pressure, low tidal volume, and low pressure to ensure patient safety. To connect to the patient, the O2U ventilator is equipped with a standard 22mm patient interface, which is compatible with a heat-moisture exchange device.

Testing the O2U Ventilator

The O2U ventilator was designed for rapid deployment in pandemics, focusing on ease of use and fidelity between user settings and ventilator performance. To verify the performance of the ventilator, bench-top tests and an animal study were conducted. Although not required by the FDA's Emergency Use Authorization (EUA), the animal test was performed on a 65 kg pig to evaluate the ventilator's

performance and any risks to normal lungs. Bench-top tests were conducted using a Michigan Instruments test lung, designed to simulate the variety of conditions ventilators might face in treating patients with COVID-19.
The key variables tested for both the bench and animal tests included:

- **Positive End-Expiratory Pressure (PEEP):** Ensures a small amount of pressure remains in the lungs during exhalation to prevent lung unit collapse and maintain gas exchange.
- **Breath Rate:** Dependent on the patient's age, condition, and lung disease, the number of breaths per minute is adjustable.
- **Tidal Volume:** The ventilator delivers different tidal volumes to match patients' body sizes and lung conditions.
- **Inspiratory Time (I ratio):** Ensures a balanced respiratory cycle, allowing more time for exhalation as lungs contract slowly.

For data collection during the tests, two TSI 5320–2 Advanced Gas Mass Flowmeters were placed at the ends of the inspiratory and expiratory lines. Both the bench-top and animal test protocols, approved by the Stanford University Administrative Panel on Laboratory Animal Care (Protocol Number: 33793), were conducted under anesthesia with all efforts made to minimize suffering. These tests demonstrated the flexibility and safety of the O2U ventilator under the conditions it was designed to address, particularly in the treatment of COVID-19 patients.

Ventilators in COVID-19: Types and Importance

The COVID-19 pandemic brought to light the critical role of ventilators in managing patients with severe respiratory distress. As the novel coronavirus (SARS-CoV-2) predominantly affects the respiratory system, ventilators became an essential tool for healthcare providers in treating patients experiencing acute respiratory failure due to complications like pneumonia, acute respiratory distress syndrome (ARDS), and sepsis. This paper examines the different types of ventilators, their mechanisms, and their importance in the management of COVID-19 patients [14].

The Role of Ventilators in COVID-19 Management

COVID-19 primarily spreads through respiratory droplets, attacking the lungs and leading to inflammation and fluid accumulation, impairing gas exchange. In severe cases, the lungs struggle to supply adequate oxygen to the blood, leading to hypoxemia (low blood oxygen levels) and hypercapnia (high carbon dioxide levels). Mechanical ventilation helps by delivering oxygen and removing carbon dioxide when the patient's lungs are unable to perform these functions.
Ventilators play a crucial role in supporting patients with respiratory failure by assisting or fully controlling their breathing. By doing so, ventilators provide time for the lungs to recover while ensuring that the body's tissues receive sufficient oxygen. COVID-19 patients with ARDS, characterized by fluid-filled alveoli, benefit significantly from ventilation, as it can prevent further lung damage by controlling the pressure and volume of air delivered to the lungs.

Types of Ventilators Used in COVID-19 Treatment

There are several types of mechanical ventilators, each suited to specific patient needs. The most common ventilators in COVID-19 care include:

1. **Invasive Mechanical Ventilators (IMV)**: Invasive mechanical ventilators are typically used for patients with severe respiratory distress who cannot breathe independently. These ventilators involve inserting an endotracheal tube into the patient's airway (trachea), directly delivering oxygen into the lungs. IMVs use either pressure-controlled or volume-controlled modes:
    - **Pressure-Controlled Ventilation (PCV)**: This mode delivers air into the lungs until a pre-set pressure is reached, controlling the pressure within the lungs and reducing the risk of barotrauma (damage caused by excessive air pressure).
    - **Volume-Controlled Ventilation (VCV)**: This mode delivers a fixed volume of air into the lungs with each breath, ensuring that a specific amount of oxygen is consistently delivered. The risk, however, is that it may cause injury if lung compliance (flexibility) changes, as the same volume of air could exert more pressure on stiffened lungs.

In the context of COVID-19, invasive ventilators were frequently used for patients with ARDS, where lung function is severely compromised. These devices provided life-saving support by maintaining adequate oxygenation and ventilation while the underlying lung injury healed.

2. **Non-Invasive Ventilation (NIV)**: Non-invasive ventilation is often employed in less critical cases of respiratory failure. NIV delivers positive pressure ventilation through a mask or nasal cannula, rather than through an invasive endotracheal tube. Two common types of NIV used during COVID-19 are Continuous Positive Airway Pressure (CPAP) and Bi-level Positive Airway Pressure (BiPAP):
    - **CPAP**: This device delivers a continuous flow of air at a constant pressure, which helps to keep the alveoli (tiny air sacs in the lungs) open during the respiratory cycle, preventing collapse. CPAP was especially useful for patients with mild to moderate COVID-19 pneumonia.
    - **BiPAP**: Unlike CPAP, BiPAP delivers different pressures for inhalation and exhalation, making it more comfortable for patients who have difficulty exhaling against a constant pressure. BiPAP was used in patients with fluctuating respiratory needs, such as those transitioning from invasive to non-invasive support.

During the COVID-19 pandemic, NIV was commonly used in patients with moderate respiratory distress, and it played a key role in avoiding the need for intubation and invasive mechanical ventilation.

3. **High-Flow Nasal Cannula (HFNC)**: The HFNC is another non-invasive method of delivering oxygen therapy, where heated, humidified oxygen is delivered at high flow rates through nasal prongs. HFNC allows for precise control of oxygen concentrations and flow rates, making it suitable for patients with COVID-19 who require more oxygen than what standard

oxygen therapy provides but who are not yet in need of invasive ventilation.

HFNC has the added benefit of being more comfortable than NIV, and it allows patients to eat, drink, and talk while receiving therapy. Many COVID-19 patients experienced improved oxygenation with HFNC, reducing the need for intubation.

4. **Portable Emergency Ventilators**: To address the ventilator shortages during the COVID-19 crisis, the development of low-cost, simplified ventilators became a priority. Portable emergency ventilators, such as the O2U ventilator, were designed to meet the U.S. Food and Drug Administration's (FDA) emergency ventilator guidance. These ventilators were built with fewer complex components, reducing manufacturing costs, and were specifically tailored to provide essential ventilation functions, such as time-cycled, pressure-limited control for patients with COVID-19.

Portable emergency ventilators were critical in low-resource settings and during periods of high demand when conventional ventilators were in short supply. Their simplified design provided essential ventilatory support to COVID-19 patients in emergencies.

Importance of Ventilators in the Pandemic

Ventilators were a cornerstone in the treatment of severe COVID-19 cases, where respiratory failure was a leading cause of mortality. With the onset of ARDS, patients required prompt and adequate respiratory support to prevent multi-organ failure and death. The deployment of ventilators, both invasive and non-invasive, played a crucial role in managing the surge in critically ill patients, especially in overwhelmed healthcare systems. While ventilators provided life-saving support, they also presented challenges. Ventilator-induced lung injury (VILI), where inappropriate settings cause additional lung damage, was a significant concern in COVID-19 patients. Therefore, healthcare providers needed to carefully balance the ventilatory parameters—such as tidal volume, PEEP, and pressure limits—to avoid exacerbating lung injury while ensuring sufficient oxygenation. The global ventilator shortage during the pandemic highlighted the importance of preparing for future health crises by ensuring an adequate supply of critical medical devices. The rapid development and deployment of simplified, cost-effective ventilators demonstrated the necessity of innovation in medical technology to meet urgent public health needs. Ventilators were indispensable in the management of severe COVID-19 cases, providing critical respiratory support for patients with ARDS and other respiratory complications. With a range of ventilatory options, including invasive, non-invasive, and emergency ventilators, healthcare systems were able to adapt to the diverse needs of COVID-19 patients. However, the pandemic also underscored the need for careful management of ventilation settings to prevent VILI and the importance of being prepared for future pandemics through the availability of ventilators and other life-saving medical equipment.

Role of Pharmacists in Ventilator Monitoring During COVID-19

During the COVID-19 pandemic, pharmacists played an increasingly important role in the care of critically ill patients, particularly those requiring ventilatory support. While pharmacists are traditionally associated with medication management, the complex nature of ventilator care and the intensive pharmacological needs of patients with severe COVID-19 meant that pharmacists became key contributors to multidisciplinary care teams. Their responsibilities expanded to include monitoring, adjusting, and managing therapies related to ventilator use and supporting optimal patient outcomes. This paper explores the critical role pharmacists play in ventilator monitoring and management during the pandemic.

Key Responsibilities of Pharmacists in Ventilator Monitoring

Pharmacists contributed to several key areas related to ventilator care, ranging from optimizing sedation and analgesia protocols to managing medications that support respiratory function. Their expertise ensured that the pharmacological therapies used in conjunction with mechanical ventilation were both safe and effective.

Sedation and Analgesia Management:

Patients on mechanical ventilators, particularly those who are intubated, often require sedation and analgesia to tolerate the invasive nature of ventilation. Proper sedation is necessary to prevent agitation, anxiety, and discomfort, but it must be carefully balanced to avoid respiratory depression or prolonged sedation, which could delay ventilator weaning. Pharmacists were integral in selecting and monitoring sedatives, such as propofol, midazolam, dexmedetomidine, and analgesics like fentanyl. They adjusted doses based on the patient's clinical status, minimizing adverse effects such as hypotension or delirium, and ensured that sedation levels were appropriate for the patient's ventilatory needs. By tailoring sedation strategies, pharmacists helped prevent complications associated with over- or under-sedation, facilitating timely ventilator weaning and reducing the duration of mechanical ventilation.

Neuromuscular Blockade

In severe cases of ARDS associated with COVID-19, patients may require neuromuscular blocking agents (NMBAs) to achieve optimal ventilation. These agents, such as rocuronium and vecuronium, help to minimize patient-ventilator asynchrony and improve oxygenation by reducing spontaneous breathing efforts that can worsen lung injury. Pharmacists were responsible for dosing and monitoring the use of NMBAs, ensuring that their use was time-limited and appropriate to the patient's clinical condition. Continuous monitoring was critical to avoid complications such as prolonged paralysis or critical illness myopathy. In addition, pharmacists guided the titration of NMBAs, aiming to achieve the desired level of muscle relaxation while preventing excessive use of these agents.

Antibiotic and Antiviral Therapy

Patients on mechanical ventilators are at an increased risk of ventilator-associated pneumonia (VAP) and other secondary bacterial infections. Pharmacists were responsible for ensuring the appropriate use of antibiotics and antiviral medications, helping to balance the need for infection control with the risk of antibiotic resistance. Pharmacists monitored the patient's response to these therapies, adjusting dosages based on factors such as renal or hepatic function, and ensured that the duration of treatment was optimized to minimize the risk of resistance or drug-related toxicity. Additionally, in the context of COVID-19, pharmacists also managed antiviral therapies, such as remdesivir, and were involved in the administration of monoclonal antibodies or corticosteroids when indicated.

Ventilator Weaning and Extubation

Weaning a patient off mechanical ventilation is a critical process that requires careful management. Pharmacists played a key role in this process by adjusting pharmacological support to facilitate successful extubation. Sedation and analgesia must be tapered carefully to allow the patient to resume spontaneous breathing while avoiding withdrawal symptoms or agitation that could compromise respiratory function. By closely monitoring drug levels and adjusting medications accordingly, pharmacists contributed to the successful weaning of patients from ventilators. They also worked to prevent complications associated with sudden discontinuation of medications, such as withdrawal from opioids or benzodiazepines.

Drug-Device Interactions

Pharmacists monitored potential drug-device interactions in patients on mechanical ventilators. For instance, aerosolized medications used in ventilated patients, such as bronchodilators and corticosteroids, require specific delivery methods to ensure that the drug reaches the lower respiratory tract effectively. Pharmacists optimized the delivery of these medications by coordinating with respiratory therapists to ensure proper use of nebulizers or metered-dose inhalers (MDIs) in the ventilated patient. They also considered the impact of ventilator settings, such as positive end-expiratory pressure (PEEP), on drug delivery and efficacy. Ensuring that medications were delivered effectively was critical in managing respiratory conditions and reducing the need for prolonged ventilation.

Collaboration in Multidisciplinary Teams

In order to give ventilated COVID-19 patients with comprehensive treatment, pharmacists collaborated closely with physicians, nurses, respiratory therapists, and intensivists. Pharmacists contributed knowledge about drug choice, dosage, and monitoring to multidisciplinary care teams, which helped customize treatment plans for specific patients. When it came to maximizing medication regimens for patients with complex conditions—particularly those with decreased organ function, which is typical in critically ill COVID-19 patients—their knowledge of pharmacokinetics and pharmacodynamics proved invaluable.

Pharmacists also participated in talks about ventilator settings, especially where those settings potentially impact drug excretion, metabolism, or absorption. Pharmacists, for instance, made sure that medication administration was modified in accordance with the influence that specific ventilation methods, like prone placement in ARDS patients, can have on pharmacokinetics. This cooperative strategy reduced the possibility of side effects from mechanical breathing and concomitant pharmaceutical treatments while also improving patient outcomes.

Ensuring Drug Availability and Management

Drug shortages posed a serious problem during the COVID-19 pandemic because of the increase in demand for ventilator-associated drugs, including sedatives, analgesics, and NMBAs, on a worldwide scale. By determining substitute treatments, modifying dosage schedules, and collaborating with hospital procurement teams to guarantee the supply of essential pharmaceuticals, pharmacists played a crucial role in controlling these shortages. Additionally, pharmacists offered advice on how to preserve medication supplies, especially during times of high demand. This required changing treatment plans and putting in place procedures for the prudent use of medications in order to increase the supply of necessary medications without sacrificing patient care. During the COVID-19 epidemic, pharmacists were crucial to the care and monitoring of ventilated patients. Their knowledge of pharmacology made sure that drugs were used safely and effectively, especially when it came to sedation, analgesia, neuromuscular blockade, and infection prevention. Pharmacists assisted in managing the complicated medication demands of critically ill patients, facilitating weaning, and improving ventilator care by collaborating with other medical specialists. During this extraordinary worldwide health crisis, their services were crucial in enhancing the prognosis for patients in need of mechanical breathing.

Conclusion

The COVID-19 pandemic revealed significant challenges in managing respiratory failure due to the virus's severe impact on the lungs, with many patients requiring mechanical ventilation to survive. Ventilators, especially invasive mechanical ventilators, have proven critical in treating patients with ARDS by providing the necessary support for oxygenation and ventilation when the lungs can no longer function effectively. This review emphasizes the urgent need for reliable, cost-effective ventilators that can be rapidly deployed to meet the growing demand during public health emergencies. One of the main findings of this study is the development and deployment of the O2U ventilator, which was designed to address equipment shortages during the pandemic. Its simple, cost-effective design, featuring a reduced number of components and compatibility with hospital oxygen systems, made it an essential tool in resource-limited settings. The O2U ventilator’s ability to provide both non-invasive and invasive ventilation, along with its flexibility in assisting patients at various stages of respiratory failure, demonstrates its significant impact in reducing the mortality associated with COVID-19. The testing of the ventilator, both through bench-top experiments and animal studies, validated its safety and efficacy, highlighting its potential as a

long-term solution for addressing ventilator shortages. Pharmacists, through their expertise in drug therapy management and their involvement in patient care, play an essential role in the successful use of ventilators. By ensuring the appropriate selection and monitoring of medications used in ventilated patients, such as sedatives, analgesics, and paralytics, pharmacists help optimize patient outcomes. Additionally, their understanding of the interactions between drugs and respiratory equipment positions them as key collaborators in multidisciplinary care teams, especially in managing the complexities of mechanical ventilation in critical care settings. This review underscores the importance of integrating pharmacists more fully into the management of ventilator-supported care, enhancing the quality of treatment provided to critically ill COVID-19 patients.

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أنواع وأهمية أجهزة التنفس للمرضى المصابين بكوفيد-19: مقال مراجعة محدث للصيادلة

الملخص:

الخلفية :سلطت جائحة كوفيد-19 الضوء على الدور الحيوي لأجهزة التنفس في إدارة فشل التنفس الحاد لدى المرضى، وخاصة أولئك الذين يعانون من متلازمة الضائقة التنفسية الحادة .(ARDS) نظرًا لأن الفيروس يستهدف بشكل أساسي الجهاز التنفسي، أصبحت أجهزة التنفس الاصطناعية ضرورية لعلاج المرضى الذين يعانون من حالات حرجة. ومع ذلك، فإن الطلب غير المسبوق على أجهزة التنفس قد أظهر نقصًا في المعدات الأساسية، خاصة في الأماكن ذات الموارد المحدودة.

الهدف :تهدف هذه المراجعة إلى تزويد الصيادلة بفهم محدث لدور أجهزة التنفس في إدارة مرضى كوفيد-19، مع التركيز على الابتكارات في تصميم واستخدام أجهزة التنفس.

الطرق :تم إجراء مراجعة أدبية لتقييم أنواع أجهزة التنفس المستخدمة خلال جائحة كوفيد-19، وآلية عملها، وتطوير حلول أجهزة التنفس منخفضة التكلفة. كما قامت الدراسة بتقييم إرشادات الترخيص للاستخدام الطارئ (EUA) التي أصدرتها إدارة الغذاء والدواء الأمريكية لأجهزة التنفس خلال الجائحة.

النتائج :أظهرت المراجعة أن أجهزة التنفس الاصطناعية، وخاصةً الأجهزة الغازية، لعبت دورًا حاسمًا في نجاة المرضى الذين يعانون من .ARDS وقد عالجت الابتكارات، مثل جهاز التنفسO2U ، النقص من خلال تقديم تصميم فعال من حيث التكلفة وسهل الاستخدام. أظهرت الاختبارات على أسطح العمل والحيوانات فعاليتها في تقديم تهوية دقيقة ودورية زمنية.

الخاتمة :تسلط المراجعة الضوء على أهمية توافر أجهزة التنفس في إدارة فشل التنفس خلال الجائحات. يعتبر الصيادلة، من خلال دورهم في إدارة الأدوية ومعرفتهم بالمعدات، أساسيين في تحسين استخدام أجهزة التنفس في رعاية مرضى كوفيد-19.

الكلمات المفتاحية :كوفيد-19، أجهزة التنفس، فشل التنفس، ARDS، الصيادلة، الترخيص للاستخدام الطارئ، التهوية الميكانيكية.