# Evidence Search Service Results of your search request:

**“Airway clearance or chest physiotherapy for mechanically ventilated COVID-19 patients or patients on VV ECMO”**

**ID of request:** 24312; **Date of request:** 16th July, 2020; **Date of completion:** 24th July, 2020

If you would like to request any articles or any further help, please contact:  Adam Tocock at [adam.tocock@nhs.net](mailto:adam.tocock@nhs.net)

Please acknowledge this work in any resulting paper or presentation as: Evidence search: Airway clearance and chest physiotherapy in COVID19 patients. Adam Tocock. (24th July, 2020). LONDON, UK: Barts Health Knowledge and Library Services.

**Sources searched**  
EMBASE (0)  
Physiopedia (1)

**Date range used** (5 years, 10 years): 2010-  
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**Search terms and notes** (full search strategies reported at the end of this document.

## Contents

[A. Synopses or Summaries](#Content2)

Physiopedia

[Respiratory Management of COVID 19](#Research703847)

[B. Original Research](#Content5)

1. [Acute Respiratory Decompensation Requiring Intubation in Pregnant Women with SARS-CoV-2 (COVID-19)](#Research703848)
2. [Comparison of two methods to clear the airways of critically ill children and adults with COVID-19 infection: a structured summary of a study protocol for a pilot randomized controlled trial.](#Research703854)
3. [COVID-19 pandemic and non invasive respiratory management: Every Goliath needs a David. An evidence based evaluation of problems](#Research703857)
4. [How the COVID-19 infection tsunami revolutionized the work of respiratory physiotherapists: An experience from Northern Italy](#Research703855)
5. [Impact of COVID-19 on people with cystic fibrosis](#Research703852)
6. [Physiotherapy Care of Patients with Coronavirus Disease 2019 (COVID-19) - A Brazilian Experience](#Research703853)
7. [Physiotherapy management for COVID-19 in the acute hospital setting: Recommendations to guide clinical practice](#Research703851)
8. [Recommendations for Hospital-Based Physical Therapists Managing Patients With COVID-19](#Research703850)
9. [Respiratory physiotherapy in patients with COVID-19 infection in acute setting: A Position Paper of the Italian Association of Respiratory Physiotherapists (ARIR)](#Research703856)
10. [The experiences of health-care providers during the COVID-19 crisis in China: a qualitative study](#Research703849)
11. [Bedside troubleshooting during venovenous extracorporeal membrane oxygenation (ECMO)](#Research703859)
12. [ECMO as a bridge to recovery from severe exacerbation in non-end stage lung disease of a patient with Cystic Fibrosis: A case report](#Research703858)
13. [Treatment of acute asthma in the ICU with a liquid perfluorocarbon and CO2 gas combination](#Research703861)
14. [Veno-venous extracorporeal life support to facilitate airway foreign body removal in a child with severe respiratory failure](#Research703860)
15. [In-patient physiotherapy for adults on veno-venous extracorporeal membrane oxygenation - United Kingdom ECMO Physiotherapy Network: A consensus agreement for best practice](#Research703862)
16. [Airway clearance therapy and physical exercise for patients with cystic fibrosis on extracorporeal membrane oxygenation as a bridge to lung transplant: an international perspective at major Centres in Europe and North America](#Research703863)
17. [H1N1 influenza-associated pneumonia with severe obesity: successful management with awake veno-venous extracorporeal membrane oxygenation and early respiratory physical therapy.](#Research703865)
18. [The physiotherapy management of patients with CF on ambulatory ECMO including airway clearance therapy and early mobilization](#Research703864)
19. [Airway pressure release ventilation for protection of tracheal repair after non-ventilatory ECMO](#Research703867)
20. [ECMO as a bridge to lung transplantation in an adolescent with cystic fibrosis](#Research703868)
21. [Extracorporeal membrane oxygenation post lung transplantation](#Research703866)
22. [Double lumen bi-cava cannula for veno-venous extracorporeal membrane oxygenation as bridge to lung transplantation in non-intubated patient](#Research703869)
23. [Bi-caval dual lumen venovenous extracorporeal membrane oxygenation and high-frequency percussive ventilatory support for postintubation tracheal injury and acute respiratory distress syndrome.](#Research703870)
24. [Evaluation of droplet dispersion during non-invasive ventilation, oxygen therapy, nebuliser treatment and chest physiotherapy in clinical practice: implications for management of pandemic influenza and other airborne infections.](#Research703871)

## A. Synopses or Summaries

#### Physiopedia

**Respiratory Management of COVID 19** (2020)

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See "resources" section for further relevant entries and guidelines.

## B. Original Research

1. **Acute Respiratory Decompensation Requiring Intubation in Pregnant Women with SARS-CoV-2 (COVID-19)**  
   J.S. Silverstein AJP Reports 2020;10(2):No page numbers.

There is a current paucity of information about the obstetric and perinatal outcomes of pregnant novel coronavirus disease 2019 (COVID-19) patients in North America. Data from China suggest that pregnant women with COVID-19 have favorable maternal and neonatal outcomes, with rare cases of critical illness or respiratory compromise. However, we report two cases of pregnant women diagnosed with COVID-19 in the late preterm period admitted to tertiary care hospitals in New York City for respiratory indications. After presenting with mild symptoms, both quickly developed worsening respiratory distress requiring intubation, and both delivered preterm via caesarean delivery. These cases highlight the potential for rapid respiratory decompensation in pregnant COVID-19 patients and the maternal-fetal considerations in managing these cases.<br/>Copyright &#xa9; 2020 Georg Thieme Verlag. All rights reserved.

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1. **Comparison of two methods to clear the airways of critically ill children and adults with COVID-19 infection: a structured summary of a study protocol for a pilot randomized controlled trial.**  
   A. Kawaguchi Trials 2020;21(1):610-610.

OBJECTIVES: As there is no treatment for COVID-19 with a proven mortality benefit at this moment in the pandemic, supportive management including mechanical ventilation is the core management in an intensive care unit (ICU). It is a challenge to provide consistent care in this situation, highly demanding and leading to potential staff shortages in ICU. We need to reduce unnecessary exposure of healthcare workers to the virus. This study aims to examine the impact of care using a non-invasive oscillating device (NIOD) for chest physiotherapy in the care of mechanically ventilated patients with COVID-19. In particular, we aim to explore if a NIOD performed by non-specialized personnel is not inferior to the standard chest physiotherapy (CPT) undertaken by physiotherapists caring for patients with COVID-19., TRIAL DESIGN: A pilot multicenter prospective crossover noninferiority randomized controlled trial., PARTICIPANTS: All mechanically ventilated patients with COVID-19 admitted to one of the two ICUs, and CPT ordered by the responsible physician. The participants will be recruited from two intensive care units in Canadian Academic Hospitals (one pediatric and one adult ICU)., INTERVENTION AND COMPARATOR: We will implement NIOD and CPT alternatingly for 3 h apart over 3 h. We will apply a pragmatic design, so that other procedures including hypertonic saline nebulization, intermittent positive pressure ventilation, suctioning (e.g., oral or nasal), or changing the ventilator settings or modality (i.e., increasing positive end-expiratory pressure or changing the nasal mask to total face continuous positive airway pressure) can be provided at the direction of bedside intensivists in charge., MAIN OUTCOMES: The primary outcome measurement is the oxygenation level before and after the procedure (SpO2/FiO2 ratio). For cases with invasive ventilation (i.e., the use of an endotracheal tube to deliver positive pressure) and non-invasive ventilation, we will also document expiratory tidal volume, vital signs, and any related complications such as vomiting, hypoxemia, or unexpected extubation. We will collect the data before, 10 min after, and 30 min after the procedure., RANDOMIZATION: The order of the procedures (i.e., NIOD or CPT) will be randomly allocated using manual generated random numbers for each case. Randomization will be carried out by the independent research assistant in the study coordinating center by using opaque sealed envelopes, assigning an equal number of cases to each intervention arm. Stratification will be applied for age (> 18 years or <= 18 years of age) and the study sites., BLINDING (MASKING): No blinding will be performed., NUMBERS TO BE RANDOMIZED (SAMPLE SIZE): We estimate the necessary sample size as 25 for each arm (total 50 cases), with a power of 0.90 and an alpha of 0.05, with a non-inferiority design., TRIAL STATUS: The protocol version number 1 was approved on 27 March 2020. Currently, recruitment has not yet started, with the start scheduled by the mid-June 2020 and the end anticipated by December 2020., TRIAL REGISTRATION: ClinicalTrials.gov NCT04361435 . Registered on 28 April 2020 FULL PROTOCOL: The full protocol is attached as an additional file, accessible from the Trials website (Additional File 1). In the interest in expediting dissemination of this material, the familiar formatting has been eliminated; this letter serves as a summary of the key elements of the full protocol.

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[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=5414c9487a385900fb363f14141d259e)

1. **COVID-19 pandemic and non invasive respiratory management: Every Goliath needs a David. An evidence based evaluation of problems**  
   Winck J. C Pulmonology 2020;:No page numbers.

Background and aim: The war against Covid-19 is far from won. This narrative review attempts to describe some problems with the management of Covid-19 induced acute respiratory failure (ARF) by pulmonologists. <br/>Method(s): We searched the following databases: MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials and reviewed the references of retrieved articles for additional studies. The search was limited to the terms: Covid-19 AND: acute respiratory distress syndrome (ARDS), SARS, MERS, non invasive ventilation (NIV), high flow nasal cannula (HFNC), pronation (PP), health care workers (HCW). <br/>Result(s): Protection of Health care workers should be paramount, so full Personal Protective Equipment and Negative pressure rooms are warranted. HFNC alone or with PP could be offered for mild cases (PaO2/FiO2 between 200-300); NIV alone or with PP may work in moderate cases (PaO2/FiO2 between 100-200). Rotation and coupled (HFNC/NIV) strategy can be beneficial. A window of opportunity of 1-2 h is advised. If PaO2/FIO2 significantly increases, Respiratory Rate decreases with a relatively low Exhaled Tidal Volume, the non-invasive strategy could be working and intubation delayed. <br/>Conclusion(s): Although there is a role for non-invasive respiratory therapies in the context of COVID-19 ARF, more research is still needed to define the balance of benefits and risks to patients and HCW. Indirectly, non invasive respiratory therapies may be of particular benefit in reducing the risks to healthcare workers by obviating the need for intubation, a potentially highly infectious procedure.<br/>Copyright &#xa9; 2020 Sociedade Portuguesa de Pneumologia

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1. **How the COVID-19 infection tsunami revolutionized the work of respiratory physiotherapists: An experience from Northern Italy**  
   Simonelli Carla Monaldi Archives for Chest Disease 2020;90(2):292-298.

Due to COVID-19 outbreak, to lighten the burden of acute and critical care hospitals, some respiratory rehabilitation departments have been used to host patients with COVID-19 in the post-acute phase. This new and unexpected situation required a change of roles and scheduling of the rehabilitation teams. In this manuscript we describe the unexpected and urgent organizational change of the Cardio-Pulmonary Rehabilitation (CPR) service during the COVID-19 emergency in a Northern Italian rehabilitation hospital, focusing on the Respiratory Physiotherapists' (RPTs) role. A quick three-days complete reorganization of the entire hospital was needed. A COVID-19 care team including a multidisciplinary panel of physicians, nurses, and RPTs was quickly performed to manage 90 beds for post acute patients with COVID-19. Within the team, the RPTs changed their shifts, so as to be available 16h per day, 7 days out of 7. Remodelled tasks in charge of RPTs were: oxygen therapy daily monitoring, non invasive ventilation (NIV) and continuous positive airways pressure (CPAP) delivery, pronation and postural changes to improve oxygenation, reconditioning with leg/arm cranking and exercises, initial and final patients' functional assessment by short-physical performance battery (SPPB) and 1-minute sit-to-stand test (1-STS) to evaluate motor conditions and exercise-induced oxygen desaturation. Three "what-to-do" algorithms were developed to guide: i) oxygen de-escalation by reducing inhaled fraction of oxygen (FiO2); ii) oxygenation improvement through the use of Venturi mask; iii) reconditioning and physical activity. One-hundred seventy patients were treated in one month. As main topics, RPTs have been involved in oxygen therapy management in almost a third of the admitted patients, reconditioning exercises in 60% of the cases, and initial and final functional motor capacity assessment in all patients. Details of activities performed by the RPT in one typical working day are also shown. Our reorganization has exploited the professional skills and clinical expertise of the RPTs. This re-organization can provide practical insights to other facilities that are facing this crisis, and may be a starting point for implementing post-COVID-19 rehabilitation. Future studies will have to improve and review this organization.

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1. **Impact of COVID-19 on people with cystic fibrosis**  
   C. Colombo The Lancet Respiratory Medicine 2020;8(5):No page numbers.

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1. **Physiotherapy Care of Patients with Coronavirus Disease 2019 (COVID-19) - A Brazilian Experience**  
   M.A. Onoue Clinics (Sao Paulo, Brazil) 2020;75:e2017-e2017.

Some patients with coronavirus disease (COVID-19) present with severe acute respiratory syndrome, which causes multiple organ dysfunction, besides dysfunction of the respiratory system, that requires invasive procedures. On the basis of the opinions of front-line experts and a review of the relevant literature on several topics, we proposed clinical practice recommendations on the following aspects for physiotherapists facing challenges in treating patients and containing virus spread: 1. personal protective equipment, 2. conventional chest physiotherapy, 3. exercise and early mobilization, 4. oxygen therapy, 5. nebulizer treatment, 6. non-invasive ventilation and high-flow nasal oxygen, 7. endotracheal intubation, 8. protective mechanical ventilation, 9. management of mechanical ventilation in severe and refractory cases of hypoxemia, 10. prone positioning, 11. cuff pressure, 12. tube and nasotracheal suction, 13. humidifier use for ventilated patients, 14. methods of weaning ventilated patients and extubation, and 15. equipment and hand hygiene. These recommendations can serve as clinical practice guidelines for physiotherapists. This article details the development of guidelines on these aspects for physiotherapy of patients with COVID-19.

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1. **Physiotherapy management for COVID-19 in the acute hospital setting: Recommendations to guide clinical practice**  
   P. Thomas Pneumon 2020;33(1):32-35.

Endorsed by: World Confederation for Physical Therapy, International Confederation of Cardiorespiratory Physical Therapists, Australian Physiotherapy Association, Canadian Physiotherapy Association, Associazione Riabiliatory dell' Insufficieza, Respiratoria, Association of Chartered Society of Physiotherapist in Respiratory Care UK (ACPRC)<br/>Copyright &#xa9; 2020, Technogramma. All rights reserved.

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1. **Recommendations for Hospital-Based Physical Therapists Managing Patients With COVID-19**  
   K.M. Felten-Barentsz Physical therapy 2020;:No page numbers.

OBJECTIVE: The COVID-19 pandemic is rapidly evolving and has led to increased numbers of hospitalizations worldwide. Hospitalized patients with COVID-19 experience a variety of symptoms, including fever, muscle pain, tiredness, cough, and difficulty breathing. Elderly people and those with underlying health conditions are considered to be more at risk of developing severe symptoms and have a higher risk of physical deconditioning during their hospital stay. Physical therapists have an important role in supporting hospitalized patients with COVID-19 but also need to be aware of challenges when treating these patients. In line with international initiatives, this article aims to provide guidance and detailed recommendations for hospital-based physical therapists managing patients hospitalized with COVID-19 through a national approach in the Netherlands. <br/>METHOD(S): A pragmatic approach was used. A working group conducted a purposive scan of the literature and drafted initial recommendations based on the knowledge of symptoms in patients with COVID-19, and current practice for physical therapist management for patients hospitalized with lung disease and patients admitted to the intensive care unit (ICU). An expert group of hospital-based physical therapists in the Netherlands provided feedback on the recommendations, which were finalized when consensus was reached among the members of the working group. <br/>RESULT(S): The recommendations include safety recommendations, treatment recommendations, discharge recommendations, and staffing recommendations. Treatment recommendations address 2 phases of hospitalization: when patients are critically ill and admitted to the ICU, and when patients are severely ill and admitted to the COVID ward. Physical therapist management for patients hospitalized with COVID-19 comprises elements of respiratory support and active mobilization. Respiratory support includes breathing control, thoracic expansion exercises, airway clearance techniques, and respiratory muscle strength training. Recommendations toward active mobilization include bed mobility activities, active range-of-motion exercises, active (-assisted) limb exercises, activities-of-daily-living training, transfer training, cycle ergometer, pre-gait exercises, and ambulation.<br/>Copyright &#xa9; The Author(s) 2020. Published by Oxford University Press on behalf of the American Physical Therapy Association.

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1. **Respiratory physiotherapy in patients with COVID-19 infection in acute setting: A Position Paper of the Italian Association of Respiratory Physiotherapists (ARIR)**  
   M. Lazzeri Monaldi Archives for Chest DiseaseMonaldi Archives for Chest Disease 2020;90(1):163-168.

Respiratory physiotherapy in patients with COVID-19 infection in acute setting: a Position Paper of the Italian Association of Respiratory Physiotherapists (ARIR) On February 2020, Italy, especially the northern regions, was hit by an epidemic of the new SARS-Cov-2 coronavirus that spread from China between December 2019 and January 2020. The entire healthcare system had to respond promptly in a very short time to an exponential growth of the number of subjects affected by COVID-19 (Coronavirus disease 2019) with the need of semi-intensive and intensive care units.

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1. **The experiences of health-care providers during the COVID-19 crisis in China: a qualitative study**  
   Q. Liu The Lancet Global Health 2020;8(6):No page numbers.

Background: In the early stages of the outbreak of coronavirus disease 2019 (COVID-19) in Hubei, China, the local health-care system was overwhelmed. Physicians and nurses who had no infectious disease expertise were recruited to provide care to patients with COVID-19. To our knowledge, no studies on their experiences of combating COVID-19 have been published. We aimed to describe the experiences of these health-care providers in the early stages of the outbreak. <br/>Method(s): We did a qualitative study using an empirical phenomenological approach. Nurses and physicians were recruited from five COVID-19-designated hospitals in Hubei province using purposive and snowball sampling. They participated in semi-structured, in-depth interviews by telephone from Feb 10 to Feb 15, 2020. Interviews were transcribed verbatim and analysed using Haase's adaptation of Colaizzi's phenomenological method. <br/>Finding(s): We recruited nine nurses and four physicians. Three theme categories emerged from data analysis. The first was "being fully responsible for patients' wellbeing-'this is my duty'". Health-care providers volunteered and tried their best to provide care for patients. Nurses had a crucial role in providing intensive care and assisting with activities of daily living. The second category was "challenges of working on COVID-19 wards". Health-care providers were challenged by working in a totally new context, exhaustion due to heavy workloads and protective gear, the fear of becoming infected and infecting others, feeling powerless to handle patients' conditions, and managing relationships in this stressful situation. The third category was "resilience amid challenges". Health-care providers identified many sources of social support and used self-management strategies to cope with the situation. They also achieved transcendence from this unique experience. <br/>Interpretation(s): The intensive work drained health-care providers physically and emotionally. Health-care providers showed their resilience and the spirit of professional dedication to overcome difficulties. Comprehensive support should be provided to safeguard the wellbeing of health-care providers. Regular and intensive training for all health-care providers is necessary to promote preparedness and efficacy in crisis management. <br/>Funding(s): National Key R&D Program of China, Project of Humanities and Social Sciences of the Ministry of Education in China.<br/>Copyright &#xa9; 2020 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY 4.0 license

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1. **Bedside troubleshooting during venovenous extracorporeal membrane oxygenation (ECMO)**  
   Patel Bhoumesh Journal of Thoracic Disease 2019;11(Suppl 14):S1698-S1707.

In this review, we discuss common difficulties that clinicians may encounter while managing patients treated with venovenous (VV) extracorporeal membrane oxygenation (ECMO). ECMO is an increasingly important tool for managing severe respiratory failure that is refractory to conventional therapies. Its overall goal is to manage respiratory failure-induced hypoxemia and hypercarbia to allow "lung rest" and promote recovery. Typically, by the time VV-ECMO is initiated, the patient's pulmonary condition requires conventional ventilator settings that are detrimental to lung recovery or that exceed the remaining functional lung's ability to maintain acceptable physiological conditions. Standard mechanical ventilation can activate inflammation and worsen the pulmonary damage caused by the underlying disease, leading to ventilator-induced lung injury. In contrast, VV-ECMO facilitates lung-protective ventilation, decreasing further ventilator-induced lung injury and allowing lung recovery. Such lung-protective ventilation seeks to avoid barotrauma (by monitoring transpulmonary pressure), volutrauma (by reducing excessive tidal volume to promote lung rest), atelectotrauma [by maintaining adequate positive end-expiratory pressure (PEEP)], and oxygen toxicity (by decreasing ventilator oxygen levels when PEEP is adequate). ECMO for adult respiratory failure was associated with overall survival of 62% in 2018, according to the Extracorporeal Life Support Organization (ELSO) January 2019 registry report. Difficulties that may arise during VV-ECMO require timely diagnosis and optimal management to achieve the most favorable outcomes. These difficulties include ventilation issues, hypoxemia (especially as related to recirculation or low ECMO-flow-to-cardiac-output ratio), sepsis, malfunctioning critical circuit components, lack of clarity regarding optimal hemoglobin levels, hematological/anticoagulation complications, and right ventricular (RV) dysfunction. A culture of safety should be emphasized to optimize patient outcomes. A properly functioning team-not only the bedside clinician, but also nurses, perfusionists, respiratory therapists, physical therapists, pharmacists, nutritionists, and other medical specialists and allied health personnel-is vital for therapeutic success.<br/>Copyright &#xa9; 2019 Journal of Thoracic Disease. All rights reserved.

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1. **ECMO as a bridge to recovery from severe exacerbation in non-end stage lung disease of a patient with Cystic Fibrosis: A case report**  
   R. Guarise Italian Journal of Pediatrics 2019;45:No page numbers.

Background: Extracorporeal life supports (ELS) are devices that enable direct oxy-genation or CO<sub>2</sub> extraction from the blood. In recent years their use has increased among CF patients with end-stage respiratory condition and failure as a bridge for lung transplantation (LTx). Nevertheless, extracorporeal membrane oxygenation ECMO support (ECMO) is considered when a patient presents a rapid deterioration of a chronic lung disease and only when it has been already included on a LTx waiting list or an evaluation process has already started. Case Report A 25 years old woman with CF, CF-related diabetes (CFRD), CF liver disease (CFLD) with portal hypertension and a history of moderate but unstable lung disease, chronic Pseudomonas Aeruginosa colonization and allergic bronchopulmonary Aspergillosis (ABPA) presented with fever (38degreeC), persistent cough, excessive stagnation of thick mucus and dyspnea. Chest X-ray showed diffuse bilateral par-enchymal thickening, several bronchiectasis with mucoid impaction, presence of voluminous sub-pleural bubbles. Intravenous antibiotics and corticosteroids were started along with intensive regimen of respiratory physiotherapy for airway clearance. During the first hours her status deteriorated, so that she needed to be transferred to the intensive care unit (ICU) where she required intubation and invasive mechanical ventilation (IMV) with assisted pressure support mode. After 4 hours, despite IMV at maximal protective pressure and maximal antibiotic coverage, arterial blood gas (ABG) analysis showed a persistent unresponsive hypoxaemia, severe respiratory acidosis and severe hypercapnia (pH 7.18, pCO<sub>2</sub> 87 cm H<sub>2</sub>O), so veno-venous ECMO was initiated. After 40 hours, ABG analysis improved, so she was successfully extubated and placed on continuous NIV. During ECMO period, mucolytic therapy was doubled and two sessions per day of airway clearance were performed by respiratory physiotherapists. Ventilation parameters improved, so she has been "bridged" from NIV to heated humidified high-flow nasal cannula therapy. ECMO de-cannulation occurred on day 10 and after 48 hours she was discharged from ICU on spontaneous breathing with 5 lt/min oxygen supplementation. Respiratory physiotherapy was continued, reassessed and optimized along with a training program. She was discharged home on after 10 days without oxygen supplementation. Conclusion Considering clinical history and the stage of pulmonary disease, this patient wasn't considered yet for LTx. ECMO is an important support to severe CF exacerbations unresponsive to conventional treatments in patients that are not yet candidates to LTx. ECMO "bridge-to-re-cover" use is emerging in CF and could extend native lungs function in order to take time for waiting list evaluation and optimize allocation. The patients gave the consent to publish clinical data.

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1. **Treatment of acute asthma in the ICU with a liquid perfluorocarbon and CO2 gas combination**  
   B.T. Wierstra American Journal of Respiratory and Critical Care Medicine 2018;197:No page numbers.

Introduction Worldwide approximately 400,000 asthma deaths occur each year. New approaches to reduce this mortality are required. Case DetailsThe patient was a thirty-five-year-old male with poorly controlled, atypical asthma who presented to a community hospital in respiratory distress. On presentation, arterial blood gases (ABG) were; 7.04/107/22/29, (pH/PCO<sub>2</sub>/PaO2/ bicarbonate). He was emergently intubated and placed on pressure-controlled mechanical ventilation with tidal volumes (Vt) of 500-600 ml. Subsequent ABG demonstrated improvement to 7.25/63/136/28. He was admitted to the ICU and started on bronchodilators, broad spectrum antibiotics, iv methylprednisolone, inhaled corticosteroids and ketamine. Despite this treatment he became difficult to ventilate with escalating airway pressures refractory to inhaled isoflurane. The patient was transferred to a tertiary care center for further evaluation and consideration of extracorporeal therapy. The patient continued to deteriorate and was emergently cannulated for veno-veno extracorporeal oxygenation (VV-ECMO). He was decannulated after 6 days and extubated 6 days later. Unfortunately, within an hour he went into respiratory failure requiring re-intubation and urgent re-initiation of VV-ECMO. Treatments now included paralysis, steroids, inhaled bronchodilators, isoflurane, and prostaglandins with intravenous magnesium, salbutamol and ketamine infusions. It was thought that the patient might benefit from enhanced mucous clearance from distal airways, however, previous conventional bronchoscopic interventions to facilitate this were unsuccessful. It was decided to trial bronchoscopic BAL with perflubron to promote mucous clearance in combination with a CO<sub>2</sub> enriched respiratory gas to facilitate bronchodilation and gas exchange. During bronchoscopy, 100 ml of perflubron was given in aliquots into left and right pulmonary segments. Following this a medical gas enriched with 10% V/V CO<sub>2</sub> was administered into the airways and ventilation was minimized to help retain the CO<sub>2</sub> in the airways for the short (5mins) treatment duration. Almost immediately the patient's respiratory mechanics improved with Vt going from 250ml to over 600ml on PVS 7/8 without increasing work of breathing (Figure 1). Hemodynamic parameters were not adversely affected by the administration of perflubron. The patient was de-cannulated from ECMO on day 3. Discussion The rationale for this treatment was based on the properties of perflubron and CO<sub>2</sub> on lung function. Perflubron has surfactant and mucolytic properties and is an excellent carrier of respiratory gases. CO<sub>2</sub> is a potent and rapid broncho-dilator that readily dissolves in perflubron. Together they act synergistically, have excellent safety profiles and provide a novel approach for managing airway obstruction in severe asthma. (Figure presented) .

1. **Veno-venous extracorporeal life support to facilitate airway foreign body removal in a child with severe respiratory failure**  
   H.J. Kallas ASAIO Journal 2018;64:6-6.

Introduction: Airway foreign body (FB) is a relatively common cause of potentially life-threatening respiratory failure. In the vast majority of patients, various bronchoscopic techniques can successfully remove the FB. However, there is a small subset of patients who may be too unstable to safely tolerate rigid bronchoscopy and constitute a high-risk cohort. We report a case of a child with airway FB and severe respiratory failure where rigid bronchoscopy was safely accomplished without any direct ventilatory support using VVDL ECMO. Case Description: A previously healthy 3-year-old, 15.5-kg boy was found at the bottom of a home swimming pool after a brief lapse in supervision. He was noted to be pulseless and apneic; the mother (a physician) started bystander cardiopulmonary resuscitation (CPR). After approximately 2 min, he had return of spontaneous circulation, agonal respirations and emesis. EMTs performed direct laryngoscopy, removing a piece of hotdog from his larynx. He was endotracheally intubated for hypoxemia and altered mental status. Initial ABG had pH 7.05, PaCO2 51, and BE of-16. After ICU admission, he continued to have progressively severe respiratory failure with hypoxia and hypercapnia. Expiratory airflow obstruction was noted. Chest x-ray had marked bilateral pulmonary infiltrates. Pulmonary aspiration was suspected. Neurologic exam was limited by sedatives, but he was noted to have reactive pupils and likely purposeful movement to painful stimulation. He failed high settings on conventional mechanical ventilation (CMV) and was transitioned to high-frequency ventilation, but still had poor gas exchange (O2 sats 75-90%, PaCO2 70-96) on high settings (VDR4 with FiO2 100%, oscillatory PEEP 17 cmH2O, pulsatile flow rate with peak pressure of 40 cmH2O, convective rate 40 min-1, pulse frequency 450 Hz). He had acceptable hemodynamics without inotropic support. Airway FB was suspected. On hospital day #1 (HD #1), a quick bedside flexible bronchoscopy demonstrated near-occlusive airway FB occupying the mid-trachea. He had significant O2 desaturation during the brief procedure and further bronchoscopy was deemed unsafe. <br/>Intervention(s): A decision was made to place patient on VVDL ECMO to facilitate rigid bronchoscopy. He had percutaneous placement of a 19 Fr Avalon Elite cannula via the right internal jugular vein. He was given 50-unit/kg heparin just prior to cannula insertion and heparin infusion was used to initially keep ACT 160-180. Patient was transitioned to CMV on "rest" settings. Once considered "stable" on ECMO, the endotracheal tube (ETT) was removed. Neuromuscular blockade was maintained throughout the subsequent laryngoscopy and rigid bronchoscopy. The entire procedure was performed in the ICU. In coordination with the ENT surgeon, the ECMO team controlled the head position to assure cannula safety and adequate ECMO parameters while also optimizing airway access. Direct laryngoscopy facilitated removal of the first hotdog piece from the posterior oropharynx. Rigid bronchoscopy was then done using a 4.0 ventilating bronchoscope. Mucoid partially dissolved material was suctioned from the trachea; then, a hotdog piece was removed from the mid trachea using endoscopic grasping forceps. More mucoid partially dissolved material blocking the left mainstem bronchus was removed with a wire basket stone extractor. Bilateral mainstem bronchi were thoroughly suctioned and cleared of mucoid material using a 5 Fr catheter through the scope; then, another hotdog piece was visualized in the left inferior lobar bronchus and removed using long endoscopic grasping forceps. Last-look bronchoscopy visualized no more foreign material. At procedure's end, he was intubated and placed on "rest" CMV settings. During the entire 52 min laryngobronchoscopic procedure, the patient was stable without any direct ventilatory support and on room air; ECMO facilitated adequate gas exchange while providing excellent conditions for airway FB removal in this critically ill child. Follow Up: Patient's pulmonary compliance markedly improved after bronchoscopic airway clearance. ECMO sweep gas was progressively weaned off as patient was transitioned back to supportive CMV. He was decannulated on HD #2 after being on ECMO for a total of 29 hours. Pulmonary status continued to improve. On HD #3, repeat flexible bronchoscopy revealed no residual FB in visible airways; he was then extubated to high flow nasal cannula. He was weaned to room air by HD #5 and discharged home on HD #7 in excellent condition without apparent neurologic morbidity. Neurodevelopmental evaluation 9 months after discharge was deemed to be normal in all parameters. <br/>Conclusion(s): There are scant reports of patients with complicated airway FB where extracorporeal support is employed to facilitate bronchoscopic FB removal (either VA or VV ECMO, or open-chest direct cardiac cannulation for cardiopulmonary bypass). Our case adds to the literature and demonstrates that VVDL ECMO may be a valuable modality in such critically ill patients creating ideal conditions to facilitate bronchoscopic removal of an obstructing airway FB while maintaining patient stability.

1. **In-patient physiotherapy for adults on veno-venous extracorporeal membrane oxygenation - United Kingdom ECMO Physiotherapy Network: A consensus agreement for best practice**  
   A. Eden Journal of the Intensive Care Society 2017;18(3):212-220.

Clinical specialist physiotherapists from the five severe respiratory failure centres in England where respiratory extracorporeal membrane oxygenation (ECMO) is practiced have established this consensus agreement for physiotherapy best practice. The severe respiratory failure centres are Wythenshawe Hospital, Manchester; Glenfield Hospital, Leicester; Papworth Hospital, Cambridge; Guy's and St Thomas' Hospital, London and The Royal Brompton Hospital, London. Although research into physiotherapy and ECMO is increasing, there is not a sufficient amount to write evidence-based guidelines; hence the development of a consensus document, using knowledge and experience of the specialist physiotherapists working with patients receiving ECMO. The document outlines safety aspects, practicalities and additional treatment considerations for physiotherapists conducting respiratory care and physical rehabilitation.<br/>Copyright &#xa9; 2017, &#xa9; The Intensive Care Society 2017.

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1. **Airway clearance therapy and physical exercise for patients with cystic fibrosis on extracorporeal membrane oxygenation as a bridge to lung transplant: an international perspective at major Centres in Europe and North America**  
   Button B. M Journal of cystic fibrosis. Conference: 39th european cystic fibrosis conference. Switzerland. Conference start: 20160608. Conference end: 20160611 2016;15:S34-S34.

Patients with CF listed for lung transplant may deteriorate significantly and extracorporeal membrane oxygenation (ECMO) may be used as a bridge to transplant. Objectives: To visit specialist centres experienced in use of IPV as airway clearance therapy (ACT) in Belgium and the use of ECMO in Germany, France, USA and Canada; to investigate optimal ACT and physical exercise to prevent loss of muscle mass and weakness while on ECMO. Methods: A travel fellowship enabled investigation of alternative ACT and management of patients on VV and VA ECMO at the 8 specialist international centres. Time was spent in ICUs with members of the multidisciplinary ECMO team including physicians, nurses, perfusionists, physio‐, physical‐, respiratory‐ and occupational therapists, speech pathologists and unit managers. Different types of ACT and physical exercise used were topics of particular focus. Results: New knowledge and techniques were gained from University Hospitals in Belgium (Brussels and Leuven); Germany (Hannover); France (Paris); USA (Durham and New York) and Canada (Toronto). ACT consisted of IPV, PEP, Oscillating PEP, Autogenic Drainage, (Belgian and French) using a number of different devices and walking as ACT. Physical exercise on ECMO included assisted and active bed exercises, sitting, standing, walking on bedside treadmill and in ward with many different types of enabling equipment available. Safety was the highest priority. Conclusions: There were great differences in ACT used with patients on ECMO. Types of exercise and dosage varied widely. Multi‐centre research is urgently needed to establish evidence based practice.

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1. **H1N1 influenza-associated pneumonia with severe obesity: successful management with awake veno-venous extracorporeal membrane oxygenation and early respiratory physical therapy.**  
   Kikukawa Tetsuei Acute Medicine and Surgery 2016;3(2):186-189.

Case: We report a case of H1N1 influenza-associated respiratory failure with severe obesity., Outcome: A 54-year-old man was admitted to our intensive care unit (ICU) because of H1N1 influenza-associated severe respiratory failure. He was severely obese, having a body mass index of 37.2. His respiratory condition remained severe under mechanical ventilation. We started veno-venous extracorporeal membrane oxygenation immediately. Awake management was started on ICU Day 6, and the patient's respiratory physical therapy began the following day. His respiratory condition showed excellent improvement immediately following the initiation of respiratory physical therapy. The patient was successfully decannulated on ICU Day 9, and he was discharged from the ICU on Day 11. He was discharged from the hospital with no severe disability on disease Day 60., Conclusion: Awake extracorporeal membrane oxygenation management with early respiratory physical therapy can be useful in the treatment of morbidly obese patients who present with severe respiratory failure.

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1. **The physiotherapy management of patients with CF on ambulatory ECMO including airway clearance therapy and early mobilization**  
   B.M. Button Pediatric Pulmonology 2016;51:152-154.

Awake veno-venous (VV) extra corporeal membrane oxygenation (ECMO) is a growing area in the life support of patients with respiratory failure. VV ECMO is sometimes used as a bridge to recovery in patients with acute respiratory distress syndrome and as a bridge to lung transplantation (LTx) in those with chronic lung diseases such as cystic fibrosis. The availability of dual lumen single ECMO cannulas (Avalon and Novalung Twinport) placed in the cervical region (internal jugular vein) has revolutionized 'lung bypass' as it allows patients to be awake and able to participate in physiotherapy. Patients are able to carry out airway clearance therapy (ACT) and physical exercise and are often able to be upright and walking while waiting for LTx. Preserving muscle mass and general physical condition has been associated with better long terms outcomes after LTx. ECMO involves gas exchange and oxygenation of blood outside the body and can provide complete or partial support of the lungs and/or heart for patients who without this treatment are not likely to survive. An ECMO system consists of cannulas to take venous blood from the body and return oxygenated blood to the circulation. Outside the body the blood circulates through a pump, a gas exchange and temperature control device. Life-threatening complications can occur while on ECMO including bleeding, thrombus formation, recirculation and sepsis (Lindstrom et al 2009). Until relatively recently patients treated on ECMO were sedated and paralyzed in the intensive care unit, breathing with the assistance of a mechanical ventilator, tube fed and unable to participate in physical activity. This approach led to the loss of muscle mass, strength, bone density and generally debilitation resulting in poor outcomes after LTx. (Fan et al 2009). Awake ECMO may lead to better outcomes after LTx compared to traditional sedation and mechanical ventilation (Fuehner et al 2012). The published peer reviewed literature and conference presentations have been mostly based on descriptions of local experiences in relatively small case series. Today, many ECMO units aim for safe early mobilization when all patient clinical measures are deemed to be acceptable. Generally ECMO cannula placement in the upper body is preferred when considering mobilizing patients out of bed, standing and walking. No randomized controlled trials have tested this assertion to date. The aims of physiotherapy for patients on awake VV ECMO are: (1) to clear lung secretions in those with chronic suppurative lung disease to prevent life-threatening sepsis; (2) to preserve muscle mass and strength while patients progress to recovery or bridge to LTx; and (3) to be safe in every aspect of treatment. Patients should not be mobilized out of bed if ECMO flows and oxygenation are sub-optimal, if patients are cardio-vascularly unstable, if there is bleeding from the respiratory tract or thrombus formation. All clinical parameters such as vasoactive agents, fraction of inspired oxygen (&lt;0.6), oxygen saturations (&gt;90), respiratory rate (&lt;30/minute), blood pressure, heart rate, level of sedation and other considerations such as ECMO cannula placement, lines and other co-morbidities need to be considered prior to active mobilization (Hodgson et al 2014). Consultation with the medical and nursing team are essential before mobilizing patients. In researching physiotherapy practice as seven internationally recognized centres (Hannover, Germany; Paris (La Pitie Salpetriere and Hopital Foch), France; Duke University Hospital, North Carolina, USA; New York Presbyterian, New York and Toronto General Hospital, Canada and The Alfred Hospital, Melbourne, Australia) choice of airway clearance techniques (ACT) varied widely. If patients were intubated or had a tracheostomy then airway suction was employed to remove secretions. Sometimes broncho-alveolar lavage was carried out by members of the medical team for ACT and combined with airway suction. In patients not on ventilators, the range of ACT included: positive expiratory pressure therapy (PEP) with a range of devices available, oscillating positive expiratory pressure therapy (OscPEP) using numerous devices, intrapulmonary percussive ventilation (IPV); positive airway pressure (single and bi-level), assisted autogenic drainage and exercise as ACT. Patients on ECMO often have thick and viscous secretions. Adjunctive mucolytic agents such as saline (0.9%), inhaled mannitol, hypertonic saline (3-7%) and dornase alpha are sometimes used in conjunction with airway clearance therapy. Early mobilization is a high priority in all of the international units previously mentioned. Strong multidisciplinary teams have been developed in these institutions to support safe and effective early physical activity in patients who are awake and able to co-operate. Adequate resources including well-trained staff and equipment to assist patients to be upright and active while on awake ECMO are required. Before safe mobilization a muscle strength assessment is necessary to ensure the patient is capable of mobilizing out of bed. The MRC and IMS mobility scores assist in determining whether the patient is suitable for mobilization out of bed (Hodgson et al 2014). Many patients have been critically ill for a period before being placed on ECMO and may already have reduced muscle mass and strength. The patient may need a period of regular passive, assisted or active bed exercises in preparation for getting up. Some units use electrical muscle stimulation to preserve muscle mass and strength. Sitting up dangling legs over the side of the bed is followed by sitting out of bed in a chair for up to four or more hours a day. This incorporates all the benefits of being upright, including lung expansion, into the daily routine. Leg strengthening and circulatory exercises are encouraged while sitting out of bed. Standing with the assistance of a tilt table often precedes supported standing out of bed. While standing upright patients may be encouraged to do supported squats and heel raises as part of the leg strengthening program. Walking frames are often used to achieve safe exercise in standing. A team of well trained staff with one person coordinating the activity is necessary for safe mobilization. It is important that the ECMO cannula is supported by a trained professional to avoid movement and ensure optimal flows and oxygenation. Supported marching on the spot at the bedside is often the first walking exercise. When a portable treadmill is available this is placed at right angles to the patient's bed. The safe achievement of this activity requires on average 5 well-trained staff. The patient is assisted into sitting with legs dangling over the edge of the bed and then assisted into standing on the treadmill using the handrails for support and walks at a slow steady pace aiming for up to 20-30 minutes per session. This will vary depending on the patient's physical state before ECMO commenced. Walking out of the room requires an extra person to bring a wheel chair along in case the patient needs to sit down or be transported back to bed. All equipment needs to be battery powered. For safe mobilization each member of the team needs to be well trained and is required to concentrate exclusively on the equipment and parts of the activity for which they are responsible. The patient is usually supported with a walking frame. Research to date consists mainly of outcomes in regional case series and retrospective reviews of patient charts. There is a lack of robust randomized controlled trials to determine safety, dosage, effectiveness and long term outcomes relative to ACT to prevent sepsis and exercise to prevent loss of muscle mass and general condition. Multi-centre trials are required to achieve adequate numbers in appropriate time frames to research and inform clinical practice. The Winston Churchill Foundation of Australia for a fellowship to travel to spec

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1. **Airway pressure release ventilation for protection of tracheal repair after non-ventilatory ECMO**  
   R. Hanson Critical Care Medicine 2013;41(12):No page numbers.

Introduction: The use of airway pressure release ventilation (APRV) has been well characterized in patients with Acute Lung Injury, Acute Respiratory Distress Syndrome, and atelectasis after major surgeries. APRV allows for the minimization of pulmonary barotrauma and facilitates lung-protective inverse-ratio ventilatory strategies in patients with significant injury who may not tolerate inverted ratios in other ventilation modes. We report the successful use of APRV for surgical site protection in a case of membranous tracheal injury requiring surgical repair and postoperative non-ventilatory extracorporeal membrane oxygenation (ECMO) support. A 57 year-old male with a past history significant for esophageal adenocarcinoma s/p robotically assisted esophogectomy presented as a transfer from outside hospital on post operative day 8 after bronchoscopy demonstrated a 7mm perforation in the left main-stem bronchus and multiple punctate perforations of the carina extending into the proximal right main-stem bronchus. A 37-French left double lumen tube was placed to maintain ventilation distal to these defects, and the patient was taken to the operating room for emergent surgical repair and veno-venous ECMO cannulation. Surgical repair was acheived using a combination of autologous pericardial patch and serratus muscle flap, and the patient was admitted to the ICU for management of non-ventilatory ECMO. His lungs were initially managed for 48 hours with a closed 5cm H2O CPAP circuit, with initiation of APRV ventilation on postoperative day 3. Initial CXR demonstrated complete opacification of bilateral lung fields, and initial tidal volumes were 35-50 cc using a P-high of 15 cm H20 and P-low of 5cm H2O. Inverse-ratio ventilation was achieved at 7:1 using a T-high of 5 seconds, and T-low of 0.7 seconds. Peak airway pressures were maintained below 20cm H2O for 48 hours after resumption of ventilation and below 25cm H2O for an additional 48 hours. Mean airway pressures were consistently 10-11cm H2O during the first 48 hours after resumption of ventilation, and peaked at 16cm H2O on postoperative day 6. Respiratory parameters normalized by 96 hours after resumption of ventilation with the patient spontaneously ventilating in excess of 8cc/kg, and ECMO was de-cannulated. Chest radiography on postoperative day 6 demonstrated clear bilateral lung fields, and bronchoscopy demonstrated patent and intact surgical repairs to the membranous trachea. The patient tolerated this ventilatory strategy well, never developed any signs of acute lung injury, and sedation was weaned sufficiently by postoperative day 4 for him to meaningfully interact with his family. The use of inverse-ratio ventilation with APRV in this case provided an ideal management strategy to minimize barotrauma on surgical airway repairs while recruiting previously non-ventilated lungs after ECMO.

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1. **ECMO as a bridge to lung transplantation in an adolescent with cystic fibrosis**  
   G.T. Coscia American Journal of Respiratory and Critical Care Medicine 2013;187:No page numbers.

Introduction: Extracorporeral membrane oxygenation (ECMO) has been used in patients awaiting lung transplantation as a means of oxygenation obviating the use of mechanical ventilation. However, there are few studies on the use of ECMO in patients with cystic fibrosis pre-transplant. We present the case of an adolescent with cystic fibrosis who underwent successful bilateral lung transplantation using ECMO as a bridge to transplant. Description of Case: A.C. is a 17 year old girl with cystic fibrosis and acute respiratory failure who was referred to our center for lung transplant evaluation. She has a history of severe lung disease, pancreatic insufficiency, ABPA and nutritional supplementation via G-tube feeds. Genetic studies revealed one deltaF508 mutation and one R1066c mutation. Sputum cultures grew mucoid Pseudomonas aeruginosa, Aspergillus fumigatus, Staph aureus (MSSA) and Citrobacter freundii. She presented to our institution for further care and possible lung transplant due to acute hypoxemic and hypercapnic respiratory failure requiring mechanical ventilation. At this time, her FEV<sub>1</sub> was 23%.On admission, she had septic shock, ARDS, and severe respiratory acidosis and hypoxemia. The arterial blood gas showed pH-7.32, pCO2-136 and pO2-90 on 80% FiO2. Her BMI was 18.8kg/m . Her hospital course 2 was complicated by pneumothoraces, C. difficile and MAC infections. She was placed on venovenous ECMO (VV-ECMO) to attempt to correct her severe gas exchange abnormalities and improve physical conditioning while awaiting transplant. After 3 days on VV-ECMO she was extubated to bi-level support, and resumed airway clearance with the VEST, the frequencer, and manual chest PT. She participated in physical and occupational therapy, and engaged in discussions about lung transplantation. She underwent bilateral lung transplantation on ECMO day#30 and was decannulated on POD#25. Post-operative complications included an SVC/RA thrombus secondary to ECMO cannulation, and a short period of diabetes due to immunosuppressive therapy. Her FEV<sub>1</sub> 10 months post-transplant is 90% predicted. Surveillance transbronchial biopsies have shown no evidence of acute rejection. <br/>Discussion(s): The use of ECMO as a bridge to transplantation in pediatric patients with cystic fibrosis has not been widely reported. Our patient was a suitable candidate for ECMO since she suffered from acute respiratory failure in the setting of progressively worsening lung disease. Also, s he had no comorbidities such as nutritional insufficiency or CF-related diabetes. ECMO offers an alternative to mechanical ventilation in a subset of patients. It enabled our patient to undergo extubation to bi-level support, which allowed lower sedation and early mobilization facilitating physical rehabilitation.

1. **Extracorporeal membrane oxygenation post lung transplantation**  
   A.W. Castleberry Current Opinion in Organ Transplantation 2013;18(5):524-530.

Purpose of review: Extracorporeal membrane oxygenation (ECMO) has been employed as a management strategy to support the failing pulmonary allograft following lung transplantation. We review the indications, technical considerations, management strategies, and outcomes of using ECMO after lung transplantation. Recent findings: ECMO is typically indicated for early pulmonary allograft failure despite optimized conventional support measures. Initiation of ECMO has been advocated early in the postoperative course (&lt;48 h) when ventilatory requirements reach a peak inspiratory pressure of 35cmH <sub>2</sub>O or FiO<sub>2</sub> surpasses 60% in order to reduce oxidative stress and barotrauma from aggressive mechanical ventilation. Both veno-venous approach and dual-stage cannulation have the potential to reduce thromboembolic complications and enable patient mobilization. Key management strategies while on ECMO include minimizing sedation, pressure-controlled ventilator support minimizing FiO<sub>2</sub>, and maintaining a hypovolemic state as tolerated. Bivalruden has been proposed as an anticoagulation alternative to heparin, which may ameliorate the effects of heparin resistance or heparin-induced thrombocytopenia syndrome. Single-center series have documented successful ECMO wean in as high as 96% of patients with 30-day survival of 82% and a 1-year survival of 64%. <br/>Summary: Advances in technology and management strategies continue to increase the effectiveness of ECMO in supporting the failing pulmonary allograft. Copyright &#xa9; 2013, Lippincott Williams & Wilkins.

1. **Double lumen bi-cava cannula for veno-venous extracorporeal membrane oxygenation as bridge to lung transplantation in non-intubated patient**  
   J. Reeb Interactive Cardiovascular and Thoracic Surgery 2012;14(1):125-127.

Extracorporeal membrane oxygenation (ECMO) is used for refractory respiratory failure. Normally, ECMO is implanted in intubated patients as a last resort. We report the case of a non-intubated patient who benefited from veno-venous (VV) ECMO. A 35-year old cystic fibrosis man presented a severe respiratory decompensation with refractory hypercapnia. We opted for an ECMO instead of mechanical ventilation (MV). We implanted a double lumen bi-cava cannula (DLC) (Avalon Elite<sup>TM</sup>) in the right jugular vein. Before ECMO implantation, the patient presented refractory respiratory failure (pH = 7.1, PaO<sub>2</sub> = 83 mmHg, PaCO<sub>2</sub> = 103 mmHg). We proposed that the patient be placed on the high emergency lung transplantation waiting list after failure to wean him from ECMO. This registration was effective 10 days after ECMO implantation. The patient was grafted the next day. Under ECMO, mean PaO<sub>2</sub>, PaCO<sub>2</sub> and TCA were 80.6 +/- 14.2, 53.8 +/- 6.4 mmHg and 56.2 +/- 9.7 s, respectively. The patient could eat, drink, talk and practice chest physiotherapy. The evolution was uneventful under ECMO. Weaning from ECMO was done in the operating theatre after transplantation. VV ECMO with DLC is safe and feasible in non-intubated patients. It avoids potential complications of MV, and allows respiratory assistance as bridge to transplantation. &#xa9; 2011 The Author 2011. Published by Oxford University Press on behalf of the European Association for Cardio-Thoracic Surgery. All rights reserved.

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1. **Bi-caval dual lumen venovenous extracorporeal membrane oxygenation and high-frequency percussive ventilatory support for postintubation tracheal injury and acute respiratory distress syndrome.**  
   Fitzgerald Julie C. Journal of pediatric surgery 2011;46(12):e11-5.

Bi-caval dual lumen venovenous extracorporeal membrane oxygenation (VV-ECMO) as a nonoperative approach to postintubation tracheal injury has not been described. We report the case of a 7-year-old boy who sustained a postintubation tracheal injury, developed acute respiratory distress syndrome from aspiration and viral pneumonitis, and was supported on bi-caval dual lumen VV-ECMO for 16 days until the trachea healed without surgical repair. Before ECMO decannulation, high-frequency percussive ventilation using a volumetric diffusive respiration ventilator was used for lung recruitment and airway clearance without disruption of the healed trachea. The use of ECMO to allow for lower mean airway pressure during initial healing and high-frequency percussive ventilation for lung recruitment and secretion clearance is a promising strategy to allow nonoperative tracheal injury repair in critically ill patients with multiple comorbidities. Copyright © 2011 Elsevier Inc. All rights reserved.

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1. **Evaluation of droplet dispersion during non-invasive ventilation, oxygen therapy, nebuliser treatment and chest physiotherapy in clinical practice: implications for management of pandemic influenza and other airborne infections.**  
   Simonds A. K Health technology assessment (Winchester, England) 2010;14(46):131-172.

Influenza viruses are thought to be spread by droplets, but the role of aerosol dissemination is unclear and has not been assessed by previous studies. Oxygen therapy, nebulised medication and ventilatory support are treatments used in clinical practice to treat influenzal infection are thought to generate droplets or aerosols. Evaluation of the characteristics of droplet/aerosol dispersion around delivery systems during non-invasive ventilation (NIV), oxygen therapy, nebuliser treatment and chest physiotherapy by measuring droplet size, geographical distribution of droplets, decay in droplets over time after the interventions were discontinued. Three groups were studied: (1) normal controls, (2) subjects with coryzal symptoms and (3) adult patients with chronic lung disease who were admitted to hospital with an infective exacerbation. Each group received oxygen therapy, NIV using a vented mask system and a modified circuit with non-vented mask and exhalation filter, and nebulised saline. The patient group had a period of standardised chest physiotherapy treatment. Droplet counts in mean diameter size ranges from 0.3 to &gt; 10 mum were measured with an counter placed adjacent to the face and at a 1-m distance from the subject/patient, at the height of the nose/mouth of an average health-care worker. NIV using a vented mask produced droplets in the large size range (&gt; 10 mum) in patients (p = 0.042) and coryzal subjects (p = 0.044) compared with baseline values, but not in normal controls (p = 0.379), but this increase in large droplets was not seen using the NIV circuit modification. Chest physiotherapy produced droplets predominantly of &gt; 10 mum (p = 0.003), which, as with NIV droplet count in the patients, had fallen significantly by 1 m. Oxygen therapy did not increase droplet count in any size range. Nebulised saline delivered droplets in the small- and medium-size aerosol/droplet range, but did not increase large-size droplet count. NIV and chest physiotherapy are droplet (not aerosol)-generating procedures, producing droplets of &gt; 10 mum in size. Due to their large mass, most fall out on to local surfaces within 1 m. The only device producing an aerosol was the nebuliser and the output profile is consistent with nebuliser characteristics rather than dissemination of large droplets from patients. These findings suggest that health-care workers providing NIV and chest physiotherapy, working within 1 m of an infected patient should have a higher level of respiratory protection, but that infection control measures designed to limit aerosol spread may have less relevance for these procedures. These results may have infection control implications for other airborne infections, such as severe acute respiratory syndrome and tuberculosis, as well as for pandemic influenza infection.

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[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=8fd775ecf16dee31081f2e34f248d2c2)

### Opening Internet Links

The links to internet sites in this document are 'live' and can be opened by holding down the CTRL key on your keyboard while clicking on the web address with your mouse

### Full text papers

Links are given to full text resources where available. For some of the papers, you will need an **NHS OpenAthens Account**. If you do not have an account you can [register online](https://openathens.nice.org.uk/).

You can then access the papers by simply entering your username and password. If you do not have easy access to the internet to gain access, please let us know and we can download the papers for you.

### Guidance on searching within online documents

Links are provided to the full text of each document. Relevant extracts have been copied and pasted into these results. Rather than browse through lengthy documents, you can search for specific words as follows:

**Portable Document Format / pdf / Adobe**  
Click on the Search button (illustrated with binoculars). This will open up a search window. Type in the term you need to find and links to all of the references to that term within the document will be displayed in the window. You can jump to each reference by clicking it.

**Word documents**  
Select Edit from the menu, the Find and type in your term in the search box which is presented. The search function will locate the first use of the term in the document. By pressing 'next' you will jump to further references.

**Disclaimer**  
We hope that you find the evidence search service useful. Whilst care has been taken in the selection of the materials included in this evidence search, the Library and Knowledge Service is not responsible for the content or the accuracy of the enclosed research information. Accordingly, whilst every endeavour has been undertaken to execute a comprehensive search of the literature, the Library and Knowledge Service is not and will not be held responsible or liable for any omissions to pertinent research information not included as part of the results of the enclosed evidence search. Users are welcome to discuss the evidence search findings with the librarian responsible for executing the search. We welcome suggestions on additional search strategies / use of other information resources for further exploration. You must not use the results of this search for commercial purposes. Any usage or reproduction of the search output should acknowledge the Library and Knowledge Service that produced it.

### SEARCH STRATEGY:

Cochrane Library search:  
  
ID    Search    Hits  
#1    (((chest\* OR respiratory) near/3 ("physical therap\*" OR physiotherap\* OR "physio-therap\*")) OR "breathing exercise"):ti,ab,kw (Word variations have been searched)    2656  
#2    MeSH descriptor: [Physical Therapy Modalities] explode all trees    24811  
#3    MeSH descriptor: [Respiration] explode all trees    6561  
#4    #2 and #3    372  
#5    MeSH descriptor: [Breathing Exercises] explode all trees    841  
#6    #1 or #4 or #5    2916  
#7    (("air way\*" OR airway\* OR lung\*) near/3 clear\*):ti,ab,kw (Word variations have been searched)    1004  
#8    MeSH descriptor: [Mucociliary Clearance] explode all trees    228  
#9    #7 or #8    1174  
#10    #6 or #9    3947  
#11    (((mechanical\* OR artificial\* OR control\*) near/3 (respirat\* OR ventilat\*)) OR "high frequency ventilation" OR "high frequency jet ventilation" OR "interactive ventilatory support" OR " intermittent mandatory ventilation" OR " intermittent positive pressure ventilation" OR "inverse ratio ventilation" OR " jet ventilation" OR " liquid ventilation" OR "manual ventilation" OR "negative pressure ventilation" OR "noninvasive ventilation" OR "non-invasive ventilation" OR "non invasive ventilation" OR NIV OR "one lung ventilation" OR "positive end expiratory pressure" OR PEEP OR " pressure support ventilation" OR "therapeutic hyperventilation" OR " ventilator weaning"):ti,ab,kw (Word variations have been searched)    26681  
#12    MeSH descriptor: [Respiration, Artificial] explode all trees    6074  
#13    #11 or #12    27721  
#14    (("veno-venous" or VV) near/3 (ECMO OR "extra-corporeal oxygenation" OR "extracorporeal oxygenation" OR "extracorporeal membrane oxygenation" OR "extra-corporeal membrane oxygenation")):ti,ab,kw (Word variations have been searched)    20  
#15    MeSH descriptor: [Extracorporeal Membrane Oxygenation] explode all trees    168  
#16    ("veno-venous" or VV):ti,ab,kw (Word variations have been searched)    846  
#17    #15 and #16    2  
#18    #14 or #17    21  
#19    ("2019-nCoV" OR 2019nCoV\* OR "19-nCoV" OR 19nCoV\* OR nCoV2019\* OR "nCoV-2019" OR nCoV19\* OR "nCoV-19" OR "COVID-19" OR COVID19\* OR "COVID-2019" OR COVID2019\* OR "HCoV-19" OR HCoV19\* OR "HCoV-2019" OR HCoV2019\* OR "2019 novel" OR Ncov\* OR "n-cov" OR "SARS-CoV-2" OR "SARSCoV-2" OR "SARSCoV2" OR "SARS-CoV2" OR SARSCov19\* OR "SARS-Cov19" OR "SARSCov-19" OR "SARS-Cov-19" OR SARSCov2019\* OR "SARS-Cov2019" OR "SARSCov-2019" OR "SARS-Cov-2019" OR SARS2\* OR "SARS-2" OR SARScoronavirus2\* OR "SARS-coronavirus-2" OR "SARScoronavirus 2" OR "SARS coronavirus2" OR SARScoronovirus2\* OR "SARS-coronovirus-2" OR "SARScoronovirus 2" OR "SARS coronovirus2" OR covid\* OR corona OR corono):ti,ab,kw (Word variations have been searched)    1292  
#20    (coronavirus\* OR coronovirus\* OR coronavirinae\* OR CoV):ti,ab,kw (Word variations have been searched)    755  
#21    (respiratory\* and (symptom\* OR disease\* OR illness\* OR condition\*) and (Wuhan\* OR Hubei\* OR China\* OR Chinese\* OR Huanan\*)):ti,ab,kw (Word variations have been searched)    950  
#22    (("seafood market" OR "food market") near/10 (Wuhan\* OR Hubei\* OR China\* OR Chinese\* OR Huanan\*)):ti,ab,kw (Word variations have been searched)    3  
#23    (pneumonia\* near/3 (Wuhan\* OR Hubei\* OR China\* OR Chinese\* OR Huanan\*)):ti,ab,kw (Word variations have been searched)    24  
#24    ((outbreak\* OR wildlife\* OR pandemic\* OR epidemic\*) near/1 (Wuhan\* OR Hubei\* OR China\* OR Chinese\* OR Huanan\*)):ti,ab,kw (Word variations have been searched)    3  
#25    ("severe acute respiratory syndrome" OR "middle east respiratory syndrome" OR "middle eastern respiratory syndrome"):ti,ab,kw (Word variations have been searched)    306  
#26    ((corona\* OR corono\*) near/1 (virus\* OR viral\* OR virinae\*)):ti,ab,kw (Word variations have been searched)    48  
#27    MeSH descriptor: [Coronavirus] explode all trees    27  
#28    MeSH descriptor: [Coronavirus Infections] explode all trees    259  
#29    #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28    2358  
#30    #18 or #29    2377  
#31    #10 and #18 and #30    1

Database: Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and Versions(R) <1946 to July 22, 2020>

Search Strategy:

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1     ("2019-nCoV\*" or 2019nCoV\* or "19-nCoV\*" or 19nCoV\* or nCoV2019\* or "nCoV-2019\*" or nCoV19\* or "nCoV-19\*" or "COVID-19\*" or COVID19\* or "COVID-2019\*" or COVID2019\* or "HCoV-19\*" or HCoV19\* or "HCoV-2019\*" or HCoV2019\* or "2019 novel\*" or Ncov\* or "n-cov" or "SARS-CoV-2\*" or "SARSCoV-2\*" or "SARSCoV2\*" or "SARS-CoV2\*" or SARSCov19\* or "SARS-Cov19\*" or "SARSCov-19\*" or "SARS-Cov-19\*" or SARSCov2019\* or "SARS-Cov2019\*" or "SARSCov-2019\*" or "SARS-Cov-2019\*" or SARS2\* or "SARS-2\*" or SARScoronavirus2\* or "SARS-coronavirus-2\*" or "SARScoronavirus 2\*" or "SARS coronavirus2\*" or SARScoronovirus2\* or "SARS-coronovirus-2\*" or "SARScoronovirus 2\*" or "SARS coronovirus2\*" or covid\* or corona or corono).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (42396)

2     (coronavirus\* or coronovirus\* or coronavirinae\* or CoV).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (39700)

3     (("seafood market\*" or "food market\*") adj10 (Wuhan\* or Hubei\* or China\* or Chinese\* or Huanan\*)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (74)

4     (respiratory\* adj2 (symptom\* or disease\* or illness\* or condition\*) adj5 (Wuhan\* or Hubei\* or China\* or Chinese\* or Huanan\*)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (269)

5     (pneumonia\* adj3 (Wuhan\* or Hubei\* or China\* or Chinese\* or Huanan\*)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (431)

6     ((outbreak\* or wildlife\* or pandemic\* or epidemic\*) adj1 (Wuhan\* or Hubei\* or China\* or Chinese\* or Huanan\*)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (120)

7     ("severe acute respiratory syndr\*" or "middle east respiratory syndr\*" or "middle eastern respiratory syndr\*").mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (21805)

8     ((corona\* or corono\*) adj1 (virus\* or viral\* or virinae\*)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (977)

9     exp Coronavirus Infections/ (22847)

10     exp Coronavirus/ (22584)

11     1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 (64333)

12     (((chest\* or respiratory) adj3 ("physical therap\*" or physiotherap\* or "physio-therap\*")) or "breathing exercise\*").mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (5510)

13     exp Physical Therapy Modalities/ (152862)

14     exp Respiration/ (115802)

15     13 and 14 (2017)

16     exp Breathing Exercises/ (3586)

17     12 or 15 or 16 (6922)

18     (("air way\*" or airway\* or lung\*) adj3 clear\*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (5320)

19     exp Mucociliary Clearance/ (2510)

20     18 or 19 (7462)

21     17 or 20 (14150)

22     (((mechanical\* or artificial\* or control\*) adj3 (respirat\* or ventilat\*)) or "high frequency ventilat\*" or "high frequency jet ventilat\*" or "interactive ventilatory support\*" or " intermittent mandatory ventilat\*" or " intermittent positive pressure ventilat\*" or "inverse ratio ventilat\*" or " jet ventilat\*" or " liquid ventilat\*" or "manual ventilat\*" or "negative pressure ventilat\*" or "noninvasive ventilat\*" or "non-invasive ventilat\*" or "non invasive ventilat\* or NIV" or "one lung ventilat\*" or "positive end expiratory pressure" or PEEP or " pressure support ventilat\*" or "therapeutic hyperventilat\*" or " ventilator wean\*").mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (116930)

23     exp Respiration, Artificial/ (76868)

24     22 or 23 (130339)

25     (("veno-venous" or VV) adj3 (ECMO or "extra-corporeal oxygenat\*" or "extracorporeal oxygenat\*" or "extracorporeal membrane oxygenat\*" or "extra-corporeal membrane oxygenat\*")).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (962)

26     exp Extracorporeal Membrane Oxygenation/ (10506)

27     ("veno-venous" or VV).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (6813)

28     26 and 27 (810)

29     25 or 28 (1107)

30     11 or 29 (65406)

31     21 and 24 and 30 (12)

EMBASE Search:

|  |  |  |  |
| --- | --- | --- | --- |
| 3 | AMED, BNI, CINAHL, EMBASE, EMCARE, HMIC, Medline, PsycINFO, PubMed | (((((airway\* OR "air way\*") ADJ clear\*) OR (chest\* ADJ (physiotherap\* OR "physical therap\*"))) AND (mechanical\* ADJ ventilat\*)) AND (covid\* OR corona\* OR ("veno-venous" ADJ (ECMO OR "extracorporeal membrane oxygenat\*")))).ti,ab | 24 |
| 17 | EMBASE | (((chest\* OR respiratory) ADJ3 ("physical therap\*" OR physiotherap\* OR "physio-therap\*")) OR "breathing exercise\*").ti,ab | 4352 |
| 18 | EMBASE | exp "BREATHING EXERCISE"/ | 7363 |
| 19 | EMBASE | (17 OR 18) | 9181 |
| 20 | EMBASE | exp "LUNG CLEARANCE"/ | 5919 |
| 21 | EMBASE | (("air way\*" OR airway\* OR lung\*) ADJ3 clear\*).ti,ab | 9321 |
| 22 | EMBASE | (20 OR 21) | 12019 |
| 23 | EMBASE | (19 OR 22) | 20638 |
| 24 | EMBASE | (((mechanical\* OR artificial\* OR control\*) ADJ3 (respirat\* OR ventilat\*)) OR "high frequency ventilat\*" OR "high frequency jet ventilat\*" OR "interactive ventilatory support\*" OR " intermittent mandatory ventilat\*" OR " intermittent positive pressure ventilat\*" OR "inverse ratio ventilat\*" OR " jet ventilat\*" OR " liquid ventilat\*" OR "manual ventilat\*" OR "negative pressure ventilat\*" OR "noninvasive ventilat\*" OR "non-invasive ventilat\*" OR "non invasive ventilat\*" OR NIV OR "one lung ventilat\*" OR "positive end expiratory pressure" OR PEEP OR " pressure support ventilat\*" OR "therapeutic hyperventilat\*" OR " ventilator wean\*").ti,ab | 128272 |
| 25 | EMBASE | exp "ARTIFICIAL VENTILATION"/ | 203266 |
| 26 | EMBASE | (24 OR 25) | 239307 |
| 27 | EMBASE | (("veno-venous" OR VV) ADJ3 (ECMO OR "extra-corporeal oxygenat\*" OR "extracorporeal oxygenat\*" OR "extracorporeal membrane oxygenat\*" OR "extra-corporeal membrane oxygenat\*")).ti,ab | 2183 |
| 28 | EMBASE | exp "EXTRACORPOREAL OXYGENATION"/ | 24029 |
| 29 | EMBASE | ("veno-venous" OR VV).ti,ab | 10392 |
| 30 | EMBASE | (28 AND 29) | 1949 |
| 31 | EMBASE | (27 OR 30) | 2445 |
| 32 | EMBASE | ("2019-nCoV\*" OR 2019nCoV\* OR "19-nCoV\*" OR 19nCoV\* OR nCoV2019\* OR "nCoV-2019\*" OR nCoV19\* OR "nCoV-19\*" OR "COVID-19\*" OR COVID19\* OR "COVID-2019\*" OR COVID2019\* OR "HCoV-19\*" OR HCoV19\* OR "HCoV-2019\*" OR HCoV2019\* OR "2019 novel\*" OR Ncov\* OR "n-cov" OR "SARS-CoV-2\*" OR "SARSCoV-2\*" OR "SARSCoV2\*" OR "SARS-CoV2\*" OR SARSCov19\* OR "SARS-Cov19\*" OR "SARSCov-19\*" OR "SARS-Cov-19\*" OR SARSCov2019\* OR "SARS-Cov2019\*" OR "SARSCov-2019\*" OR "SARS-Cov-2019\*" OR SARS2\* OR "SARS-2\*" OR SARScoronavirus2\* OR "SARS-coronavirus-2\*" OR "SARScoronavirus 2\*" OR "SARS coronavirus2\*" OR SARScoronovirus2\* OR "SARS-coronovirus-2\*" OR "SARScoronovirus 2\*" OR "SARS coronovirus2\*" OR covid\* OR corona OR corono).ti,ab | 41132 |
| 33 | EMBASE | (coronavirus\* OR coronovirus\* OR coronavirinae\* OR CoV).ti,ab | 29491 |
| 34 | EMBASE | ((respiratory\* ADJ2 (symptom\* OR disease\* OR illness\* OR condition\*)) ADJ5 (Wuhan\* OR Hubei\* OR China\* OR Chinese\* OR Huanan\*)).ti,ab | 331 |
| 35 | EMBASE | (("seafood market\*" OR "food market\*") ADJ10 (Wuhan\* OR Hubei\* OR China\* OR Chinese\* OR Huanan\*)).ti,ab | 72 |
| 36 | EMBASE | (pneumonia\* ADJ3 (Wuhan\* OR Hubei\* OR China\* OR Chinese\* OR Huanan\*)).ti,ab | 475 |
| 37 | EMBASE | ((outbreak\* OR wildlife\* OR pandemic\* OR epidemic\*) ADJ1 (Wuhan\* OR Hubei\* OR China\* OR Chinese\* OR Huanan\*)).ti,ab | 122 |
| 38 | EMBASE | ("severe acute respiratory syndr\*" OR "middle east respiratory syndr\*" OR "middle eastern respiratory syndr\*").ti,ab | 9747 |
| 39 | EMBASE | ((corona\* OR corono\*) ADJ1 (virus\* OR viral\* OR virinae\*)).ti,ab | 971 |
| 40 | EMBASE | exp \*CORONAVIRINAE/ | 8555 |
| 41 | EMBASE | exp "CORONAVIRUS INFECTION"/ | 16494 |
| 42 | EMBASE | (32 OR 33 OR 34 OR 35 OR 36 OR 37 OR 38 OR 39 OR 40 OR 41) | 66724 |
| 43 | EMBASE | (31 OR 42) | 69137 |
| 44 | EMBASE | (23 AND 26 AND 43) | 42 |
| 3 | AMED, BNI, CINAHL, EMBASE, EMCARE, HMIC, Medline, PsycINFO, PubMed | (((((airway\* OR "air way\*") ADJ clear\*) OR (chest\* ADJ (physiotherap\* OR "physical therap\*"))) AND (mechanical\* ADJ ventilat\*)) AND (covid\* OR corona\* OR ("veno-venous" ADJ (ECMO OR "extracorporeal membrane oxygenat\*")))).ti,ab | 24 |
| 17 | EMBASE | (((chest\* OR respiratory) ADJ3 ("physical therap\*" OR physiotherap\* OR "physio-therap\*")) OR "breathing exercise\*").ti,ab | 4352 |
| 18 | EMBASE | exp "BREATHING EXERCISE"/ | 7363 |
| 19 | EMBASE | (17 OR 18) | 9181 |
| 20 | EMBASE | exp "LUNG CLEARANCE"/ | 5919 |
| 21 | EMBASE | (("air way\*" OR airway\* OR lung\*) ADJ3 clear\*).ti,ab | 9321 |
| 22 | EMBASE | (20 OR 21) | 12019 |
| 23 | EMBASE | (19 OR 22) | 20638 |
| 24 | EMBASE | (((mechanical\* OR artificial\* OR control\*) ADJ3 (respirat\* OR ventilat\*)) OR "high frequency ventilat\*" OR "high frequency jet ventilat\*" OR "interactive ventilatory support\*" OR " intermittent mandatory ventilat\*" OR " intermittent positive pressure ventilat\*" OR "inverse ratio ventilat\*" OR " jet ventilat\*" OR " liquid ventilat\*" OR "manual ventilat\*" OR "negative pressure ventilat\*" OR "noninvasive ventilat\*" OR "non-invasive ventilat\*" OR "non invasive ventilat\*" OR NIV OR "one lung ventilat\*" OR "positive end expiratory pressure" OR PEEP OR " pressure support ventilat\*" OR "therapeutic hyperventilat\*" OR " ventilator wean\*").ti,ab | 128272 |
| 25 | EMBASE | exp "ARTIFICIAL VENTILATION"/ | 203266 |
| 26 | EMBASE | (24 OR 25) | 239307 |
| 27 | EMBASE | (("veno-venous" OR VV) ADJ3 (ECMO OR "extra-corporeal oxygenat\*" OR "extracorporeal oxygenat\*" OR "extracorporeal membrane oxygenat\*" OR "extra-corporeal membrane oxygenat\*")).ti,ab | 2183 |
| 28 | EMBASE | exp "EXTRACORPOREAL OXYGENATION"/ | 24029 |
| 29 | EMBASE | ("veno-venous" OR VV).ti,ab | 10392 |
| 30 | EMBASE | (28 AND 29) | 1949 |
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| 32 | EMBASE | ("2019-nCoV\*" OR 2019nCoV\* OR "19-nCoV\*" OR 19nCoV\* OR nCoV2019\* OR "nCoV-2019\*" OR nCoV19\* OR "nCoV-19\*" OR "COVID-19\*" OR COVID19\* OR "COVID-2019\*" OR COVID2019\* OR "HCoV-19\*" OR HCoV19\* OR "HCoV-2019\*" OR HCoV2019\* OR "2019 novel\*" OR Ncov\* OR "n-cov" OR "SARS-CoV-2\*" OR "SARSCoV-2\*" OR "SARSCoV2\*" OR "SARS-CoV2\*" OR SARSCov19\* OR "SARS-Cov19\*" OR "SARSCov-19\*" OR "SARS-Cov-19\*" OR SARSCov2019\* OR "SARS-Cov2019\*" OR "SARSCov-2019\*" OR "SARS-Cov-2019\*" OR SARS2\* OR "SARS-2\*" OR SARScoronavirus2\* OR "SARS-coronavirus-2\*" OR "SARScoronavirus 2\*" OR "SARS coronavirus2\*" OR SARScoronovirus2\* OR "SARS-coronovirus-2\*" OR "SARScoronovirus 2\*" OR "SARS coronovirus2\*" OR covid\* OR corona OR corono).ti,ab | 41132 |
| 33 | EMBASE | (coronavirus\* OR coronovirus\* OR coronavirinae\* OR CoV).ti,ab | 29491 |
| 34 | EMBASE | ((respiratory\* ADJ2 (symptom\* OR disease\* OR illness\* OR condition\*)) ADJ5 (Wuhan\* OR Hubei\* OR China\* OR Chinese\* OR Huanan\*)).ti,ab | 331 |
| 35 | EMBASE | (("seafood market\*" OR "food market\*") ADJ10 (Wuhan\* OR Hubei\* OR China\* OR Chinese\* OR Huanan\*)).ti,ab | 72 |
| 36 | EMBASE | (pneumonia\* ADJ3 (Wuhan\* OR Hubei\* OR China\* OR Chinese\* OR Huanan\*)).ti,ab | 475 |
| 37 | EMBASE | ((outbreak\* OR wildlife\* OR pandemic\* OR epidemic\*) ADJ1 (Wuhan\* OR Hubei\* OR China\* OR Chinese\* OR Huanan\*)).ti,ab | 122 |
| 38 | EMBASE | ("severe acute respiratory syndr\*" OR "middle east respiratory syndr\*" OR "middle eastern respiratory syndr\*").ti,ab | 9747 |
| 39 | EMBASE | ((corona\* OR corono\*) ADJ1 (virus\* OR viral\* OR virinae\*)).ti,ab | 971 |
| 40 | EMBASE | exp \*CORONAVIRINAE/ | 8555 |
| 41 | EMBASE | exp "CORONAVIRUS INFECTION"/ | 16494 |
| 42 | EMBASE | (32 OR 33 OR 34 OR 35 OR 36 OR 37 OR 38 OR 39 OR 40 OR 41) | 66724 |
| 43 | EMBASE | (31 OR 42) | 69137 |
| 44 | EMBASE | (23 AND 26 AND 43) | 42 |

Pedro database at <https://www.pedro.org.au/>:

covid chest physiotherap\*

coronavirus chest physiotherap\*

corona chest physiotherap\*

MedRxiv pre-publication database at <https://www.medrxiv.org/search>:

title "covid corona coronavirus" (match any words) and abstract or title "breathing exercise" (match all words)

abstract or title "airway clearance" (match all words)

Google

<https://www.google.com/search?q=airway+clearance+mechincal+ventilation+covid&rlz=1C1CHBF_en-gbGB778GB778&oq=airway+clearance+mechincal+ventilation+covid&aqs=chrome..69i57j33l2.6727j0j8&sourceid=chrome&ie=UTF-8>