Introduction

Coronavirus Disease 2019 (COVID-19), caused by Severe Acute Respiratory Syndrome-Corona Virus-2 (SARS-CoV-2), is a single-stranded ribonucleic acid (RNA) encapsulated corona virus and is highly contagious. Transmission is thought to be predominantly by droplet spread (i.e. relatively large particles that settle in the air), and direct contact with the patient, rather than 'airborne spread' (in which smaller particles remain in the air longer). There is still no specific antiviral treatment for COVID-19 infection, only supportive therapies including respiratory care for affected patients, especially in more severe cases. [1]

Approximately 15% of individuals with COVID-19 develop moderate to severe disease and require hospitalisation and oxygen support, with a further 5% who require admission to an Intensive Care Unit and supportive therapies including intubation and ventilation.[2] The most common complication in severe COVID-19 patients is severe pneumonia, but other complications may include Acute Respiratory Distress Syndrome (ARDS), Sepsis and Septic Shock, Multiple Organ Failure, including Acute Kidney Injury and Cardiac Injury, which are more prevalent in at-risk groups including Older Age (> 70 years) and those with Co-morbid Diseases such as Cardiovascular Disease, Lung Disease, Diabetes and those who are Immunosuppressed[2]. In a small proportion of these, the illness may be severe enough to lead to death. Data currently suggests that illness is less common and usually less severe in younger adults. [3]

Many patients presenting with COVID 19 will have no specific airway clearance needs. It is important that staff contact is kept to a minimum with positive patients to help reduce the risk of transmission therefore follow usual on-call policies and criteria. To date, COVID 19 patients who require hospitalisation are presenting with pneumonia features and bilateral patchy shadows or ground-glass opacity in the lungs. There have been no reports of COVID 19 positive patients having high secretion loads that would require intensive respiratory physiotherapy/airway clearance. This may change as the situation evolves and for that reason, all presenting patients should be discussed with Consultant Respiratory Clinicians/Critical Care Consultants before mechanical devices are used and guidance from a physiotherapist's specific Service Provider should be followed. It is important to note that some therapeutic interventions will be contraindicated for patients with COVID 19. There may be patients with existing respiratory conditions who require personalised physiotherapy treatments which may include mechanical airway clearance or oscillating devices. In this scenario, it is important that the risk and benefit of continuing with the regime are discussed with Consultant Respiratory Clinicians/Critical Care Consultants. [4]

Clinical Syndromes

Mild **Illness**	Patients present with uncomplicated upper respiratory tract viral infection and may have non-specific symptoms such as fever, fatigue, cough (with or without sputum production), anorexia, malaise, muscle pain, sore throat, dyspnea, nasal congestion, or headache. Rarely. patients may also present with diarrhoea, nausea, and vomiting. The elderly and immunosuppressed may present with atypical symptoms. Symptoms due to physiologic adaptations of pregnancy or adverse pregnancy events, such as dyspnea, fever, GI-symptoms or fatigue, may overlap with COVID- 19 Symptoms.
Pneumonia	**Adult:** with pneumonia but no signs of severe pneumonia and no need for supplemental oxygen. **Child:** with non-severe pneumonia who has a cough or difficulty breathing + fast breathing: Fast Breathing (in breaths/min) .< 2 months old ≥ 60; 2-11 months old ≥ 50; and 1-5 years old ≥ 40, and no signs of severe pneumonia. Patients may be productive, with an increased sputum load but this is a less common presentation in viral pneumonia.
Severe Pneumonia	**Adolescent or Adult:** Fever or suspected respiratory infection, plus one of the following: High Respiratory Rate > 30 breaths/min; Severe Respiratory Distress; or SpO2 ≤ 93% on Room Air. **Child:** with a cough or difficulty in breathing, plus at least one of the following: Central Cyanosis or SpO2 < 90%; Severe Respiratory Distress (e.g. Grunting, Very Severe Chest Indrawing); Signs of Pneumonia with a general

	danger sign: Inability to breastfeed or drink, Lethargy or Unconsciousness, or Convulsions. Other signs of pneumonia may be present: Chest Indrawing; Fast Breathing (in breaths/min): < 2 months: ≥ 60; 2 - 11 months: ≥ 50;1 - 5 years: ≥ 40. While the diagnosis is made on clinical grounds, chest imaging may identify or exclude some pulmonary complications.
Acute Respiratory Distress Syndrome (ARDS)	**Onset:** Within 5 - 7 days from the onset of initial respiratory symptoms **Diagnostic Tools (Radiograph, CT Scan, or Lung Ultrasound):** Bilateral Opacities, not fully explained by volume overload, lobar or lung collapse, or nodules; Origin of Pulmonary Infiltrates: Respiratory failure not fully explained by cardiac failure or fluid overload; Need Objective Assessment (e.g. Echocardiography) to exclude Hydrostatic cause of infiltrates/oedema if no risk factor present. **Oxygenation Impairment in Adults:** Based on PF Ratio, which is the ratio of arterial oxygen partial pressure to fractional inspired oxygen **Mild ARDS:** 200 mmHg < PaO2/FiO2a ≤ 300 mmHg (with PEEP or CPAP ≥ 5 cmH2O, Ornon-ventilated) **Moderate ARDS:** 100 mmHg < PaO2/FiO2 ≤ 200 mmHg (with PEEP ≥ 5 cmH2O, or Non-ventilated) **Severe ARDS:** PaO2/FiO2 ≤ 100 mmHg (with PEEP ≥ 5 cmH2O, or Non-ventilated) When PaO2 is not available, SpO2/FiO2 ≤ 315 suggests ARDS (including in Non-ventilated patients). **Oxygenation Impairment in**

	Children: Note OI = Oxygenation Index and OSI = Oxygenation Index using SpO_2. Use PaO_2-based metric when available. If PaO_2 not available, wean FiO_2 to maintain $SpO_2 \leq 97\%$ to calculate OSI or SpO_2/FiO_2 ratio: **Bilevel** (NIV or CPAP) ≥ 5 cmH_2O via full face mask: $PaO_2/FiO_2 \leq 300$ mmHg or $SpO_2/FiO_2 \leq 264$ **Mild ARDS** (Invasively Ventilated): $4 \leq OI < 8$ or $5 \leq OSI < 7.5$ **Moderate ARDS** (Invasively Ventilated): $8 \leq OI < 16$ or $7.5 \leq OSI < 12.3$ **Severe ARDS** (Invasively Ventilated): $OI \geq 16$ or $OSI \geq 12.3$.
Sepsis	**Adults:** Life-threatening organ dysfunction caused by a dysregulated host response to suspected or proven infection. Signs of organ dysfunction include: Altered Mental Status; Difficult or Fast Breathing; Low Oxygen Saturation; Reduced Urine Output; Fast Heart Rate; Weak Pulse; Cold Extremities; Low blood Pressure; Skin Mottling; Laboratory Evidence of Coagulopathy, Thrombocytopenia, Acidosis, High Lactate, or Hyperbilirubinemia. **Children:** Suspected or proven infection and ≥ 2 age-based systemic inflammatory response syndrome criteria, of which one must be abnormal temperature or white blood cell count.
Septic Shock	**Adults:** Persisting hypotension despite volume resuscitation, requiring vasopressors to maintain MAP MAP ≥ 65 mmHg and serum lactate level > 2 mmol/L. **Children:** Any hypotension (SBP < 5th centile or > 2 SD below normal for age) or two or three of the following: Altered Mental State; Tachycardia or Bradycardia - HR < 90 bpm or > 160 bpm in Infants or HR < 70 bpm or > 150 bpm in Children; Prolonged Capillary Refill (> 2

sec) or Feeble Pulse; Tachypnoea; Mottled or Cool Skin or Petechial or Purpuric Rash; Increased Lactate; Oliguria; Hyperthermia or Hypothermia

The World Health Organisation outlines the following Clinical Syndromes associated with COVID-19: [2]

Patients with severe disease often need oxygenation support. High-flow oxygen and noninvasive positive pressure ventilation have been used, but the safety of these measures is uncertain, and they should be considered aerosol-generating procedures that warrant specific isolation precautions and PPE considerations. Some patients may develop acute respiratory distress syndrome and warrant intubation with mechanical ventilation; extracorporeal membrane oxygenation may be indicated in patients with refractory hypoxia.

Physiotherapy may be beneficial in the respiratory treatment and physical rehabilitation of patients with COVID-19, although a productive cough is a less common symptom, physiotherapy may be indicated if patients with COVID-19 present with airway secretions that they are unable to independently clear. This may be evaluated on a case- by-case basis and interventions applied based on clinical indicators, and may also be utilised in high risk individuals e.g. patients with existing comorbidities that may be associated with hypersecretion or ineffective cough (e.g. neuromuscular disease, respiratory disease, cystic fibrosis etc). [5]

Guideline Recommendations: Senior physiotherapists should be involved in determining the appropriateness of physiotherapy interventions for patients with suspected and/or proven COVID-19 in consultation with senior medical staff and according to a referral guideline. [5]

Physiotherapy will have a strong role in providing exercise, mobilisation and rehabilitation interventions to survivors of critical illness myopathies associated with COVID-19 in order to enable a functional return to home. [5]

Procedures at Risk of Contamination

COVID-19 is spread by inhalation of infected matter containing live virus, which can travel up to 2m or by exposure from contaminated surfaces. SARS-CoV-2 remains viable for at least 24 hours on hard surfaces and up to eight hours on soft surfaces. Aerosol airborne infected particles created during a sneeze or cough remain viable in the air for at least three hours. [5] Aerosol-generating procedures create an increased risk of transmission of infection. Rachael Moses, a Consultant Physiotherapist at Lancashire Teaching Hospital, suggests that particular attention should be given during those interventions that place the health care staff at greater risk of contamination for aerial dispersion of droplets.[3][5]

Aerosol Generating Procedures (AGP)

Aerosols generated by medical procedures are one route for the transmission of the COVID-19 virus. For patients with suspected/confirmed COVID-19, any of these potentially infectious AGPs should only be carried out when essential and minimised as much as possible. Where these procedures are indicated, they should be carried out in a single room with the doors shut but preferably should be completed in a Negative Pressure Side Room. Only those healthcare staff who are needed to undertake the procedure should be present. Full PPE Equipment including a disposable, Fluid Repellent Surgical Gown, Gloves, Eye Protection and an FFP3 Respirator Mask should be worn by those undertaking the procedure and those in the room and good hand hygiene following the procedure. Hair cover should also be considered. The following procedures are considered to be potentially infectious AGPs: [3]

- Intubation, Extubation and Related Procedures;
- Tracheotomy/Tracheostomy Procedures;
- Manual Ventilation;
- Open Suctioning;
- Bronchoscopy;
- Non-Invasive Ventilation (NIV) e.g. Bi-level Positive Airway Pressure (BiPAP)and Continuous Positive Airway Pressure Ventilation (CPAP);
- Surgery and Post-Mortem Procedures in which high-speed devices are used;
- High-Frequency Oscillating Ventilation (HFOV);
- High-flow Nasal Oxygen (HFNO)
- Induction of Sputum; Note: *Induction of sputum typically involves administration of nebulised saline to moisten and loosen respiratory secretions (this may be accompanied by chest physiotherapy such as percussion and vibration to induce forceful coughing). This may be required if lower respiratory tract samples are needed*

Certain other procedures/equipment may generate an aerosol from material other than patient secretions but are not considered to represent a significant infectious risk. Procedures in this category include: [3]

- Administration of Pressurised Humidified Oxygen;
- Administration of Medication via Nebulisation; *Note: During nebulisation, the aerosol derives from a non-patient source (the fluid in the nebuliser chamber) and does not carry patient-derived viral particles. If a particle in the aerosol coalesces (combines) with a contaminated mucous membrane, it will cease to be airborne and therefore will not be part of an aerosol. Staff should use appropriate hand hygiene when helping patients to remove nebulisers and oxygen masks.*

Physiotherapy Specific Aerosol Generating Techniques [3]

- Manual Techniques (e.g. Percussion/Manual Assisted Cough) that may lead to coughing and expectoration of sputum
- Use of Positive Pressure Breathing Devices (e.g. IPPB), Mechanical Insufflation-Exsufflation (Cough Assist) Devices, Intra/Extra Pulmonary High Frequency Oscillation Devices (e.g. the Vest / MetaNeb / Percussionaire etc.)
- Any Mobilisation or Therapy that may result in Coughing and Expectoration of Mucus
- Any Diagnostic Interventions that involve use of Video Laryngoscopy that can result in Airway Irritation and Coughing (e.g. Direct Visualisation during airway clearance techniques or when assisting Speech and Language Therapists perform Fibreoptic Endoscopic Evaluation of Swallow)

Decontamination

Reusable (communal) non-invasive equipment must be decontaminated:

- between each patient and after patient use;
- after blood and body fluid contamination; and
- at regular intervals as part of equipment cleaning.

An increased frequency of decontamination should be considered for reusable non-invasive care equipment when used in isolation/cohort areas. [31]

Equipment

- Reusable equipment should be avoided if possible; if used, it should be decontaminated according to the manufacturer's instructions before removal from the room. If it is not possible to leave equipment inside a room then follow IPC Guidelines on Decontamination. This usually involves cleaning with neutral detergent, then a chlorine-based disinfectant, in the form of a solution at a minimum strength of 1,000ppm available chlorine (e.g. "Haz-Tab" or other brands).
- If possible use dedicated equipment in the isolation room. Avoid storing any extraneous equipment in the patient's room
- Dispose of single-use equipment as per clinical waste policy inside a room
- Point of care tests, including blood gas analysis, should be avoided unless a local risk assessment has been completed and shows it can be undertaken safely
- Ventilators and mechanical devices (e.g. Cough Assist Machines) should be protected with a high-efficiency viral-bacterial filter such as BS EN 13328-1.
- When using mechanical airway clearance, filters should be placed at the machine end and the mask end before any expiratory or exhalation ports. Filters should be changed when visibly soiled or dependent on the filter used either after each use or every 24 hours. Complete circuit changes should be

undertaken every 72 hours (please follow specific Service Provider guidance on this)
- Closed system suction should be used if patients are intubated or have tracheostomies
- Disconnecting a patient from mechanical ventilation should be avoided at all costs but if required the ventilator should be placed on standby
- Manual hyperinflation (bagging) should be avoided if possible and attempt ventilator recruitment manoeuvres where possible and required
- Water humidification should be avoided and a heat and moisture exchanger should be used in ventilator circuits
- Disposable crockery and cutlery may be used in the patient's room as far as possible to minimise the numbers of items which need to be decontaminated
- Any additional items such as Stethoscopes, Pulse Oximeters or Ultrasound Probes that are taken into a room will also need to be disinfected, regardless of whether there has been direct contact with the patient or not. This is due to the risk of environmental contamination of the equipment within the isolation room. [3]

Patients Rooms

- If AGPs are undertaken in the patient's own room, the room should be decontaminated 20 minutes after the procedure has ended (please follow specific Service Provider IPC guidance on this also).
- If a different room is used for a procedure it should be left for 20 minutes, then cleaned and disinfected before being put back into use.
- Clearance of any aerosols is dependent on the ventilation of the room. In hospitals, rooms commonly have 12 to 15 air changes per hour, and so after about 20 minutes, there would be less than 1 per cent of the starting level (assuming cessation of aerosol generation).
- If it is known locally that the design or construction of a room may not be typical for a clinical space, or that there are fewer air changes per hour, then the local IPCT would advise on how long to leave a room before decontamination. [3]

Oxygen Therapy

In the mild and moderate stages of disease, normal oxygen supportive measures (facemask oxygen) may be advantageous. WHO [2] recommends supplemental oxygen therapy immediately for patients with respiratory distress, hypoxaemia or shock with a target SpO2 > 94%. Patients may continue to have increased work of breathing or hypoxemia even when oxygen is delivered via a face mask with reservoir bag (flow rates of 10 - 15 L/min, which is typically the minimum flow required to maintain bag inflation; FiO2 0.60 - 0.95). [2] Nasal cannulas are not recommended as they may cause a higher spread of droplets.[6]

Early recognition and referral of patients with worsening respiratory function while on conventional oxygen therapies, such as simple face masks or masks with reservoir bags, are important to ensure the timely and safe escalation of respiratory support. Early optimisation of care and involvement of Intensive Care Unit is recommended. In patients with COVID-19 there is the potential for a worsening of hypoxia and an increased need for intubation and invasive mechanical ventilation so close monitoring is advised.[7]

Oxygen therapy targets may vary depending on the presentation of the patient.[5]

For patients with presenting with severe respiratory distress, hypoxaemia or shock

- SpO2 > 94% is targeted [2]

Once a patient is stable

- SpO2 > 90% [2] in non-pregnant adults and 92-95% [8] in pregnant adults are targeted.

In adults with COVID-19 and Acute Hypoxaemic Respiratory Failure

- SpO2 target should not be maintained higher than 96% [9]

High Flow Nasal Oxygen (HFNO)

There have been some differing opinions on the use of HFNO due as an aerosol generating procedure but based on the Italian experience, HFNO has been found to be beneficial at the early stage, with a select cohort of patients who present with hypoxemic respiratory failure with no evidence of hypercapnia and can prevent intubation in some patients. [1] Given that HFNO is an aerosol generating procedure negative pressure rooms are preferable for patients receiving HFNO therapy and all staff entering the room should wear optimal PPE Equipment including a disposable, fluid repellent surgical gown, gloves, eye protection and an FFP3 respirator mask to ensure a low risk of airborne transmission. Flow rates of up to 60% and 100% oxygen are possible with HFNO. [10][1]

Early recognition and referral of patients with worsening respiratory function (hypercapnia, acidaemia, respiratory fatigue), haemodynamic instability or those with altered mental status are important to ensure the timely and safe escalation of respiratory support, with consideration for early invasive mechanical ventilation if appropriate.[11][1]

Guideline Recommendations: While HFNO does carry a small risk of aerosol generation, it is considered a recommended therapy for hypoxia associated with COVID-19, as long as staff are wearing optimal airborne PPE. The risk of airborne transmission to staff is low when optimal PPE and other infection control precautions are being used. Negative pressure rooms are preferable for patients receiving HFNO. [5]

Ventilatory Support

Acute or chronic hypoxaemia is a common reason for admission to intensive care and for provision of mechanical ventilation. Various refinements of mechanical ventilation or adjuncts are employed to improve patient outcomes.

Non-Invasive Ventilation (CPAP/NIV)

Routine use of non-invasive ventilation is not recommended.

Non-invasive ventilation, an aerosol generating procedure, is when oxygen is given as breathing support by using a face mask or nasal mask under positive pressure, and is a recognised evidence-based intervention utilised for the treatment of hypercapnic respiratory failure. The amount of pressure generally alternates depending on inhalation or exhalation. Although non-invasive ventilation may temporarily improve oxygenation and reduce the work of breathing in patients with viral infections complicated by pneumonia, this method does not necessarily change the natural disease course and as such non-invasive ventilation is not routinely recommended and has no role in severe hypoxemic respiratory failure. Where non-invasive ventilation is utilised, a clear plan for treatment failure and escalation of care should be in place. [11]

Current experience suggests that non-invasive ventilation for COVID-19 can be associated with a high failure rate, delayed intubation and possibly increased risk of aerosolisation with poor mask fit [12][11] It seems clear from the available evidence that non-invasive ventilation should not be routinely used when the patient has severe respiratory failure or a trajectory that suggests that invasive ventilation is inevitable. In such circumstances, deteriorating patients should be considered for early endotracheal intubation and transitioned from oxygen therapy via a simple facemask to invasive ventilation without delay. [11][13] Negative prognostic factors for non-invasive ventilation success are overall severity, renal failure and hemodynamic instability.[1]

Non-invasive ventilation has been considered an effective strategy with a specific cohort of patients in the early presentation of COVID-19, in particular with presentations of COVID-19 with hypercapnic respiratory failure, such as

those with concomitant respiratory conditions e.g. COPD.[1] In Italy, where non-invasive ventilation has been utilised with this cohort group, they recommend to **perform a single attempt of up to 1 hour. If substantial improvement does not occur, the medical team must be alerted because the patient should be considered for early endotracheal intubation and invasive ventilation within a controlled environment with adequate infection prevention and control measures taken.** [10]
In order for non-invasive ventilation to be delivered in a safe manner and minimise the risk of aerosolisation, negative pressure single rooms should be used, using a dual link system with separate expiatory port or use of a double port filter system with a viral filter placed between the mask and the respiratory port.

Recommendations in terms of non-invasive ventilation preferences are;

1. **First Choice:** CPAP without humidification and with Hood / Helmet PEEP between 10 - 12 cmH20 and up to 15-20 cmH2O according to patient's needs, tolerance and any side-effects.
2. **Second Choice:** CPAP with mask
3. **Third Choice:** NIV with face mask (total full face mask / oronasal face mask with filter between mask respiratory port)

Non-invasive ventilation can be used effectively to bridge extubation and can be used to support extubation in the intensive care unit. The following Standard Operating Protocol for the Setup and Use of Non-Invasive Ventilation or HiFlow Oxygen (AirVo) for Patients with Suspected or Confirmed Coronavirus Version 1.7 - March 17th, 2020 provides a detailed outline for HFNO & NIV use. [14]
Guideline Recommendation: Routine use of NIV is not recommended. as current experience with COVID-19 hypoxic respiratory failure reflects a high associate failure rate. If utilised e.g. with a patient with COPD or post-extubation it must be provided with strict airborne PPE. [5]

Invasive Ventilation

Lung protective mechanical ventilation (MV) is the recommended strategy for the management of acute respiratory failure, which aims to protect the lung. This is when mechanical ventilation is employed with the use of a low tidal volume strategy (4-8ml/kg predicted body weight) and limiting plateau pressures to less than 30 cmH2O. Permissive hypercapnia is usually well-tolerated and may reduce volutrauma, local over distention of normal alveoli as achievement of adequate oxygenation is key. Higher levels of PEEP, greater than 15 cmH2O, are recommended. [11]

Alternate modes of ventilation such as APRV may be considered based on clinician preference and local experience. Viral (rather than HME) filters should be utilised and circuits should be maintained for as long as allowable, as opposed to routine changes. [11]

Generally patients are sedated to allow adequate control of ventilation. While good practice to perform daily sedation holds, patients with COVID-19 may be kept under deeper sedation until adequate oxygenation levels are achieved to reduce the risk of ventilator dyssynchrony and control respiratory drive (which is important to achieve adequate target tidal volumes). Use of neuromuscular blockade agents are not generally recommended, unless the patient has significant worsening hypoxia or hypercapnia and in situations where the patient's respiratory drive cannot be managed with sedation alone resulting in ventilator dyssynchrony and lung decruitment. [2][11][12]

Use of recruitment measures are not recommended in severe ARDS but may be considered during the weaning phase but in the case of COVID-19 patients, manual recruitment methods such as manual hyperinflation which involve a break in the circuit are not recommended due to increased risk of droplet spread.

In the majority of patients with COVID-19, endotrachael tubes are used, with very few requiring tracheostomy. It is vital that cuffs are inflated at all times and never deflated during any treatments. If tracheostomy is indicated subglotic tracheotomy should be utilised so above cuff vocalisation can be achieved without needing to deflate the cuff to improve communication and swallow.

Guideline Recommendation: Patients with worsening hypoxia, hypercapnia, acidaemia, respiratory fatigue, haemodynamic instability or those with altered mental status should be considered for early invasive mechanical ventilation if appropriate. The risk of aerosol transmission is reduced once a patient is intubated with a closed ventilator circuit. [5]

Positioning

Positioning is a vital component of management for the mechanically ventilated COVID-19 patient, with regular turning recommended to prevent atelectasis, optimise ventilation and prevent pressure sores. Positioning can include lateral (side lying) positioning but may also include prone positioning, which is well recognised to treat hypoxemic respiratory failure. Prone ventilation is ventilation that is delivered with the patient lying in the prone position. Prone ventilation may improve lung mechanics and gas exchange, thus improving oxygenation in the majority of patients with ARDS, and could improve outcomes. Current reports suggest prone ventilation is effective in improving hypoxia associated with COVID-19 and should be completed in the

context of a hospital guideline that includes appropriate PPE for staff and that minimise the risk of any adverse events, e.g. accidental extubation and breaking of the circuit. [2][11] With adult patients, prone positioning is recommended for at least 16 hours per day[6].

View a set of pragmatic proning guidelines, from the American Journal of Respiratory and Critical Care Medicine[15].

Suctioning

Closed inline suction catheters are **recommended and imperative**. Any disconnection of the patient from the ventilator should be avoided to prevent lung decruitment and aerosolisation. If necessary, the endotracheal tube should be **clamped and the ventilator disabled** (to prevent aerosolisation). [11] Suctioning is not required routinely but should be used as required.

Nebulisation

The use of nebulised agents (e.g. salbutamol, saline) for the treatment of non-intubated patients with COVID-19 is **not recommended** as it increases the risk of aerosolization and transmission of infection to health care workers in the immediate vicinity. The use of metered-dose inhalers are preferred where possible. [5][11]

If a nebulizer is required and deemed essential, liaise with local guidelines for directions to minimise aerosolization e.g. use of a Pari sprint with inline viral filter with use of adequate airborne precautions and PPE. [5]

Humidification

Use of humidification, both cold and warm water, is not recommended and HME Filters should be used. [1][10]

Weaning and Liberation from Mechanical Ventilation

Standard weaning protocols should be followed. HFNO and/or NIV with well-fitted facemask with separate inspiratory and expiratory can be considered as bridging therapy post-extubation but must be provided with strict use of staff PPE. [11]

Specific Physiotherapy Techniques[18]

Physiotherapy is an important intervention that prevents and mitigates the adverse effects of prolonged bed rest and mechanical ventilation during critical illness. Rehabilitation delivered by the physiotherapist is tailored to patient needs and depends on the conscious state, psychological status and physical strength of the patient. It incorporates any active and passive therapy that promotes movement and includes mobilisation. Much of the role of the ICU physiotherapist will continue during the COVID-19 pandemic, with the main change in practice being the routine use of full PPE while working within the ICU environment.

Acute Phase

In the early stages of Covid 19 and respiratory distress, care is advised when planning a treatment programme. Common modalities often used by respiratory physiotherapists may be contraindicated in the acute phase as they may further compromise the increased work of breathing. These include interventions such as:[19]

- Diaphragmatic breathing
- Pursed lips breathing
- Bronchial hygiene/lung re-expansion techniques (PEP Bottle, EzPAP®, cough machines, etc.)
- Incentive spirometry
- Manual mobilisation techniques or stretching of the rib cage
- Nasal washings
- Respiratory muscle training
- Exercise training
- Patient mobilisation during clinical instability

Physiotherapists should continue to actively screen and/or accept referrals for mobilisation, exercise and rehabilitation. When screening, discussion with nursing staff, the patient (e.g. via phone) or family is recommended before deciding to enter the patient's isolation room. For example,to try to minimise staff who come in to contact with patients with COVID-19, physiotherapists may screen to determine an appropriate aid to trial. A trial of the aid may then be performed by the nursing staff already in an isolation room, with guidance provided if needed by the physiotherapist who is outside the room.[5]

Weaning Phase

Where the patient is awake, cooperative and in the weaning stage, consider the use of the active cycle of breathing technique as well as lung volume

recruitment procedures (e.g. breath stacking) combined with positioning to ensure the patient is involved in his/her treatment.

Ventilator Disconnection

Anything in relation to ventilator disconnection should not be utilised e.g. manual hyper inflation / bagging.

Mechanical Insufflation-Exsufflation (Cough Assist) Devices

Generally, cough assist devices are not indicated or required in viral pneumonia, as they do not tend to have productive chests, retained secretions or problems with secretion retention or mucus plugging. If it was felt that such a device was indicated, the issue must be discussed with the medical team considering the physiological impact of Insufflation-Exsufflation in someone who may already have an acute lung injury, which may be counterproductive to the lung protection strategy utilised. The use of this type of device may be considered in patients with co-morbid conditions where these techniques were part of their normal airway clearance strategies, but benefit versus risk would need to be discussed with the team. This is not recommended and would not be considered first line intervention. Because it is an AGP, full PPE would be required and in order to protect the machine and the patient, a double viral filter system should be in place at the mask and device expiratory port.

Lung Ultrasound

Diagnostic lung ultrasound has been identified as a potential diagnostic tool in the assessment and management of COVID-19. It shows similar findings to radiological cases and has a higher degree of accuracy than the bedside chest radiograp, with findings of multi-lobar distribution of B-lines and diffuse lung consolidation.[20][21][5][5] It approaches the level of accuracy seen with computed tomography (CT) for many pathologies that reach the pleura.[20] Lung ultrasound can be used throughout the course of the treatment process to track the evolution of the disease, to monitor lung recruitment manoeuvres, to provide feedback in relation to the success of interventions and to assist decision-making in relation to weaning and liberation from mechanical ventilation.[20] The following provides a practical guideline for the use of lung ultrasound during the COVID-19 Pandemic within an acute hospital setting:

- Physiotherapists use of Lung Ultrasound during the COVID-19 Pandemic - A Practical Guideline on Supporting Acute Hospital Colleagues.

Manual Techniques

There is controversy about the effectiveness of manual techniques in general. There is minimal evidence for percussion. There is some evidence for expiratory vibrations to mobilise secretions and manual assisted cough to improve cough effectiveness and aid mucocillary clearance if required. This could be an adjunct and safe to use with patients who are both mechanically ventilated and extubated provided adequate PPE is used.

Rehabilitation Phase

This is where we will see the main role of the physiotherapist in the management of the patient with COVID-19. There is strong evidence to suggest that early mobilisation with a focus on returning to functional activities helps in reducing the length of hospital stay and minimising functional decline, thus the sooner patients start mobilising, the sooner they can leave the ICU, and potentially have better long-term outcomes. This phase of management should incorporate a multi-disciplinary approach including measures to prevent avoidable physical and non-physical morbidity, support adequate nutrition (particularly following the effects of prone ventilation) and an individualised, structured rehabilitation programme. This phase should follow the typical approach for rehabilitation and exercise within the Intensive Care Unit, followed by transfer to ward-based rehabilitation.

- Passive, Active Assisted, Active, or Resisted Joint Range of Motion Exercises to maintain or improve joint integrity and range of motion and muscle strength; [5]
- Mobilisation and Rehabilitation (e.g. bed mobility, sitting out of bed, sitting balance, sit to stand, walking, tilt table, standing hoists, upper limb or lower limb ergometry, exercise programs). [5]

Prevention of Complications

Physiotherapists can play a key role in the prevention of a range of complications including ventilator-associated pneumonias, secondary infections, contractures or pressure areas/sores.

Reduced Days of Mechanical Ventilation

- Use weaning protocols or development of individual weaning plans
- Assessment of spontaneous breathing capacity and readiness for extubation, including involvement in daily sedation holds and spontaneous breathing trials[2].

Reduce the Incidence of Ventilator-Associated Pneumonia

It is really important to reduce this risk because any secondary infection will increase the number of days the patient is intubated and ventilated and thus their overall time in the ICU, taking up bed space for longer than should be required and reduce flow through the hospital.

- Keep the patient in a semi-sitting position (30 - 45 Degrees)
- Regular 2 hourly turning to minimise the risk of atelectasis and consolidation
- Prone ventilation where indicated and appropriate. In China & Italy they often had multiple patients proned within the ICU
- Use a closed suction system; periodically drain and discard condensate intubing
- Use a new ventilation circuit for each patient, once the patient is ventilated change the circuit only if it is damaged or soiled, not routinely
- Change heat moisture exchanger when it malfunctions, when soiled, or every 5-7 days[2]
- Assist in the extubation phase, and weaning potential from invasive ventilation.

Reduce the Incidence of Pressure Ulcers

- Turn the patient every 2 hours [2]

Reduce the Incidence of Intensive Care-Related Myopathy

- Early mobilisation is encouraged. Actively mobilise the patient as soon as their condition allows and when safe to do so. [2]

Indications for Physiotherapy Referral

The following guidelines outline the relevant indications for physiotherapy in the presence of a suspected or confirmed case of COVID-19. [5]

Airway Clearance

COVID-19 Patient Presentation (Confirmed or Suspected)	**Physiotherapy Referral ?**
Mild symptoms without significant respiratory compromise e.g. fevers, dry cough, no	Physiotherapy interventions are not indicated for airway clearance or sputum samples No physiotherapy contact with patient.

chest x-ray changes.	
Pneumonia presenting with features: Low-level oxygen requirement (e.g. oxygen flow ≤5L/min for SpO2 ≥ 90%). Non-productive cough; Patient coughing and able to clear secretions independently.	Physiotherapy interventions are not indicated for airway clearance or sputum samples. No physiotherapy contact with patient.
Mild symptoms and/or pneumonia AND co-existing Respiratory or Neuromuscular Comorbidity e.g. Cystic Fibrosis, neuromuscular disease, spinal cord injury, bronchiectasis, COPD, AND current or anticipated difficulties with secretion clearance	Physiotherapy referral for airway clearance. Staff use airborne precautions. Where possible, patients should wear a surgical mask during any physiotherapy.
Mild symptoms and/or pneumonia AND evidence of exudative consolidation with difficulty clearing or inability to clear secretions independently e.g. weak, ineffective and moist sounding cough, tactile fremitus on chest wall, moist/wet sounding voice, audible transmitted sounds.	Physiotherapy referral for airway clearance. Staff use airborne precautions. Where possible, patients should wear a surgical mask during any physiotherapy.
Severe symptoms suggestive of pneumonia / lower respiratory tract infection e.g. increasing oxygen requirements, fever, difficulty breathing, frequent, severe or productive coughing episodes, Chest X-ray / CT / Lung Ultrasound changes consistent with Consolidation.	Consider physiotherapy referral for airway clearance. Physiotherapy may be indicated, particularly if weak cough, productive and/or evidence of pneumonia on imaging and/or secretion retention. Staff use airborne precautions. Where possible, patients should wear a surgical mask during any physiotherapy. Early optimisation of care and involvement of ICU is recommended.

Mobilisation, Exercise & Rehabilitation

COVID-19 Patient Presentation (Confirmed or Suspected)	**Physiotherapy Referral ?**
Any patient at significant risk of developing or with evidence of significant functional limitations e.g. patients who are frail or have multiple comorbidities impacting on their independence e.g. mobilisation, exercise and rehabilitation in ICU patients with	Physiotherapy referral. Use droplet precautions. Use airborne precautions if close contact required or possible AGPs. If not ventilated, patients should wear a surgical mask during any physiotherapy whenever possible.

significant functional decline and/or (at risk for) ICU-acquired weakness	

On Call Physiotherapy Considerations

Acutely unwell confirmed or suspected COVID-19 patients should NOT be routinely referred to physiotherapy. There are currently no reports that suggest COVID-19 patients have high secretion loads requiring intensive respiratory physiotherapy/airway clearance. Physiotherapy intervention is likely to be of limited benefit in the acute stages and most beneficial use of physiotherapy resources will be to facilitate the treatment and discharge of non-infected patients as well as training and supporting our colleagues in managing the acutely unwell. Physiotherapists will have a role in the rehabilitation of COVID-19 patients who have not returned to their functional baseline once they are no longer acutely unwell. [4]

The WHO recommends limiting the number of Health Care Workers who are in contact with a suspected and confirmed COVID-19 patients and to limit the number of persons present in the room to the absolute minimum required for the patient's care and support. [2]

Physiotherapy referrals should only be made for patients that meet the **On-Call Physiotherapy** Criteria, which normally would include; [4]

Inclusion Criteria: Patients likely to benefit from on-call physiotherapy:

- An increase in oxygen therapy to FiO2 >60%
- Evidence of retained pulmonary secretions with difficulty expectorating
- Ineffective cough/airway clearance

Exclusion Criteria: Patient unlikely to benefit from on-call physiotherapy:

- Viral Pneumonia
- ARDS
- Cardiovascular Instability
- Uncooperative Patient
- Unstable Intracranial Pressure
- Uncontrolled Bronchospasm
- Pulmonary Embolism
- Non-acute COPD

Criteria not appropriate for emergency call-out:

- Patients with a diagnosis of COVID 19 with a dry unproductive cough

- Patients with a diagnosis of COVID 19 with severe hypoxaemia requiring intubation
- Routine respiratory patients e.g. post-operatively, unless the criteria above are met.
- Patients who are requiring suction only - If the patient requires suction ONLY, consider as a nursing technique. Mobilise any patient who is well enough as this is the most natural way of encouraging optimal pulmonary function. Such a patient is unlikely to require emergency physiotherapy.

Resources

Physiotherapy Specific

1. **Physiotherapy Specific Guidelines for the Acute Hospital Setting**
- Physiotherapy Management for COVID-19 in the Acute Hospital Setting: Recommendations to Guide Clinical Practice. Version 1 23 March 2020
2. **Rachael Moses, Consultant Respiratory Physiotherapist at Lancashire Teaching Hospitals.**
- COVID 19: Respiratory Physiotherapy Management Information and Guidance. Version 1 Dated 15th March 2020
- COVID-19 Respiratory Physiotherapy On Call Information and Guidance. Version 2 Dated 14th March 2020
- COVID 19 and Respiratory Physiotherapy Referral Guideline. Version 1 Dated 18th March 2020
3. **Adam Rochester, NIV Lead for Respiratory Support Services. Royal Brompton and Harefield NHS Trust.**
- Standard Operating Protocol for the Setup and Use of Non-Invasive Ventilation or HiFlow Oxygen (AirVo) for Patients with Suspected or Confirmed Coronavirus. Version 1.7 Dated March 17th, 2020
4. **Italian Association of Respiratory Physiotherapists (ARIR)**
- Respiratory Physiotherapy in patients with COVID-19 Infection in Acute Setting
5. **David McWilliams, Consultant Physiotherapist, University Hospitals Birmingham NHS Foundation Trust**
- COVID-19 Early Experiences from a Physiotherapy Perspective
6. **Kelly Morris, Isobel Hinton, Laura Mylott, Rachel Farley, Hannah Mitchell & Hannah Cumming, Physiotherapy Team, Guy's and St.Thomas' NHS Foundation Trust**
- COVID-19 Physiotherapy Experience at Guy's and St.Thomas' Hospital
7. **British Thoracic Society**
- BTS Advice for Community Respiratory Services in Relation to COVID19 Version 1 Dated 16th March 2020

Airway Management Guideline

1. **World Health Organisation**
- Clinical Management of Severe Acute Respiratory Infection when Novel Coronavirus (nCoV) Infection is Suspected Interim Guidance Dated 28th January 2020
2. **Australian and New Zealand Intensive Care Society**
- The Australian and New Zealand Intensive Care Society (ANZICS) COVID-19 Guidelines Version 1 Dated 16th March 2020
3. **Italian Thoracic Society (AIPO - ITS) and Italian Respiratory Society (SIP/IRS)**
- Managing the Respiratory Care of patients with COVID-19 Version 1 Dated 8th March 2020
4. **British Thoracic Society**
- Use of Acute NIV in Patients Hospitalised with Suspected or Confirmed COVID-19 Infection Version 1 Dated 16th March 2020

Proning Guidelines

1. **The Faculty of Intensive Care Medicine**
- Guidance For: Prone Positioning in Adult Critical Care

Evidence Based Resources

1. **The First A﷽liated Hospital, Zhejiang University School of Medicine**
- Handbook of COVID-19 Preventionand Treatment
2. **Cochrane Special Collections**
- Coronavirus (COVID-19): Evidence Relevant to Critical Care
3. **British Medical Journal**
- Coronavirus (COVID-19): Latest News and Resources

Related articles

Respiratory Management of People with COVID-19 – PhysioplusRespiratory Management of People with COVID-19 Learn about physiotherapy management of patients with moderate to severe symptoms of COVID-19 in an Acute Hospital Setting Sign Up This is a valuable course for any professional! See more testimonials Introduction Approximately 15% of individuals with COVID-19 develop moderate to severe disease and require hospitalisation and oxygen support, with a further 5% who require admission to an Intensive Care Unit and supportive therapies including intubation and ventilation. The most common complication in severe COVID-19 patients is severe pneumonia, but other complications may include Acute Respiratory Distress Syndrome (ARDS), Sepsis and Septic Shock, Multiple Organ Failure, including Acute Kidney Injury and Cardiac Injury. Physiotherapists need to understand their role in the management of patients with COVID-19 in the acute hospital setting and also in the rehabilitation following recovery from the disease. Aims This course aims to provide you with an understanding of respiratory management of patients with COVID-19 and the role physiotherapists can play in managing issues related to treating patients with

moderate to severe symptoms in an acute hospital setting. Outline This course is made up of videos, reading, forum posts and a final quiz. The course content is split into the following sections: Videos Reading activity Quiz Target audience This course is aimed at Physiotherapy and Physical Therapy clinicians, students and assistants. Other interested professionals such as athletic trainers, occupational therapists, nurses or medical doctors interested in this subject are also invited to participate. More details Practicalities Hours of Learning - No deadlines are applied to this course and it can be started and completed in your own time according to your personal schedule. We expect the required elements to take around 1.5 hours depending on your schedule and learning style. Additionally there are many optional resources provided and if you choose to review these the course could take longer to complete. Types of Activities - Reading Physiopedia pages, journal articles, book chapters. Watching videos. Attempting quizzes. Participating in an international discussion forum. Certificates - At the end of the course, when you have completed all of the required elements, you will be able to download a certificate of completion and 1.5 Physioplus points will be added to your personalised learning dashboard. Requirements to complete this course In order to complete this course and receive a course completion certificate plus CEUs/CCUs/CPD points you will need to: Respect the Physioplus Community Culture. Log all the required learning activities as complete (represented by the orange icons!). Actively and appropriately participate in the course discussions. Pass a final quiz with a score of 80% or more. Complete a course evaluation form. Learning outcomes At the end of this course you will be able to: List the most common complication seen in hospitalised patients with COVID-19 Select the radiological presentation for Acute Respiratory Distress Syndrome Correctly identify the type of cough and sputum load in patients with COVID-19 Discuss which procedures are aerosol generating and which precautions to take Describe non-invasive and invasive mechanical ventilation in terms of uses, settings, precautions, and preventing complications Identify when a patient with COVID-19 is appropriate for respiratory physiotherapy referral Select appropriate physiotherapy interventions for patients with COVID-19 who have respiratory symptoms Presented by: Physioplus Team A team of committed individuals with a very wide variety of clinical and educational experience. View all courses by Physioplus Team Certificate of completion 1.5 Physioplus points Accredited by 1 organisation Keywords: ARDS, coronavirus, COVID-19, ICU, Intensive care unit, intubation, pneumonia, respiratory, ventilator, virus This course can be accessed with a FREE trial account Sign up Related courses

Coronavirus Disease (COVID-19) - Physiopedia

Introduction to COVID-19 The World Health Organisation (WHO) has declared the coronavirus disease 2019 (COVID-19) a pandemic[1]. A global coordinated effort is needed to stop the further spread of the virus. A pandemic is defined as “occurring over a wide geographic area and affecting an exceptionally high proportion of the population.”[2] The last pandemic reported in the world was the H1N1 flu pandemic in 2009. On 31 December 2019, a cluster of cases of pneumonia of unknown cause, in the city of Wuhan, Hubei province in China, was reported to the World Health Organisation. In January 2020, a previously unknown new virus was identified[3][4], subsequently named the 2019 novel coronavirus, and samples obtained from cases and analysis of the virus’ genetics indicated that this was the cause of the outbreak. This novel coronavirus was named Coronavirus Disease 2019 (COVID-19) by WHO in February 2020.[5] The virus is referred to as SARS-CoV-2 and the associated disease is COVID-19[6]. As of 30 March 2020, over 740,147 cases have been identified globally in 177 countries with a total of over 35,097 fatalities. Live data can be accessed here. [7] [8] [9] What is Coronavirus? Coronaviruses are a family of viruses that cause illness such as respiratory diseases or gastrointestinal diseases. Respiratory diseases can range from the common cold to more severe diseases, such as Middle East Respiratory Syndrome (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS-CoV)[10]. A novel coronavirus (nCoV) is a new strain that has not been identified in humans previously. Once scientists determine exactly what coronavirus it is, they give it a name

(as in the case of COVID-19, the virus causing it is SARS-CoV-2). Coronaviruses got their name from the way that they look under a microscope. The virus consists of a core of genetic material surrounded by an envelope with protein spikes. This gives it the appearance of a crown. The word Corona means “crown” in Latin. Coronaviruses are zoonotic[11], meaning that the viruses are transmitted between animals and humans. It has been determined that MERS-CoV was transmitted from dromedary camels to humans and SARS-CoV from civet cats to humans[10]. The source of the SARS-CoV-2 (COVID-19) is yet to be determined, but investigations are ongoing to identify the zoonotic source to the outbreak[12]. Clinical Presentation Typically Coronaviruses present with respiratory symptoms. Among those who will become infected, some will show no symptoms. Those who do develop symptoms may have a mild to moderate, but self-limiting disease with symptoms similar to the seasonal flu[13]. Symptoms may include: Respiratory symptoms Fever Cough Shortness of breath Breathing difficulties Fatigue Sore throat A minority group of people will present with more severe symptoms and will need to be hospitalised, most often with pneumonia, and in some instances, the illness can include ARDS, sepsis and septic shock[13][14]. Emergency warning signs where immediate medical attention should be sought[15] include: Difficulty breathing or shortness of breath Persistent pain or pressure in the chest New confusion or inability to arouse Bluish lips or face High-Risk Populations The virus that causes COVID-19 infects people of all ages. However, evidence to date suggests that two groups of people are at a higher risk of getting severe COVID-19 disease[16]: Older people (people over 70 years of age) People with serious chronic illnesses such as: Diabetes Cardiovascular disease Chronic respiratory disease Cancer Hypertension Chronic liver disease The WHO has issued and published advice for these high-risk groups and community support. This is to ensure that these high-risk populations are protected from COVID-19 without being isolated, stigmatised, left in positions of increased vulnerability or unable to have access to basic provisions and social care. WHO advice for high-risk populations[16]: When having visitors at your home, extend “1-meter greetings”, like a wave, nod or bow. Request that visitors and those who live with you, wash their hands. Clean and disinfect surfaces in your home (especially those that people touch a lot) on a regular basis. Limit shared spaces if someone you live with is not feeling well (especially with possible COVID-19 symptoms). If you show signs and symptoms of COVID-19 illness, contact your healthcare provider by telephone, before visiting your healthcare facility. Have an action plan in preparation for an outbreak of COVID-19 in your community. When you are in public, practice the same preventative guidelines as you would at home. Keep updated on COVID-19 through obtaining information from reliable sources. Transmission of COVID-19 Evidence is still emerging, but current information is indicating that human-to-human transmission is occurring. The routes of transmission of COVID-19 remains unclear at present, but evidence from other coronaviruses and respiratory diseases indicates that the disease may spread through large respiratory droplets and direct or indirect contact with infected secretions[17]. The incubation period of COVID-19 is currently understood to be between 2 to 14 days[15]. This means that if a person remains well after 14 days after being in contact with a person with confirmed COVID-19, they are not infected. [18] Preventing Transmission The WHO suggests the following basic preventative measures to protect against the new coronavirus[19][20]: Stay up to date with the latest information on the COVID-19 outbreak through WHO updates or your local and national public health authority. Perform hand hygiene frequently with an alcohol-based hand rub if your hands are not visibly dirty or with soap and water if hands are dirty. Avoid touching your eyes, nose and mouth. Practice respiratory hygiene by coughing or sneezing into a bent elbow or tissue and then immediately disposing of the tissue. Wear a medical mask if you have respiratory symptoms and performing hand hygiene after disposing of the mask. Maintain social distancing (approximately 2 meters) from individuals with respiratory symptoms. If you have a fever, cough and difficulty breathing seek medical care. [21] Diagnostic Procedures A COVID-19

diagnostic testing kit has been developed and is available in clinical testing labs[22]. The gold standard for testing for COVID-19 is Reverse Transcription Polymerase Chain Reaction (RT-PCR). However, current data suggest that RT-PCR is only 30-70% effective for acute infection, this may be due to incorrect use of lab kits or not enough virus in the blood at the early stages of testing. Plus, the availability of testing will vary from country to country. The CDC recommends that any person who may have had contact with a person who is suspected of having COVID-19 and develops a fever and respiratory symptoms listed above are advised to call their healthcare practitioner to determine the best of course of action[23]. The main criteria for testing are:[24] Location Age Medical history and risk factors Exposure to the virus and contact history Duration of symptoms If the above criteria are met it is advised that the following testing procedure is followed:[22] Collect and test upper respiratory tract specimens, using a nasopharyngeal swab If available testing of lower respiratory tract specimens If a productive cough is evident then a sputum specimen should be collected For patients who are receiving invasive mechanical ventilation, a lower respiratory tract aspirate or broncho-alveolar lavage sample should be collected Imaging may be useful in identifying patients with COVID-19 which is especially relevant in places with good access to imaging technology but poor access to reliable and quick laboratory testing[25]. Chest X-rays are not especially sensitive for COVID-19, but chest CT gives a much more detailed view appears to have good sensitivity in initial stages of the disease[26]. However chest CT or X-ray is not currently recommend as a diagnostic method as they can easily be confused with other infections such as H1N1, SARS, MERS and seasonal flu. Lung ultrasound is also emerging as a valuable diagnostic testing procedure. According to the CDC, even if a chest CT or X-ray suggests COVID-19, viral testing is the only specific method for diagnosis[27]. Case Definitions The definitions used by the WHO in COVID-19:[28] Suspect case: Patient with acute respiratory illness (fever and at least one other symptom such as cough or difficulty breathing (shortness of breath)) AND with no other aetiology that explains symptoms AND a history of travel to a country/area that reported transmission of SARS-CoV-2 virus OR Patient with acute respiratory illness AND who have been in contact with a confirmed or probable COVID-19 case in the last 14 days prior to the onset of signs and symptoms OR Patient with severe respiratory illness (fever and at least one other symptom such as cough or difficulty breathing (shortness of breath)) AND that requires hospitalisation AND with no other aetiology that explains clinical picture/presentation of the patient Probable case: A probable case is a suspected case for whom the report from laboratory testing for the COVID-19 virus is inconclusive. Confirmed case: A confirmed case is a person with laboratory confirmation of infection with the COVID-19 virus, irrespective of clinical signs and symptoms. Differential Diagnosis Differential diagnosis should include the possibility of a wide range of common respiratory disorders such as: Other Coronaviruses (SARS, MERS) Adenovirus Influenza Human metapneumovirus (HmPV) Parainfluenza Respiratory syncytial virus (RSV) Rhinovirus (common cold) Bacterial pneumonia, mycoplasma pneumonia (MPP) and chlamydia pneumonia[29]. Differentiation should also be made from lung disease caused by other diseases[30]. A CT scan has great value in early screening and differential diagnosis for COVID-19 [31]. Management / Interventions In the case of mild to moderate symptoms the following considerations should be taken into account: Early identification - Clinicians, especially physiotherapists, are most often in direct contact with their patients, which can make them infected or infected by others. It is therefore very important for physiotherapists and other health professionals to be familiar with the condition of COVID-19, how to identify it and how to prevent it. Strategies for infection prevention and control (IPC) - Suspect, probable and confirmed cases should be educated on IPC strategies to prevent transmission of the disease and health management strategies for quarantine. Find out more about the role of the physiotherapist in COVID-19 here. For hospitalised patients the WHO highlights several considerations[14]: Recognising and sorting patients with severe acute respiratory disease - Early recognition of suspected patients allows for

timely initiation of IPC. Early identification of those with severe manifestations allows for immediate, optimised supportive care treatments and safe, rapid admission (or referral) to the intensive care unit according to institutional or national protocols. For those with mild illness, hospitalisation may not be required unless there is a concern for rapid deterioration. All patients discharged home should be instructed to return to the hospital if they develop any worsening of illness. Strategies for infection prevention and control (IPC) - IPC is a critical and integral part of the clinical management of patients and should be initiated at the point of entry of the patient to the hospital. Standard precautions should always be routinely applied in all areas of health care facilities. Standard precautions include hand hygiene; use of PPE to avoid direct contact with patients' blood, body fluids, secretions (including respiratory secretions) and non-intact skin. Standard precautions also include prevention of needle-stick or sharps injury; safe waste management; cleaning and disinfection of equipment; and cleaning of the environment. Early supportive therapy and monitoring - Give supplemental oxygen therapy immediately to patients with severe acute respiratory illness (SARI) and respiratory distress, hypoxaemia, or shock. Use conservative fluid management in patients with SARI when there is no evidence of shock. Closely monitor patients with SARI for signs of clinical deterioration, such as rapidly progressive respiratory failure and sepsis, and apply supportive care interventions immediately. Understand the patient's co-morbid condition(s) to tailor the management of critical illness and appreciate the prognosis. Communicate early with the patient and family. Collection of specimens for laboratory diagnosis - Collect blood cultures for bacteria that cause pneumonia and sepsis, ideally before antimicrobial therapy. Collect specimens from both the upper respiratory tract (nasopharyngeal and oropharyngeal) and lower respiratory tract. Management of respiratory failure and ARDS - Recognise severe hypoxaemic respiratory failure when a patient with respiratory distress is failing standard oxygen therapy. In the case of respiratory failure, intubation and protective mechanical ventilation may be necessary[32]. Non-invasive techniques can be used in non-severe forms, however, if the scenario does not improve or even worsen within a short period of time (1–2 hours) then mechanical ventilation must be preferred[32]. Management of septic shock - Haemodynamic support is essential for managing septic shock[32]. Prevention of complications - Implement the following interventions to prevent complications associated with a critical illness such as: reduce days of invasive mechanical intervention reduce the risk of ventilator-associated pneumonia reduce the risk of venous thromboembolism reduce the risk of pressure ulcers reduce the incidence of ICU related weakness Treatment interventions - There is no current evidence from RCTs to recommend any specific anti-nCoV treatment for patients with suspected or confirmed COVID-2019 infection. For more details on the management of hospitalised patients see this WHO document. Find out more about the physiotherapy management of people with COVID-19 here: Role of the physiotherapist in COVID-19 Respiratory management of COVID-19 Use of Personal Protective Equipment The type of personal protective equipment (PPE) used when caring for COVID-19 patients will vary according to the setting and type of personnel and activity. Healthcare workers involved in the direct care of patients should use the following PPE: gowns, gloves, medical mask and eye protection (goggles or face shield). Specifically, for aerosol-generating procedures (e.g., tracheal intubation, non-invasive ventilation, tracheostomy, cardiopulmonary resuscitation, manual ventilation before intubation, bronchoscopy) healthcare workers should use respirators, eye protection, gloves and gowns; aprons should also be used if gowns are not fluid resistant[33]. Among the general public, persons with respiratory symptoms or those caring for COVID-19 patients at home should receive medical masks. For asymptomatic individuals, wearing a mask of any type is not recommended. Wearing medical masks when they are not indicated may cause unnecessary cost and a procurement burden and create a false sense of security that can lead to the neglect of other essential preventive measures[34]. WHO has provided a document that specifically outlines the recommended type of

personal protective equipment (PPE) to be used in the context of COVID-19 disease, according to the setting, personnel and type of activity, you can see it here. In the case of a pandemic, supplies of PPE may become limited. Strategies to optimise the availability of personal protective equipment (PPE) include[20]: Minimise the need for PPE by considering telemedicine (providing health care remotely), using physical barriers such as glass or plastic windows e.g. in receptions, restricting healthcare workers not involved in care from being in close proximity with COVID-19 patients. Ensure PPE use is rationalised and appropriate by assessing the risk of exposure and transmission. Coordinate PPE supply chain mechanisms. Special Population Considerations Older People Although the virus can infect people of all ages, evidence suggests that older people (those of 60 years old) have an increased risk of developing a severe form of the disease.[16] This may be due to: Ageing is associated with a decline in immune function Higher risk of co-morbidities (Diabetes, Heart Disease, Lung Conditions, Cancer) Residence/Location - Many older people live in care homes or nursing facilities, where the disease can spread more rapidly To read more about Infection Control in Older Adults see here Disabled People with disability may be at greater risk of contracting COVID-19 because of[35]: Barriers to implementing hand hygiene. Difficulty in enacting social distancing. The need to touch things to obtain information from the environment or for physical support. Barriers to accessing public health information. Barriers to accessing healthcare. This WHO document, Disability considerations during the COVID-19 outbreak, outlines actions for authorities, healthcare workers, disability service providers, the community, people with disability and their household. Pregnant Women and Newborns The risk for adverse maternal and neonatal outcomes associated with COVID-19 is largely unknown, but medical experts suspect symptoms of COVID-19 may be more severe in pregnant woman compared to non-pregnant women[36]. This may be due to changes in their bodies and immune systems pregnant women can be badly affected by some respiratory infections[37]. Women with COVID-19 can breastfeed and have close contact with their newborn, but they should diligently perform respiratory and hand hygiene[37]. Low and Middle-Income Countries (LMICs) The link between mortality and health care resources in the COVID-19 pandemic may cause concerns for LMICs because[38]: Inability to afford large-scale diagnostics. ICU beds and personnel trained in critical care may be limited. Inability to fund the additional cost of critical care units from limited health budgets. Disruption of supply chains and depletion of stock, such as medical supplies, equipment and PPE. High numbers of internally displaced people and displace refugees who often have co-morbidities and reside in large-scale camps[39]. Resources Physiotherapy Member Organisation by Country: Best Practices for Coronavirus https://www.wcpt.org/news/Novel-Coronavirus-2019-nCoV - WCPT list of links to various global organisations and resources Governmental Information for Health Professionals https://www.gov.uk/government/collections/wuhan-novel-coronavirus - UK https://www.health.qld.gov.au/news-events/news/novel-coronavirus-covid-19-sars-queensland-australia-how-to-understand-protect-prevent-spread-symptoms-treatment - Australia https://www.cdc.gov/coronavirus/2019-nCoV/hcp/index.html - CDC (US) https://www.who.int/emergencies/diseases/novel-coronavirus-2019 - WHO https://openwho.org/ - Free Online Coursework via WHO https://www.un.org/coronavirus - United Nations https://www.ecdc.europa.eu/sites/default/files/documents/COVID-19-infection-prevention-and-control-healthcare-settings-march-2020.pdf - European Centre for Disease Prevention and Control Overview Resources and Factsheets https://www.cdc.gov/coronavirus/2019-ncov/communication/factsheets.html https://www.cochrane.org/news/special-collection-coronavirus-covid-19-evidence-relevant-critical-care - Evidence Relevant to Critical Care (Cochrane) https://www.cdc.gov/flu/professionals/infectioncontrol/resphygiene.htm - Infection Control Respiratory Hygiene https://www.thelancet.com/coronavirus?dgcid=etoc-edschoice_email_tlcoronavirus20 - The Lancet COVID-19 Resource Center

https://www.coursera.org/learn/covid-19?#syllabus - This is a current online course offered through Imperial College London https://coronavirus.jhu.edu - the Johns Hopkins University & Medicine Coronavirus Resource Center JAMA network Coronavirus Disease 2019 (COVID-19) - research articles related to the pandemic Respiratory physiotherapy in patients with COVID-19 infection in acute setting: a Position Paper of the Italian Association of Respiratory Physiotherapists (ARIR) Link to a real-time map of global cases by Johns Hopkins University This article explains it further https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(20)30120-1/fulltextVentilation and Weaning - PhysiopediaIntroduction Ventilation can be defined as the process of exchange of air between the lungs and the ambient air[1]. In the clinical setting, a machine known as a mechanical ventilator is used to perform this function on patients faced with serious respiratory illness. Once a patient is stable and in a position to move towards spontaneous breathing it is important that that steps are taken to wean the patient of the dependency of supported breathing. Weaning is the gradual withdrawal of a patient from assisted breathing on a life-support system or other form of therapy[1]. Weaning a patient from a ventilator occurs when the condition of the patient improves and a decision is made to remove them from the ventilator through a trial of spontaneous breathing through the endotracheal tube and eventually extubation (removal of the tube). Goals of Mechanical Ventilation The goals of mechanical ventilation are to[2]: Provide adequate (not perfect) oxygenation and ventilation Reduce our patient's work of breathing Minimise the damage to the lung caused by the ventilator known as ventilator induced lung injury (VILI). Improve cardiac function Decreases preload Decreases afterload Decreases metabolic demand Mechanical Ventilation Mechanical ventilation can be[2]: Non - invasive (if patient can protect airway and is hemodynamically stable) Mask: usually orofacial to start Invasive Endotracheal tube (ETT) Tracheostomy – if upper airway is obstructed Indications for Mechanical Ventilation[1][3] Cardiac or respiratory arrest Tachypnea or bradypnea with respiratory fatigue or impending arrest Acute respiratory acidosis Refractory hypoxemia Refractory hypoxemia (when the P a O 2 could not be maintained above 60 mm Hg with inspired O 2 fraction (F I O 2)>1.0) Inability to protect the airway associated with depressed levels of consciousness Shock associated with excessive respiratory work Inability to clear secretions with impaired gas exchange or excessive respiratory work Newly diagnosed neuromuscular disease with a vital capacity <10 capacity <10 - 15 mL/kg Short term adjunct in management of acutely increased intracranial pressure (ICP) Basic settings on a mechanical ventilator include: Mode Tidal Volume Respiratory rate (RR) Inspired oxygen concentration (Fio2) Positive end expiratory pressure (PEEP) Mechanical ventilator breaths[2] Breaths can be either controlled, assisted or supported by the ventilator. Controlled Breaths: These breaths are completely "controlled" by the ventilator. A ventilator is purposely never set up in a mode with controlled breaths only. However, controlled breaths are delivered for safety at a set time interval if your patient is paralyzed or doesn't have a respiratory drive (sedation, comatose, ect). Assisted Breaths: Unlike the controlled breaths, which come at a set time interval, assist breaths will be delivered to your patient if they attempt to trigger a breath. If your patient attempts a breath, then the ventilator will sense this, and deliver a full mechanical breath. For an assist breath, the patient must trigger the ventilator (sucking in on ETT and generate a change in pressure or flow), then the ventilator completely takes over and delivers a full breath Supported (Spontaneous) Breaths: These types of breaths are triggered by patient effort (like assisted breaths), but once triggered the ventilator will give you some support, but not full support like an assisted breath. Modes of Mechanical Ventilation[2] The different modes of mechanical ventilators and all of them have different roles. See below for some examples: Volume assist/control Pressure assist/control Pressure support (PS) Synchronised intermittent mandatory ventilation (SIMV) +PS Pressure regulated volume control (PRVC) [2] [2] Procedure of Weaning patient Weaning is gradual reduction of ventilation. In some cases this process is rapid and uneventful; however, for some patients the process may

be prolonged for days or weeks. Weaning is a term that is used in two separate ways. Firstly, it implies the termination of mechanical ventilation and secondly the removal of any artificial airway[4]. When to wean[4] Normalised I:E ratio Reducing FiO2 (usually <0.5) No requirement for high PEEP Appropriate underlying respiratory rate Appropriate tidal volume with moderate airway pressures The procedure is as follows: Explanation of the procedure to the patient, assuring them it is only for a trial period The ventilator support is gradually reduced (e.g. reducing pressure during pressure support) The patient is placed into a better postural position (e.g. sitting upright or half-sitting) The airway is suctioned The patient is disconnected from the ventilator and given oxygen or mechanical assistance (CPAP) The patient is encouraged to breathe spontaneously The patient is monitored for signs of laboured breathing, anxiety or an increase in PaCO2 Extubation should occur as soon as possible because breathing through an endotracheal tube increases the work of breathing Encourage the patient to cough after being extubated Patients may be extubated when they are alert, show a stable breathing pattern and control their airway. Difficulties in weaning patients from a ventilator can occur due to: Inspiratory muscle atrophy Fatigue Paralysis of the diaphragm A fear of suffocating Physiotherapy Role in Mechanical Ventilation and Weaning Traditionally, physiotherapists have been involved in the respiratory care of patients on mechanical ventilation in ICU.[3] The respiratory care involves optimisation of ventilation, airway clearance, prevention of pulmonary complications, and hastening weaning from mechanical ventilation. Techniques used by physiotherapy to help improve patient breathing and wean patients off ventilators may include: Suctioning Postural drainage Central lavage (Paediatrics) Percussion Vibrations Guidelines 1) Evidence-Based Practice of Weaning from Ventilator: A Review[5] 2) Clinical Practice Guidelines for Weaning Critically Ill Adult Patients from Mechanical Ventilation[6] 3) Ventilator Discontinuation Protocols[7]Role of the Physiotherapist in COVID-19 - PhysiopediaIntroduction Physiotherapists (Physical Therapists) and other clinicians often have direct contact with patients, which makes them susceptible to the transmission of infectious diseases. Physiotherapists are also often first contact practitioners, which means that they are in a position to take responsibility for the early identification of infectious disease and/or managing workload in primary care settings. It is therefore very important for physiotherapists and other health professionals to be familiar with COVID-19 and how to prevent its transmission, and understand how they can be involved in workforce planning. They must use their professional judgment to determine when, where, and how to provide care, with the understanding this is not always the optimal environment for care, for anyone involved[1]. At the same time, consideration must be given to the fact that our profession plays a crucial role in the health of our society, and there are people in our communities whose health will be significantly impacted by disruptions to care. Key considerations: Stay current - Ensure that you are well read on current COVID-19 guidance. The WHO and the CDC have good evolving resources, also check with your local authority. Stay calm - Have an objective view of the crisis we are facing. People, for example, staff and patients, may look to you as a leader to provide information to help them make decisions and also provide reassurance that we can take care of them at this time of need. Minimise exposure in your setting - review infection prevention and control (IPC) guidelines, practice social distancing, implement triage strategies, reschedule non-urgent care, consider digital service delivery, consider closures, for example, if you don't have PPE available. Get involved in workforce planning - where appropriate offer services to reduce the load on emergency departments and frontline practitioners. Get educated - all staff should be trained in COVID-19 related strategies and procedures, including rehearsals of potential scenarios, such as a COVID-19 case being identified on the clinic premises. Physiotherapists work in many different settings and although IPC will be the same for everyone and any setting can potentially contribute to reducing the workload of hospitals, the role of the physiotherapist in each setting may differ. In primary care (i.e. private clinics, physician shared or GP practices) the emphasis will be triage and

early identification of cases. In community care (i.e. in the home) the emphasis will be on educating patients and carers. In acute care (i.e. the hospital setting) the emphasis will be on the management of respiratory symptoms. Primary (Clinic) Care There are two main considerations in primary care: Avoid transmission Provide education Avoid Transmission To avoid the transmission of COVID-19, the following are recommended practices for clinical staff: 1. Adhere to basic protective measures at all times Perform hand hygiene frequently with an alcohol-based hand rub if your hands are not visibly dirty or with soap and water if hands are dirty. Avoid touching your eyes, nose and mouth. Practice respiratory hygiene by coughing or sneezing into a bent elbow or tissue and then immediately disposing of the tissue. Wear a medical mask if you have respiratory symptoms and perform hand hygiene after disposing of the mask. Maintain social distancing (a minimum of 1 m/3 ft[2]) and according to the CDC at least 2m/6ft from individuals with respiratory symptoms [3]. If you have a fever, cough and have difficulty breathing seek medical care. 2. Promote respiratory, hand and clinic hygiene Ensure that you have appropriate written infection prevention and control protocols in your practice setting and communicate these protocols to all staff. Place additional signage in and around the clinic to encourage regular hand washing. You can get these from the WHO. Ensure that alcohol-based hand sanitisers and/or handwashing stations are available. Ensure regular cleaning and disinfection of the clinic and equipment, especially after attendance by a COVID-19 patient. 3. Provide up to date information about the virus to staff and patients Share educational messages with patients. Review and amend information on your clinic website, appointment reminders and appointment protocols. Signage, about hand and respiratory hygiene and other basic protective measures, should be displayed prominently at the first point of contact to the service such as reception areas, waiting rooms. Signage should also prompt visitors, staff, volunteers and patients to self-identify if they are at risk of having COVID-19. 4. Avoid unnecessary direct physical contact with individuals who may be infected Don't perform physical assessments. Avoid exposure to respiratory secretions. Encourage patients with symptoms to stay at home. 5. Liaise with staff and local public health specialists Stay up to date with the latest information on the COVID-19 outbreak through WHO updates or your local and national public health authority. Liaise with local public health specialists to keep up to date with local guidelines. Hold regular team meetings with staff to review this information and provide any updates. 6. Initiate early identification strategies If your clinic remains open, physiotherapists should undertake active screening (asking questions) and passive screening (signage) of patients for COVID-19. - On booking an appointment If an individual phones to make an appointment or has concerns about COVID-19 in advance of attending an appointment, they should be asked if they have had: recent travel to places with presumed ongoing community transmission of COVID-19. recent contact with anyone with confirmed COVID-19. recent work in or visits to a healthcare facility where patients with confirmed COVID-19 were being treated. If the answer is NO to all of the above questions they can proceed to make/attend an appointment. If the answer is YES to any of the above questions the individual should be asked if they have any of the following symptoms - fever, cough, shortness of breath or any other features or an upper respiratory tract infection such as nasal discharge or frequent sneezing. If the individual has any of the above symptoms then they should not make an appointment and should be advised about local authority guidelines. If the individual does not have any of the above symptoms, it is ok for them to make an appointment BUT they should be advised to follow local guidelines for people who may be at risk of transmission (which may include quarantine). - On attending clinic Patients with respiratory symptoms and relevant travel history may also be identified when they book in at reception for example by direct questioning or incorporating a question on symptoms of cold or flu-like illness and travel in registration paperwork. Ask the patient about recent travel to places with presumed ongoing community transmission of COVID-19. recent contact with anyone with confirmed COVID-19. recent work in or visits to a healthcare

facility where patients with confirmed COVID-19 were being treated. if they have any of the following symptoms - fever, cough, shortness of breath or any other features or an upper respiratory tract infection such as nasal discharge or frequent sneezing. If concerns about possible COVID-19 are identified in the course of a consultation: Isolate the patient away from other patients. Ideally, this should be an unoccupied room with the door closed. If a room is not available the person should be asked to wait in their car or be seated in an area separated by at least 6 feet or 2 meters from other individuals. Initiate basic protective procedures and use personal protective equipment (PPE: gowns, gloves, medical mask and eye protection)[4]. Provide the patient with tissues, a surgical face mask and alcohol hand rub. Follow local authority guidelines to arrange COVID-19 assessment. If the patient is to return home, they should quarantine themselves while awaiting home assessment. Patients should not travel home by taxi, public transport or walking. The patient may travel home by car if the patient feels well enough to drive or can be driven by a person who has already had significant exposure, who is aware of the risks and who is willing to drive them. Follow clinic cleaning and disinfection protocols once the patient has left the clinic. Provide Education Physiotherapists have a responsibility to share knowledge on preventing transmission of COVID-19. This should be done at any patient interaction be it in the clinic, on the phone or via digital consultation. In addition to this, many people will face weeks of isolation in quarantine and promoting health at these times will be key. Physiotherapists are well placed to provide and should be proactive in offering health maintenance strategies including: Activity - taking into consideration each particular persons individual situation and health condition, provide advice on how to take appropriate activity. Nutrition - good nutrition is key to boosting immunity. Sleep - again, sleep is key to keeping a strong immune system. People should be advised to maintain normal sleep patterns and good sleep hygiene. Mind - the longer people are isolated the more mental health will suffer, particularly for people living on their own. Be sure to offer strategies for good mental health by advising people to keep mentally active with learning and playing, maintain social relationships using online video conferencing tools such as WhatsApp and FaceTime. Community (Home) Care In the situation where a person has suspected COVID-19 with mild symptoms, care can be provided at home. It is suggested that a healthcare professional assesses whether the residential area is suitable for providing the necessary care. This might be particularly relevant when the person has co-morbidities, reduced functioning, disabilities and/or is elderly. The WHO has provided advice for providing home care for a case with mild symptoms[5]. Factors to Consider Will the patient and family be able to adhere to the recommended precautions as part of home care isolation (adhere to hand and respiratory hygiene principles, cleaning of the home environment, limitation of movement around the home). Will the patient and family be able to correctly handle safety concerns that arise while isolating at home (accidental ingestion or fire hazards that may be associated with the use of alcohol-based hand sanitisers). A communication link between the patient, the healthcare professional and the public health authority of a specific area/country should be confirmed. Education of the patient and family members of basic hand and respiratory hygiene principles. Provision of ongoing support to the patient and family. Recommendations for Patients, Families and Carers Patients should remain in a well-ventilated room (open windows and doors). Limit movement of patients around the home and limit shared spaces. Shared spaces should be well-ventilated at all times. Family or household members should stay in different rooms and keep a distance of at least 1m from the ill family/household member. Limit the number of caregivers and no visitors allowed until the patient has recovered and has no more signs and symptoms. Proper hand hygiene is essential after any contact with the patient or their immediate environment. The patient should wear a medical mask to contain respiratory secretions. Respiratory hygiene should be practised - cover mouth or nose with a disposable paper tissue when coughing or sneezing and dispose of appropriately. When tissue isn't available, sneeze or cough into the bend of the elbow

and not into hands. Caregivers are advised to wear medical masks when providing care to the patient. Avoid direct contact with bodily fluids. The patient should use dedicated linen and eating utensils - these should be cleaned with soap and water after use. Surfaces in the patient's room or areas where the patient is should be cleaned and disinfected. It is recommended to use regular household cleaning products first and then a household disinfectant afterwards. Bathroom and toilet surfaces should be cleaned at least once daily. The patients' clothes and linen may be washed with regular laundry products and water. Machine wash at temperatures of 60 - 90 °C. All gloves and masks used during home care isolation should be disposed of as infectious waste. Avoid any exposure to contaminated items used by the patient (toothbrushes, towels, linen, wash clothes, eating utensils, etc). Healthcare professionals tending to patients under home care should be familiar with and be able to select, use, remove and dispose of the correct personal protective equipment (PPE) to be used[6]. [7] Acute (Hospital) Care A minority group of people will present with more severe symptoms of COVID-19 and will need to be hospitalised, most often with pneumonia. In some instances, the illness includes severe pneumonia, ARDS, sepsis and septic shock[8]. In these cases, the physiotherapist may find themselves involved in the respiratory care of the patient. Safety First Specific advice for front line clinicians: Ensure that there are enough supplies and access to appropriate Personal Protective Equipment (PPE) for front line staff. Ensure that staff have an opportunity to take adequate breaks during and between shifts. Ensure access to appropriate support services for the psychological health of staff. As with any contagious respiratory condition, care must be taken to protect yourself and those in the immediate environment by following strict protocols and ensuring the use of PPE as well as taking the following steps[9]: Where possible treat the patient in a single room with the door closed. Limit the number of staff present. Minimise entry and exit from the room during treatment. Respiratory Interventions As with any patient displaying respiratory symptoms, it may be necessary to provide treatment to relieve symptoms and improve function. The secretion load of people with COVID-19 is low so they don't usually require invasive or intensive airway clearance techniques[10]. Physiotherapy support is more focused on non-invasive ventilation support measures and then the rehabilitation phase[10]. In the mild and moderate stages of disease, normal oxygen supportive measures (facemask oxygen) may be advantageous. Patients with severe pneumonia often need oxygenation support. High flow nasal oxygen** is recommended at this stage, in conjunction with negative pressure room (if available)[11]. Nebulisation is not recommended[11]. Some patients may go on to develop ARDS. Noninvasive ventilation (NIV) is not routinely recommended[11] and these patients usually warrant intubation with mechanical ventilation. Prone positioning may assist ventilation and closed suctioning is recommended[11]. Extracorporeal membrane oxygenation may be indicated in patients with refractory hypoxia. During the acute phase of COVID 19, Lazerri et al suggest any interventions that could potentially increase the risk of breathing are contraindicated and should be avoided[12]. Once stable and no longer in the , if indicated the main goal in respiratory physiotherapy is to mobilise secretions and ease the work of breathing. Interventions may include techniques such as positioning, autogenic drainage, deep breathing exercises, breath stacking, active cycle of breathing mobilisation and manual techniques (e.g. percussion, vibrations, assisted cough) to aid sputum expectoration**[13][14][15][9]. These interventions can be performed at any stage of the disease where appropriate and safe to perform. **Particular attention should be given during those interventions that place the health staff at greater risk of contamination for aerial dispersion of droplets, such as sputum induction, open suctioning, nebulisers, high flow oxygen, NIV, as these are a potential route for transmission for the virus[16]. Airborne PPE must be used. This section on respiratory interventions is a summary, please read the Respiratory Management of COVID-19 for more specific information. Management of Contacts According to the WHO any person (including healthcare workers) who has been exposed to an individual with suspected

COVID-19 is considered a "contact". These contacts are advised to monitor their health for 14 days from the last day of possible contact in order to take appropriate action if necessary.[5] The WHO[17] describes a contact as a person who is involved in any of the following from 2 days before and up to 14 days after the onset of symptoms in the patient: Providing direct care for patients with COVID-19 disease without using proper personal protective equipment. Staying in the same close environment as a COVID-19 patient (including sharing a workplace, classroom or household or being at the same gathering). Travelling in close proximity with (that is, having less than 1 m separation from) a COVID-19 patient in any kind of conveyance. The following counts as exposure to contacts: Healthcare-related contact - providing direct care to patients with COVID-19. Working in close proximity or sharing a classroom with a person with COVID-19. Travelling with a person(s) with COVID-19 in any kind of vehicle. Living in the same household as a person with COVID-19 within 14 days after the onset of the person's symptoms. Healthcare professionals should monitor their contacts on a regular basis. Recommendations if a contact develops symptoms[5]: Notify the relevant healthcare authorities as well as the medical facility where symptomatic contact will be directed to. Symptomatic contact should wear a medical mask while travelling to seek care. The symptomatic contact should avoid taking public transport if possible - an ambulance can be dispatched or if the person is being transported via private vehicle, all the windows should be opened (vehicle well-ventilated). The symptomatic contact should be advised on proper hand and respiratory hygiene as well as to keep a distance of at least 1 m from others. Clean and disinfect any surfaces that could have been contaminated with respiratory secretions during transport of the symptomatic contact with cleaning products and then with a disinfectant. Workforce Planning Physiotherapists may find themselves in a position to reduce the workload in emergency departments and/or divert staff to contribute to the care of hospitalised COVID19 cases. The key to workforce planning is to identify what the unique contribution is of your clinic and/or staff, and what your generic contribution is to pandemic planning: Respiratory and on-call teams can be mobilised to the intensive care units and medical wards. Musculoskeletal physiotherapists can contribute in the rehabilitation phase to assist recovered COVID-19 cases return to full function. Outpatient departments in hospitals could assist with acute/urgent injury cases that present to emergency departments to keep them out of the contagious environments, such as keeping them out of COVID-19 screening queues. Service providers can set up telemedicine services to keep people socially distanced and out of contagious environments. Protecting Staff It is important when planning services that physiotherapists who fall into the high-risk categories should avoid contact with Covid-19 patients. These include members of the team that[18]: Are pregnant - although at present the risks from COVID-19 are unconfirmed it is known that exposure to any respiratory disease carries an increased risk of complications for mother and baby. Have a known chronic respiratory illness Are immunosuppressed or have immune deficiences Are over the age of 60 years Have an underlying health condition such as heart disease, lung disease or diabetes Have immune deficiencies, such as neutropenia, disseminated malignancy and conditions or treatments that produce immunodeficiency [12]. Telemedicine Consultations To reduce transmission or in the case where a clinic is forced to close, you may consider implementing digital strategies to continue the delivery of your service. There are currently no established or recognised global standards or agreement for delivering physiotherapy care digitally. However, the overall emerging evidence appears to indicate that digital technologies are providing new opportunities for the physical therapy profession to deliver high-quality and acceptable care to users of their service in ways that can have benefits for all[19]. Some national physiotherapy organisations are welcoming the use of digital practices where it enhances the service to the patient[20]. To implement telemedicine a variety of approaches can be used such as the use of general communication tools such as email, chat/messaging and video conferencing and/or physiotherapy specific platforms such

as online exercise prescription tools. It is important to take into account the barriers to access the use of these tools may present for some patients and provide support where required if possible.[21] Review and follow all national or state laws (practice acts/legislations) regarding telemedicine or telehealth services. [22] Rehabilitation After COVID-19 Rehabilitation in the recovery phase is going to be a key responsibility of physiotherapists in collaboration with the multidisciplinary team, including occupational therapists, speech and language therapists, dieticians and psychologists. Resources Interim Infection Prevention and Control Recommendations for Patients with Suspected or Confirmed Coronavirus Disease 2019 (COVID-19) in Healthcare Settings Interim Guidance for Implementing Home Care of People Not Requiring Hospitalization for Coronavirus Disease 2019 (COVID-19) Preventing the Spread of Coronavirus Disease 2019 in Homes and Residential Communities Physiotherapy Management for COVID-19 in the Acute Hospital Setting: Recommendations to Guide Clinical Practice Respiratory physiotherapy in patients with COVID-19 infection in acute setting: a Position Paper of the Italian Association of Respiratory Physiotherapists (ARIR)Non Invasive Ventilation - PhysiopediaIntroduction Non-invasive ventilation delivered by a oronasal mask Non-invasive ventilation (NIV) is the delivery of oxygen (ventilation support) via a face mask and therefore eliminating the need of an endotracheal airway.[1] NIV achieves comparative physiological benefits to conventional mechanical ventilation by reducing the work of breathing and improving gas exchange.[2] The intervention is recognised as an effective treatment for respiratory failure in chronic obstructive pulmonary disease, cardiogenic pulmonary oedema and other respiratory conditions without complications such as respiratory muscle weakness, upper airway trauma, ventilator-associated pneumonia, and sinusitis.[1][3] NIV works by creating a positive airway pressure - the pressure outside the lungs being greater than the pressure inside of the lungs. This causes air to be forced into the lungs (down the pressure gradient), lessening the respiratory effort and reducing the work of breathing[4]. It also helps to keep the chest and lungs expanded by increasing the functional residual capacity (the amount of air remaining in the lungs after expiration) after a normal (tidal) expiration; this is the air available in the alveoli available for gaseous exchange[5]. There are two types of NIV non-invasive positive-pressure (NIPPV) and Negative-Pressure Ventilation (NPV). For anatomy of the lungs see here Non-Invasive Positive-Pressure NIPPV describes the delivery of oxygen at either constant or variable pressures via a face mask, such as Bi-level Positive Airway Pressure (BiPAP) and Constant Positive Airway Pressure (CPAP) [6] CPAP CPAP is the most basic level of support and provides constant fixed positive pressure throughout inspiration and expiration, causing the airways to remain open and reduce the work of breathing[7]. This results in a higher degree of inspired oxygen than other oxygen masks. When indicated for home use it is usually via a low flow generator and is commonly used for patients requiring nocturnal CPAP for sleep apnoea[8]. High flow systems used in a hospital environment are designed to ensure that airflow rates delivered are greater than those generated by the distressed patient[8]. As well as having an effect on respiratory function it can also assist cardiac function where patients have a low cardiac output with pre-existing low blood pressure[8]. It is also commonly used for severe obstructive sleep apnoea and also for type 1 respiratory failure, for example, acute pulmonary oedema (by recruiting collapsed alveoli). Indications When a patient remains hypoxic despite medical intervention Atelectasis - Complete or partial collapse of a lung or lobe[9] Rib fractures - to splint the rib cage open; to stabilise the fracture and prevent damage to the lung[9] Type I respiratory failure Congestive Heart Failure Cardiogenic pulmonary oedema Obstructive sleep apnoea Pneumonia: as an interim measure before invasive ventilation or as a ceiling of treatment Nasal CPAP is more commonly used with infants.[10] BiPAP NIV is often described as BiPAP, however, BiPAP is actually the trade name. As the name suggests provides differing airway pressure depending on inspiration and expiration. The inspiratory positive airways pressure (iPAP) is higher than the

expiratory positive airways pressure (ePAP)[11]. Therefore, ventilation is provided mainly by iPAP, whereas ePAP recruits underventilated or collapsed alveoli for gas exchange and allows for the removal of the exhaled gas. In the acute setting, NIV is used in type 2 respiratory failure (for example in a COPD exacerbation), with respiratory acidosis (pH < 7.35)[12]. Indications Type II respiratory failure Acidotic exacerbation of chronic obstructive pulmonary disease (COPD)[13] Increased work of breath causing ventilatory failure, for example, hypercapnia (increased CO2 in arterial blood gas), fatigue or neuromuscular disorder Weaning from tracheal intubation Negative-Pressure Ventilation (NPV) Negative-pressure ventilators provide ventilatory support using a device that encases the thoracic cage, such as the iron lung. Although not seen as much in today's society they were popular in the first half of the twentieth century during the polio epidemic. They work by lowering the pressure surrounding the thorax, creating subatmospheric pressure which passively expands the chest wall to inflate the lungs. Exhalation occurs with passive recoil of the chest wall. Their use is still indicated in chronic respiratory failure. The three types used each with their own advantages and disadvantages[14]: The earliest version is the tank ventilator, more commonly known as the iron lung. It is a large cylindrical device that encases the patient's body with only the head visible, a neck collar provides an airtight seal The poncho-wrap is an airtight bodysuit using a rigid metal framework covered with an airtight nylon parker that surrounds the trunk The cuirass is made up of a rigid fibreglass shell which fits over the chest wall and upper abdomen Contraindications of NIV Coma Undrained pneumothorax Frank haemoptysis Vomiting blood (haematemesis) Facial fractures Cardiovascular system instability Cardiac Arrest Respiratory Failure Raised ICP Recent upper GI surgery Active Tuberculosis Lung abscess No additional contraindications in the paediatric population[10] Precautions Emphysema - check chest x-ray for bullae Patient compliance Skin integrity Airway obstruction[10] Patients Unlikely to Do Well On NIV Agitation, encephalopathic, uncooperative Severe illness including extreme acidosis (pH <7.2) Presence of excessive secretions or pneumonia Multiple organ failure Haemodynamic instability Inability to maintain a lip seal Inability to protect the airway Overt respiratory failure requiring immediate intubation[10] Setting Up the Equipment Do not set up NIV unless you are familiar with the equipment, circuits, masks, etc.and are confident as to how safely to establish the patient on NIV and appropriately respond to blood gas results. The decision to use NIV and the settings must always be made with the medial and nursing team looking after the patient. Introduce the treatment to the patient slowly. Patients need to keep their mouth closed if using a nasal mask. Some patients are less suited to NIV; however, each situation should be individually assessed. NIV should generally be used in ICU/HDU environments - make sure you are aware of your local policy.[10] Parts of the Machine Bi-level positive airway pressure (BiPAP) generator Anti-bacterial filter Smoothbore tubing Exhalation port Face mask, spacer and headgear Oxygen tubing Heated humidifier and tubing (if required) Oximeter with an integral recorder [15] Instructions on Using the Ventilator Introduce the patient slowly to the equipment and all its parts. Ensure the mask fits comfortably and that the patient can experience the mask on their face without the ventilator. Allow the patient the opportunity to feel the operation of the machine through the mask on their hands or cheek before applying it over their nose or mouth. Allow the patient the opportunity to practice breathing with the ventilator, either by holding the mask in place or allowing them to hold it in place. Adjust the settings initially for comfort and establish whether the patient can relax comfortably in a sleeping position. Provide opportunities for the patient to feedback any discomfort. Assess and adjust the performance of the ventilator during an afternoon nap to optimise gas exchange and comfort. Progress to an overnight study, continuing to monitor and optimise gas exchange and sleep quality.[10] Complications Facial Pressure Ulcers Pressure ulcers associated with the use of NIV is a growing clinical problem due to the increased popularity of the intervention. Prevalence of grade I pressure ulcers have been estimated at 5-50% after a couple of hours and 100% after

48 hours[16]. The development of pressure ulcers is associated with poor clinical outcomes, increased complications, and length of hospital stay that compound with the consequences of acute illness. Medical devices such as NIV masks have unique risk factors including - the existence of a microclimate individual to the device, the method in which the device is secured, that devices may obscure the skin, and that the areas at risk are not routinely checked[17]. Clinicians' primary focus has been to attain a mask seal, as air leaks are associated with reduced tolerance to the intervention[18]. The alternating airflow from bi-level positive pressure means that a seal is important to avoid ventilator asynchrony. Therefore strap tension is increased, with the risk of pressure damage a secondary consideration[19]. It is important to consider that the patient may not be able to respond to an uncomfortable mask fit or excessive load delivered to vulnerable areas of skin due to sedation, medication, or neurological disease or injury. Furthermore, the patient may be too weak to reposition the device. Oronasal masks have traditionally been preferred for their comfort and ease of use however other interfaces have been recommended as superior[20]. Prophylactic interventions should also be considered[21]. Eye Irritation It is important to ensure the mask is fitted correctly if it is not it can cause oxygen to leak upwards to the eyes, causing eye irritation and conjunctivitis.[22] Retention of Secretions The use of a full face mask may interfere with the ability to cough and the effective clearance of secretions. As well as this, the positive pressure created may compromise the patient's ability to generate sufficient expiratory flow rates affecting the mobilisation of secretions and also a resistance to cough leading to the retention of secretions.[8] Resources British Thoracic Society guidelines on non-invasive ventilation.

References

1. ↑ Jump up to:1.0 1.1 1.2 1.3 1.4 1.5 1.6 The Italian Thoracic Society (AIPO - ITS) and Italian Respirarory Society (SIP/IRS). Managing the Respiratory Care of Patients with COVID-19. Version - March 08, 2020 [Available from: https://www.acprc.org.uk/Data/Resource_Downloads/ManagingtheRespiratorycareofpatientswithCOVID-19(1).pdf?date=18/03/2020%2020:14:01]
2. ↑ Jump up to:2.00 2.01 2.02 2.03 2.04 2.05 2.06 2.07 2.08 2.09 2.10 2.11 2.12 2.13 World Health Organisation. Clinical Management of Severe Acute Respiratory Infection (SARI) when COVID-19 Disease is Suspected - Interim Guidance. WHO, 13 March 2020
3. ↑ Jump up to:3.0 3.1 3.2 3.3 3.4 3.5 3.6 3.7 Rachael Moses, Consultant Respiratory Physiotherapist. COVID-19 Respiratory Physiotherapy On Call Information and Guidance.Lancashire Teaching Hospitals. Version 2 Dated 14th March 2020
4. ↑ Jump up to:4.0 4.1 4.2 Rachael Moses, Consultant Respiratory Physiotherapist. COVID 19 and Respiratory Physiotherapy Referral Guideline. Lancashire Teaching Hospitals. Version 1 Dated 17th March 2020
5. ↑ Jump up to:5.00 5.01 5.02 5.03 5.04 5.05 5.06 5.07 5.08 5.09 5.10 5.11 5.12 5.13 5.14 5.15 5.16 Thomas P, Baldwin C, Bissett B, Boden I, Gosselink R, Granger CL, Hodgson CL, Jones AYM, Kho ME, Moses R, Ntoumenopoulos G, Parry SM, Patman S, van der Lee L (2020): Physiotherapy management for COVID-19 in the acute hospital setting. Recommendations to guide clinical practice. Version 1.0, published 23 March 2020. Journal of Physiotherapy.
6. ↑ Jump up to:6.0 6.1 Lazzeri M, Lanza A, Bellini R, Bellofiore A, Cecchetto S, Colombo A et al. Respiratory physiotherapy in patients with COVID-19 infection in acute setting: a Position Paper of the Italian Association of Respiratory Physiotherapists (ARIR). Monaldi Archives for Chest Disease. 2020;90(1).

7. Jump up↑ Meng L, Qiu H, Wan L, Ai Y, Xue Z, Guo Q, Deshpande R, Zhang L, Meng J, Tong C, Liu H. Intubation and Ventilation amid the COVID-19 Outbreak: Wuhan's Experience. Anesthesiology. 2020 Mar 19.
8. Jump up↑ Metro North, Interim infection prevention and control guidelines for the management of COVID-19 in healthcare settings, 2020: https://www.health.qld.gov.au/__data/assets/pdf_file/0038/939656/qh-covid-19-Infection- control-guidelines.pdf.
9. Jump up↑ Alhazzani, W., M. Moller, Y. Arabi, M. Loeb, M. Gong, E. Fan, S. Oczkowski, M. Levy, L. Derde, A. Dzierba, B. Du, M. Aboodi, H. Wunsch, M. Cecconi, Y. Koh, D. Chertow, K. Maitland, F. Alshamsi, E. Belley-Cote, M. Greco, M. Laundy, J. Morgan, J. Kesecioglu, A. McGeer, L. Mermel, M. Mammen, P. Alexander, A. Arrington, J. Centofanti, G. Citerio, B. Baw, Z. Memish, N. Hammond, F. Hayden, L. Evans, and A. Rhodes, Surviving sepsis campaign: Guidelines of the Management of Critically Ill Adults with Coronavirus Disease 2019 (COVID-19). Critical Care Medicine, 2020. EPub Ahead of Print.
10. ↑ Jump up to:10.0 10.1 10.2 Associazione Riabiliatori Dell'Insufficienza Respiratoria. Indicazioni Per La Fisioterapia Respiratoria In Pazienti Con Infezione Da COVID-19. Updated 16/03/2020
11. ↑ Jump up to:11.00 11.01 11.02 11.03 11.04 11.05 11.06 11.07 11.08 11.09 11.10 Australian and New Zealand Intensive Care Society. ANZICS COVID-19 Guidelines. Melbourne: ANZICS 2020
12. ↑ Jump up to:12.0 12.1 Ñamendys-Silva SA. Respiratory support for patients with COVID-19 infection. The Lancet Respiratory Medicine. 2020 Mar 5.
13. Jump up↑ David J Brewster, Nicholas C Chrimes, Thy BT Do, Kirstin Fraser, Chris J Groombridge, Andy Higgs, Matthew J Humar, Timothy J Leeuwenburg, Steven McGloughlin, Fiona G Newman, Chris P Nickson, Adam Rehak, David Vokes and Jonathan J Gatward. Consensus Statement: Safe Airway Society principles of airway management and tracheal intubation specific to the COVID-19 Adult Patient Group. Medical Journal of Australia. Updated 17 March 2020
14. Jump up↑ Adam Rochester, NIV Lead for Respiratory Support Services. Standard Operating Protocol for the setup and Use of Non-Invasive Ventilation or HiFlow Oxygen (AirVo) for Patients with Suspected or Confirmed Coronavirus. Royal Brompton and Harefield NHS Trust. Version 1.7 – March 17th, 2020
15. Jump up↑ Messerole E, Peine P, Wittkopp S, Marini JJ, Albert RK. The pragmatics of prone positioning. American journal of respiratory and critical care medicine. 2002 May 15;165(10):1359-63.
16. Jump up↑ Jonathan Downham. Proning the ARDS Patient- Why do we do it?. Available from: http://www.youtube.com/watch?v=FS4t5w1eCYw[last accessed 17/03/2020]
17. Jump up↑ Critical Care & Major Trauma Network. Prone Position 1. Available from: http://www.youtube.com/watch?v=bE4mmGdjA5I[last accessed 17/03/2020]
18. Jump up↑ Rachael Moses. Physiotherapy Interventions for COVID-19.March 2020. https://vimeo.com/398333258 Accessed 18 March 2020
19. Jump up↑ Lazzeri M, Lanza A, Bellini R, Bellofiore A, Cecchetto S, Colombo A, D'Abrosca F, Del Monaco C, Gaudellio G, Paneroni M, Privitera E. Respiratory

physiotherapy in patients with COVID-19 infection in acute setting: a Position Paper of the Italian Association of Respiratory Physiotherapists (ARIR). Monaldi Archives for Chest Disease. 2020 Mar 26;90(1).

20. ↑ Jump up to:20.0 20.1 20.2 Simon Hayward and Dr Chris Duncan. Physiotherapists use of Lung Ultrasound during the COVID-19 Pandemic - A Practical Guideline on supporting Acute Hospital Colleagues. 2020
21. Jump up↑ Peng, Q.Y., X.T. Wang, L.N. Zhang, and G. Chinese Critical Care Ultrasound Study, Findings of lung ultrasonography of novel corona virus pneumonia during the 2019-2020 epidemic. Intensive Care Med, 2020.