The Faculty of Intensive Care Medicine

intensive care society

proud to be the voice of critical care since 1970

50 YEARS

Clinical guide

for the management and care of critically ill adults with COVID-19 during the Coronavirus pandemic

1 Introduction

This clinical guidance provides contemporary information for practising clinicians caring for critically ill adult patients with COVID-19. Whilst many of these patients will be cared for on intensive care units, some patients receiving high-flow nasal oxygen therapy (HFNO), continuous positive airways pressure (CPAP) and/or non-invasive ventilation (NIV) may be cared for on specialist respiratory wards. Version5 updates the previous FICM and ICS guideline published on 28th October 2020 incorporating the contents of the Rapid Update published on 13th January 2021 and is supported by the UK Critical CareNursing Alliance.

This document will continue to be updated at regular intervals during the COVID-19 pandemic. Please always refer to the most up-to-date version, which will be available on the four organisations (Association of Anaesthetists, FICM, ICS, Royal College of Anaesthetists) hub. This can be found here: https:// icmanaesthesiacovid-19.org. Nursing care resources related to COVID-19 management can be found here: Royal College of Nursing, British Association of Critical Care Nurses.
This guide summarises the clinical characteristics of COVID-19 and offers advice on:

- Dealing with 'surge' including mutual aid
- COVID-19 clinical characteristics and specific treatments
- Clinical decision-making
- Management of respiratory failure
- Management of non-respiratory organ failure

This revised version contains important additions relating to:

- Steroid therapy
- Interleukin-6 receptor antagonists
- Clinical decision making under surge conditions
- Non-invasive respiratory support
- Long-COVID

The COVID-19 pandemic has placed an extraordinary burden on critical care that has been met through the creation of surge capacity within and beyond hospital walls. Many non-specialist healthcare providers have supported critical care specialists to provide care. Staff safety and wellbeing remain crucial, as the need to respond to the pandemic continues. *Maintenance of this sustained response in parallel with continuation of elective services and other emergency pressures willcontinue to challenge the resilience of critical care provision.*

Monitoring and regular reporting of care and outcomes in the context of COVID-19 has been established by ICNARC through accelerated data submission to the Case Mix Programme, the nationalclinical audit for adult critical care. ICNARC has also developed the ability for direct data entry of a reduced dataset for critically ill patients not on a critical care unit, e.g. respiratory wards.

Please contact ICNARC to ascertain how to capture data on this important group of patients that are critically ill with COVID-19. Analyses of Case Mix Programme data will inform future versions of this guidance.

The effectiveness of many interventions in the context of COVID-19 is currently uncertain. This guide is informed by emerging information about COVID-19 management as well as best available evidence from non-COVID-19 patients. Multi-centre clinical trials are currently underway in patients with COVID-19 and will inform future versions of this guidance.

COVID-19 related clinical trials are important to the rapid development of an evidence base for this new disease and should be supported. The only solution to the threat posed by the virus is to develop effective preventative and therapeutic interventions through high-quality research. Clinicians' firmly held beliefs in the effectiveness or otherwise of interventions, in the absence of reliable evidence (so-called "lack of equipoise"), are an obstacle to such progress.

The list of prioritised trials for COVID-19, including several in which critical care patients could be recruited (such as REMAP-CAP, ISARIC-4C, GenoMICC, and HEAL-COVID) can be found here.

The guideline development group members are listed below:

- Suzanne Bench (London, UK Critical Care Nursing Alliance)
- Jeremy Bewley (Bristol)
- Joe Cosgrove (Newcastle, FICM representative)
- Paul Dean (East Lancashire, ICS representative)
- Jane Eddleston (Manchester, NHS England Clinical Reference Group)
- Kevin Fong (London, NHS England)
- Mike Grocott (Southampton, guideline development group chair)
- Andy Johnston (Birmingham)
- Chris Meadows (London)
- Ben Messer (Newcastle)
- Hugh Montgomery (London, ICS representative)
- Ramani Moonesinghe (London, NHS England)
- James O'Carroll (London)
- Marlies Ostermann (London)
- Julie Platten (Newcastle)
- Suman Shrestha (Frimley, UK Critical Care Nursing Alliance)
- Mervyn Singer (London)
- Charlotte Summers (Cambridge)
- Mark Tomlin (Southampton)
- Alain Vuylsteke (Cambridge)
- Matthew Williams (Portsmouth, FICM representative)

2 Dealing with surge

Surge: Refers to an increase in the rate and/or volume of arrival of patients that exceeds baseline operational capacity.

Critical Care Surge Capacity: In the context of critical care, surge capacity refers to the rate of arrival and/or total volume of critically ill patients that can be accommodated by a healthcare system before decompensation occurs.

Mutual Aid: Defined as the gift, loan or exchange of resources for mutual current or future benefit.

Consideration should be given to the use of mutual aid in line with regional and national surge plans. Examples of "resources" would include patient transfers (transferring care to reduce the local clinical burden) and transfer of staff, equipment, consumable items or drugs to a hospital in need. The COVID-19 pandemic has highlighted the importance of collaboration and material support between hospitals. Clinicians should not hesitate to seek advice and support from colleagues in other units when they feel that their own clinical experience or their local resources are stretched.

Close liaison with Regional Emergency Preparedness Response and Resilience (EPRR) teams is key to the management of acute surge. Senior clinicians and managers should understand how and when to communicate with, and escalate concerns to, EPRR teams. This dialogue should occur before the consequences of surge begin to limit the capacity of the hospital to deliver care in order to allow time for an appropriately tailored responses to be put in place.

Hospital systems should undertake advanced planning to identify triggers for when additional staff and beds are made available to critical care. This will need to include triggers for sequential reduction in elective activity and should dovetail into the activities of "COVID-Secure" facilities including the use of the independent sector.

Supporting and augmenting critical care surge capacity requires different ways of working including delivery of critical care in locations outside formal intensive care units. Delivery of care outside established hospital intensive care units may occur in existing high-acuity care areas within the hospital or in external purpose-built structures such as the NHS Nightingale facilities.

Such care delivery may involve:

- The re-deployment of staff from other specialties to support the delivery of critical care.
- Working with new and unfamiliar equipment and the associated training burden.
- Managing a greatly increased demand for consumables and drugs including haemofilters and PPE.
- Significant increase in consumption of oxygen may lead to hospital wide or ward level oxygen pipeline supply problems (See Section 5)
- Reinforcement of Critical Care Patient Transfer Networks

Further advice on staffing levels and other workforce issues under surge conditions can be found here.

As the requirement for **'mutual aid'** within critical care networks and between networks increase, the number of inter-hospital transfers will also increase. Under such conditions, transfer of patients receiving CPAP may be considered under exceptional circumstances and with careful patient and journey (short duration) selection, suitable equipment and appropriately trained transfer team (see CPAP guide).

At such times, learning from others' experiences working within the clinical and ethical constraints imposed by high demand and finite resources will be important. (See Section 4: Clinical decision-making).

During surge conditions, data collection for operational purposes is critical to managing the response. Resources should be allocated to support mandatory data collection for local, regional and national reporting such as through the Directory of Services (DOS), NHSE / I Sit-Rep reporting and ICNARC case-mix programme and COVID-19 process audit.

The safety and welfare of staff are essential if critical care provision is to remain resilient in the face of the demands of a sustained pandemic and should include:

- PPE- such as the PHE Infection Prevention and Control guidance
- Sustainable staffing patterns and rotas
- Attention to staff physical wellbeing rest, diet and physical activity
- Attention to the psychological wellbeing of medical, nursing and other staff, particularly in relation to concerns about personal safety and responsibility (difficult clinical decision-making)
- Attention to the stresses on individuals working outside their usual scope of practice, e.g. non-specialists looking after critical care patients.
- Attention to the stresses on patients, relatives and staff due to restrictions on hospital and ICU visiting, particularly around end-of-life.
- Recovery/restart: careful consideration should take place regarding restitution of services, including reinstating normal staffing ratios where relevant, following the ICS Recovery and Restitution of Critical Care Services document.

3 Clinical characteristics and specific treatments

SARS-CoV-2 infection causing COVID-19 can manifest as:

- Acute hypoxemic respiratory failure
- Non-respiratory organ dysfunction including:
  - Cardiovascular
  - Renal
  - Cardiac
  - Neurological
  - Hepatic
  - Gastrointestinal (less common)
- Arterial, venous and pulmonary thromboembolism
- Hyper-inflammation syndromes

Risk factors for worsened clinical outcomes in hospitalised patients:

- Age: over 50 years old, substantial risk over 70 years old
- Male sex
- Obesity
- Minority ethnic – particularly Asian and Black
- Socio-economic deprivation
- Comorbidities: cardiovascular disease, diabetes, cancer; and chronic, kidney, liver, neurological (including dementia) and non-asthma respiratory disease, and chronic immunosuppression.

The ISARIC 4C score predicts mortality and deterioration in hospitalised COVID-19 patients.

Diagnosis

- SARS-CoV-2 RNA Reverse Transcriptase - Polymerase Chain Reaction (RT-PCR)
  - Lower respiratory tract samples if possible
  - Beware false negative upper airway sample if clinical picture is typical
  - Consider co-infection with other respiratory pathogens
- Diagnostic imaging
  - Chest radiograph (CXR): bilateral patchy infiltrates, pneumothoraces and pneumomediastinum.
  - Computerised Tomogram (CT) chest:
    - May help establish the diagnosis if there is uncertainty
    - Consider use early to identify large or small/multiple pulmonary thrombi/emboli
- Laboratory findings

Useful and common laboratory findings include:

- Low lymphocyte count
- Procalcitonin – if elevated may indicate bacterial infection
- Creatinine Kinase – commonly elevated, and usually of skeletal muscle origin, but may indicate myositis/myocardial involvement
- Troponin - elevation = myocardial involvement (interpret with caution when renal function abnormal)

Severity of illness markers include (not all necessary) elevated:

- D-dimers
- Troponin/Brain Natriuretic Peptide (BNP)
- Ferritin
- C-Reactive Protein (CRP)
-

Management

Anti-viral therapy

- Preliminary data from the WHO Solidarity trial suggest that there is no benefit from Remdesivir administration in critically ill patients (updated guidance available here: Remdesivir NHS guidance)

Steroid therapy

- The RECOVERY trial supports administration of dexamethasone 6 mg once per day (enteral or intravenous) for 10 days. This reduced deaths:
  - in ventilated patients from 41.4% to 29.3%
  - in patients receiving oxygen only, from 26.2% to 23.3%

  No benefit (possible harm) in those patients who did not receive oxygen.
- Meta-analysis of data from seven clinical trials recruiting critically ill patients with COVID-19 indicates that both dexamethasone 6mg once daily and hydrocortisone (50 mg intravenously every 6 hours for seven days) reduce all-cause mortality at 28 days.
- Dexamethasone 2mg tablets are readily absorbed. IV dexamethasone should be prescribed as whole ampoules. 6.6 mg dexamethasone base is equivalent to 8 mg dexamethasone phosphate or 8.6 mg dexamethasone sodium phosphate.
- Prednisolone and hydrocortisone are the preferred steroids during pregnancy as per RCOG guidance. Dexamethasone should not be used during pregnancy except when indicated for foetal lung maturity.
- When patients require corticosteroids for other indications (either at replacement doses for known adrenal insufficiency or as a treatment for another underlying condition such as asthma or Chronic Obstructive Pulmonary Disease), they should **not** be withheld.
- The risk of adrenal insufficiency should be considered in all patients who receive steroids.
- Steroid therapy may harm skin integrity which should be carefully monitored.

Interleukin-6 receptor antagonists (Tocilizumab and Sarilumab)

- The RECOVERY trial reported improved 28-day survival with Tocilizumab (33% mortality in the usual care group, 29% mortality in Tocilizumab group) with a 14% relative reduction in risk of death in hospitalised COVID-19 patients with hypoxia and CRP > 75.
- The REMAP-CAP trial reported improved survival with Tocilizumab (36% mortality in the standard care group, 27% mortality in Tocilizumab/Sarilumab group) with a 24% relative reduction in the risk of death in intensive care patients with COVID-19.
- A single dose of Tocilizumab 8mg/kg by intravenous administration (peripheral or central) is recommended as adjuvant treatment to dexamethasone for hospitalised patients with COVID-19 pneumonia, consistent with MHRA guidance:
    - where oxygen saturation is <92% on room air on repeated measurement or an ongoing requirement for supplementary oxygen AND CRP of ≥75mg/L; OR
    - within 24 hours of starting respiratory support (HFNO, CPAP or NIV), or invasive mechanical ventilation), if an IL-6 inhibitor has not already been administered
- Sarilumab is recommended, consistent with MHRA guidance, as an alternative treatment to Tocilizumab for critically ill COVID-19 patients within 24 hours of starting respiratory support (HFNO, CPAP or NIV, or invasive mechanical ventilation), if an IL-6 inhibitor has not already been administered.

IL-6 receptor antagonists are immunosuppressants which may:

- suppress CRP response for up to 3 months after administration, making it a less reliable marker of infection.
- lower the ability of the immune system to fight infections which could increase the risk of nosocomial infections and/or worsen any infection that occur.

Pre-existing infection may be exacerbated by IL-6 receptor antagonist therapy and careful consideration should be given to the risks and benefits of therapy where such infection may be present.

Monitoring of the long-term progress of these patients, via recruitment of patients into the ISARIC-CCP study, is recommended.

All handovers of clinical care (including between hospitals if patients are transferred, between levels of care and clinical teams within hospitals, and between hospitals and primary care) must explicitly document that an IL-6 receptor antagonist has been given and the date of administration.

The use of IL-6 receptor antagonists in the treatment of COVID-19 is unlicensed. Any serious suspected adverse reactions must be reported to the MHRA via the new dedicated COVID-19 yellow card reporting site.

Other Anti-SARS-CoV-2/COVID-19 therapies should only be administered within the context of a nationally approved trial. COVID-19 related clinical trials should be supported to enable the rapid development of an evidence base for this new disease.

Thrombolysis for massive pulmonary embolism

- Thrombolysis should be considered in a patient with COVID-19 with a pulmonary embolus who develops acute haemodynamic instability following BTS guidance. This should be guided by echocardiography and/or CT pulmonary angiogram.

Antibiotics and other antimicrobials

- Antibiotic administration is **not** recommended for uncomplicated COVID-19 infection.
- Careful attention to antimicrobial stewardship is important.
- There is limited information available on interactions between seasonal influenza and COVID-19: viral co-infection is possible. Seek evidence of this even if SARS-CoV-2 is detected, and vice versa. COVID-19 and influenza should be cohorted separately.
- Secondary bacterial and/or fungal infection may be seen, typically later in ICU stay.
- Antibiotics should be considered if there is suspected bacterial super-infection.
- Antifungals should be considered in patients not responding to antibacterial treatment, who are known or strongly suspected to have fungal infection.
- Procalcitonin may be useful in guiding decision making around the use of antibiotics although it is not known if it is suppressed by the use of Tocilizumab or Sarilumab.
- CRP is suppressed by Tocilizumab or Sarilumab and is therefore an unreliable marker of new infection or the effective treatment of infection.

Perform regular microbiological surveillance, including blood cultures, line cultures, fungal biomarkers (ß-D-glucan and Galactomannan) and molecular diagnostics, if available. Patients who have been given steroid and/or IL-6 therapy may be more prone to reactivation of pathogens such as TB, CMV, HSV and VZV.
Infection Prevention and Control practices are essential for the minimisation of secondary infections.

Steroid continuation

- There is limited evidence to guide steroid dose and duration in the critically ill COVID-19 patient after a 10-day course of dexamethasone 6mg has been completed.
- From studies in early non- Covid ARDS (within the first 14 days after diagnosis) some patients with persistent lung inflammation may benefit from continued or higher-dose corticosteroid treatment. These studies have used steroid doses up to 20mg dexamethasone per day Villar 2020.
- Such use should be decided on an individual patient basis and involve discussion with consultant colleagues. Decisions should be based on consideration of imaging findings, risk of superadded infection, presence of deteriorating pulmonary function and biochemical markersof persistent inflammation.
- Dexamethasone should be the steroid of choice in most patients with COVID-19 (except pregnancy). There have been shortages of other steroid drugs.
- Steroid equivalences: Dexamethasone 6mg = Hydrocortisone 160mg = Methylprednisolone 32mg = Prednisolone 40mg.
- Steroid therapy should be weaned according to local guidelines.

High dose / Late administration of steroids

- Higher doses of steroids (more than 20mg dexamethasone) or late administration (after 14 days) should only be considered after discussion with an appropriate specialist MDT.

Treatment of other conditions in the context of COVID-19

- Take care not to neglect treatment of exacerbations of any underlying conditions, e.g. heart failure, COPD, diabetes, hypertension.
- Consider other possibilities in the differential diagnosis for patients with possible COVID-19.

Impact of ACE-inhibitors and Angiotensin II receptor blockers (ARBs) on COVID-19

- Where patients are already taking ACE-inhibitors and ARBs for other conditions, national and international bodies, including Renal Association UK, European Renal Association, the European Society of Cardiology and European Medicines Agency suggest that COVID-19 is not a reason alone for discontinuation. Usual practice should be followed whilst the patient is in critical care.

4 Clinical decision-making

General comments

- The principles of intensive care decision-making are the same whether the patient has COVID-19 or any other condition.
- All patients should be treated respectfully and equitably, and should receive the best available care. Careful attention should be given to ensuring that any processes put in place to guide decision making do not inadvertently result in discrimination (unjust or prejudicial treatment) against patients with particular characteristics.
- Decisions should be consistent with established and accepted ethical and legal frameworks within the NHS and ideally occur via shared decision-making with patients, or, for patients assessed as lacking capacity, via Best Interests Processes (England and Wales), Common Law (Northern Ireland) or Least Restrictive Options by reference to the principles in the Adults with Incapacity Act (Scotland).
- Any decisions about treatment limitations, including treatment escalation plans (TEPs) and "do not attempt cardio-pulmonary resuscitation" (DNACPR) decisions, should never be made on a blanket basis and should be made in consultation with the patient/significant others and the multi-disciplinary team.
- Patients should never be treated differently because of anticipated future pressures. It is important to focus on current clinical demands and available resources across regional and national critical care networks. Assess what care is likely to provide benefit to the patient, taking into account the best available evidence on factors that predict this and applying it tothe specific situation of the patient being treated.
- Doctors, and other senior clinicians, should consider national guidance about clinical decision making from the DHSC, NHS-E/I (or equivalent in the devolved nations), GMC, NMC, NICE and professional and regulatory bodies, including guidance specific to the current pandemics.

Dealing with surge

- As limited resources (particularly workforce) are distributed between greater numbers of critically ill patients, the capacity to provide the usual standard of care may be affected.
- Having exhausted all options to improve resource availability, Medical Directors and Chief Executives have overall responsibility for deciding if this has occurred and for taking appropriate action.
- In order to reduce the risk of an individual hospital's critical care demand exceeding available resources, Mutual Aid (defined as the gift, loan or exchange of resources for mutual current or future benefit) should be requested in line with regional and national surge plans. Mutual aid may include patient transfers (transferring care to reduce the local clinical burden) and/or transfer of staff, equipment, consumable items or drugs to the hospital in need.
- All hospitals/trusts/boards should have a framework in place to support clinicians with decision making, particularly under conditions in which clinical demand exceeds local resources. Such a framework may include immediate availability of consultant colleagues to discuss difficult and/or complex decisions, support with decisions from senior local medical leadership (Medical Director or delegated clinician) and local or regional ethics councils.

- Guidance to support decisions is available and may help guide conversations about the likelihood of individual patients benefiting from intensive care. Such guidance is not, and should not be used as, a triage tool.
- The challenges of decision-making during this COVID surge, and the need for healthcare professionals to be supported, are acknowledged by the Chief Medical Officers, Chief Nursing Officers, and Chair of the GMC.

Referral and admission to intensive care or palliative care

- **Treatment escalation plans (TEP)** should be discussed with patients, and/or their relatives, at the first opportunity and be clearly documented. TEPs should take account of the person's values and of the goals of treatment.
- **Referral** for consideration of admission to ICU should be considered carefully by a senior clinician, using current guidance, e.g. NICE pathway, local and national guidelines, as an aid.
- The **decision to admit to intensive care is the responsibility of the intensive care consultant.** When an intensive care consultant is not immediately available, and a time-critical decision is required, another senior clinician with knowledge of intensive care interventions and outcomesshould decide in the best interests of the patient.
- Decisions should be discussed with the patient, when they have the capacity to make decisions, or next of kin, personal representative, Lasting Power of Attorney (for health and welfare) or Independent Mental Capacity Advocate (IMCA) or utilising relevant arrangements as determined by each devolved nation's legal framework.
- Decisions should also be discussed with the senior nursing team in relation to staffing and equipment availability and disposition of patients across available critical care beds and locations.
- Ensure that all discussions and decisions are clearly documented by the referring or ICU team as appropriate.
- When there is potential or actual disagreement, a clinical ethics panel should be rapidly available, at least on a regional basis, and consulted.

Treatment decisions

- All patients treated by intensive care services should have a named intensive care consultant responsible for their care and treatment decisions. Clinical handovers between responsible consultants should follow usual practice guidelines.
- The intensive care consultant may delegate decision making and interventions to other members of the team, but retains overall responsibility for the treatment of the patient.
- Good practice in critical care routinely involves continuous assessment of every individual patient's progress, discussion within the multidisciplinary team (including bedside nurses), the likelihood of an outcome that is acceptable to the patient, and the adjustment of treatment plans in light of these factors.
- On admission to intensive care, the patient's expectations and the goals of treatment should be reviewed.
- All patients must have at least daily review by an intensive care consultant to assess whether the goals of treatment are being met and whether the outcomes expected at admission remain realistic. If an intensive care consultant is not available for direct review, the assessmentcan be delegated by them to a clinician with knowledge of intensive care interventions and

outcomes. Responsibility for any decisions taken in light of these reviews remains with the intensive care consultant.

- Regular communication updates with the patient's representative by informed members of the critical care team are recommended. Consideration should be given to the use of approved videoconferencing when visiting for relatives may not be possible.
- When treatment is limited or withdrawn, there must be clear and complete documentation of the rationale for any decisions, and documentation of discussions with the patient or their representative (as determined by each nation's legal framework) and the other clinical staff involved.
- When treatment is limited or withdrawn, the priority will become to deliver the best possible end-of-life care to the patient. The benefit of involving a palliative care team should be considered, especially if the patient is managed outside the intensive care unit.
- Review of TEPs should occur before ward discharge of survivors of critical care.

5 Management of respiratory failure

Oxygen therapy

- Avoid hyperoxaemia in patients receiving supplemental oxygen.
- Document oxygen saturation targets clearly during ward rounds and titrate oxygen flow to meet targets to avoid over-administration of oxygen.
- Generally, aim for SpO_2 92-96%, however, a SpO_2 target of 90-93% is acceptable in patients with visible continuous pulse oximetry in an appropriately monitored care environment with trained staff to monitor for clinical deterioration.
- The target should be 88-92% in patients with COPD, obesity and patients with neuromuscular disease causing respiratory muscle weakness.

Oxygen supply

- Oxygen demand substantially increases in hospitals treating large numbers of COVID-19 patients and this has resulted in critical incidents relating to oxygen supply. There may be greater risk of this over Winter months when other patients with high oxygen demand may be admitted.
- High demand, particularly in cohorted areas outside theatres or critical care, may lead to pressure drops in the oxygen supply system that may affect oxygen flow to individual patients or areas.
- There are a number of other risks associated with unusually high oxygen usage including icing of vacuum insulated evaporators (VIEs - the liquid oxygen storage tanks outside hospitals). VIE icing can also lead to oxygen supply drops. This can occur throughout the year but is a particular risk in cold weather.
- Preparation for treatment of increased numbers of COVID-19 patients, particularly in surge centres, must involve local oxygen engineering teams, with attention paid to planned locations of treatment with high-flow oxygen devices, and potential systems limitations.
- At times of surges in demand for oxygen, initiation of HFNO should be a consultant level decision. Replacement of high flow CPAP/NIV machines with lower flow machines is advised at times of high demand on oxygen supplies.
- An oxygen analyser should be used with CPAP/NIV machines which entrain room air to ensure a constant FiO_2 is being delivered, especially when patients have high peak inspiratory flow rates.
- Consider ways of conserving oxygen such as:
    - Turning off oxygen flow meters, nasal high flow and CPAP/NIV devices when not in use
    - Staggering of interventions that may lead to sudden surges in oxygen demand between patient e.g., nebuliser use, switching from CPAP to HFNO to enable feeding
    - Assessing and managing leaks from CPAP/NIV facemasks & hoods
    - Awareness that turning oxygen flowmeters up to maximum can result in significantly more oxygen being delivered than the highest gradation on the flowmeter.
- Where local expertise exists, a circuit with an active exhalation valve to deliver NIV or tracheostomy ventilation can reduce oxygen requirements.

- If oxygen alarms sound, this must be taken seriously, oxygen engineering teams should be called and an immediate review of all oxygen usage undertaken to reduce unnecessary use.
- Ensure portable oxygen cylinders are available at each bedspace.
- Other information about safe oxygen use can be found in this CAS-Alert.

Non-invasive respiratory support (CPAP/NIV/HFNO)

- COVID-19 pneumonitis is a disease continuum which may progress to meet the criteria for ARDS with poor compliance and hypoxaemia.
- The widespread use of non-invasive respiratory support in 2020/21 for COVID-related acute hypoxaemic respiratory failure is a new phenomenon and represents a change in practice compared to the management of pre-COVID acute hypoxaemic respiratory failure / ARDS
- The RECOVERY-RS trial compared CPAP against low-flow oxygen and HFNO against low-flow oxygen in a 3-arm randomised controlled trial. Patients were eligible for recruitment if FiO2 ≥0.4 on low flow oxygen with O_2 sats ≤ 94%, and for full escalation of treatment. The primary outcome was a composite of requirement for invasive mechanical ventilation, and mortality, within 30 days of randomisation.
- The following recommendations are made on the basis of the results:
    - Patients who have O_2 sats ≤94% on FiO2 ≥ 0.4 on low-flow oxygen therapy and do not require immediate intubation, should be considered for a trial of CPAP
    - There is no benefit for HFNO. However, it may have a role for comfort (e.g. palliative therapy) or for rest from CPAP (e.g. at mealtimes).
    - The relative benefits of different non-invasive respiratory interventions in patients who have been deemed not for escalation to mechanical ventilation is unknown. However, given the benefit in terms of avoidance of intubation, clinicians may consider CPAP as an appropriate therapy in these patients.

- Predicting which patients will deteriorate on non-invasive respiratory support and subsequently require invasive mechanical ventilation, or which patients will avoid intubation, is often difficult.
- Potential indicators for failure of non-invasive respiratory support include: increased work of breathing, deteriorating oxygenation, high expired tidal volume, high minute ventilation persistently rising inflammatory markers and D-dimers, agitation and distress, and failure to tolerate rest periods on HFNO. Such markers of potential deterioration should be taken in context of the patient's overall clinical condition.
- Patients with COVID treated with non-invasive respiratory support who exhibit these signs should be monitored closely for deterioration and should be considered for intubation and lung protective mechanical ventilation if escalation is appropriate.
- Pneumomediastinum, pneumothoraces and surgical emphysema are a feature of COVID pneumonitis and may be exacerbated by a high spontaneous minute ventilation and positive pressure ventilation.
- No specific absolute duration of non-invasive respiratory support has been identified as detrimental in an individual COVID patient who may remain stable for days before eventual improvement. It is thus crucial to individualise care, including the types of non-invasive support offered, alone or in combination, to find which approach best suits any particular patient. Prediction of NIRS failure is complex but may be assisted by a scoring system taking into account age, GCS, respiratory rate-oxygenation index, comorbidities and vasopressor use.

- It should be noted that median time to intubation for CPAP patients in the RECOVERY-RS trial was 2.2 days (95% C.I. 1.0 to 4.6).
- Calculating the ROX index may help decision-making over timing of intubation in patients on HFNO.
- Clinicians should note that days of CPAP or NIV (> 1 day) prior to invasive mechanical ventilation where mask ventilation is used at >12hrs/day in a patient whose P:F ratio is < 20kPa or PaCO2 > 6.5kPa, or if there is evidence of a high minute ventilation, are counted as 'ventilator days' in assessing suitability for extracorporeal support (see ECMO below).

Delivery of non-invasive respiratory support

- Acute non-invasive respiratory support should only be used in clinical areas equippedwith at least:
    - Continuous pulse oximetry for all patients.
    - Continuous ECG monitoring for all patients with a clinical indication (pulse rate > 120 bpm, dysrhythmia or possible cardiomyopathy).
    - Point of care blood gas analyser that is readily accessible.
    - An adequate oxygen supply.
    - Trained staff to monitor for clinical deterioration and 24/7 immediate medical cover.
    - Note that in RECOVERY-RS, 8% of patients recruited to all trial arms had haemodynamic instability.
    - If not already treated within Critical Care, patients in hypoxaemic respiratory failure who are for escalation to intubation should be discussed daily with a consultant intensivist and reviewed accordingly.
- For units delivering non-invasive respiratory support outside of a Critical Care area, the local operational policy should include a management / escalation plan to intensive care.
- Such a plan should include patients who need more input from experienced ICU nurses and other clinicians, use of alternative respiratory support devices not available outside the ICU, and monitored use of sedation/anxiolytics. Adequate humidification, sleep, patient position, physiotherapy, skin integrity,nutrition, and hydration are all crucial factors to consider.
- Patients who are not considered suitable for invasive ventilation may still benefit from intensive care admission for the above reasons, if consideredappropriate.
- Regular clinical review of patients receiving CPAP/NIV/HFNO is recommended to identify patients who are likely to require mechanical ventilation and to avoid emergency intubations of very sick patients. A reasonable approach would be toconduct a formal review at 4 hours, and then at most 24 hours later, and then at least every subsequent 24 hours following initiation of therapy with review of the overall clinical picture, level of respiratory support, arterial blood gases, trajectory of illness, and resuscitation and escalation status.

- Guidance for ward based respiratory support is available here: British Thoracic Society
- For some patients, non-invasive respiratory support will form the appropriate ceiling of treatment. These patients should be identified early to prevent inappropriate escalation to invasive support. Consideration of invasive ventilatory support should be made in the context that an individual has the physical reserve to tolerate invasive ventilatory support. (ICNARC median duration of advanced airway support is 12 days with IQR of 6 to 23 days).

Technical Aspects

- Due to the certainty of FiO_2 delivered, CPAP/NIV machines that blend oxygen and airare preferred over machines which entrain room air unless inspired oxygen concentration is being continually monitored.
- Careful attention should be given to the compatibility of CPAP/NIV devices with vented/non-vented masks.
- Staff members caring for patients on non-invasive respiratory support should wear PPE consistent with relevant Infection Prevention and Control guidance.
- An appropriate antimicrobial filter should be located on the patient side of the expiratory port of a CPAP/NIV circuit.
- Respiratory circuits for Non-Invasive Respiratory Support should be approved by critical care or respiratory physicians and physiologists to ensure the circuit is safe for the patient and minimises viral transmission.
- Due to a risk of environmental viral contamination, when possible deliver mask ventilation in an isolated environment (negative or neutral pressure room - check the air exchanges in positive pressure rooms - or cohort in restricted access areas).

Intubation

- Follow intubation guidance from: https://icmanaesthesiacovid-19.org
- Intubation in likely COVID-19 patients should be performed by a skilled operator wearing appropriate PPE for an aerosol-generating procedure. See PHE IPC guidance here
- The use of Mobile Emergency Rapid Intubating Teams with appropriate portable equipment, PPE and protocols are recommended, but will be dependent on available local staffing resources.
- Take care not to damage the tube or pilot tube. Clamping of the ET tube (not in spontaneously breathing patients) should be performed when disconnection of the patient from the gas supply is necessary. Clamp away from the plastic of the 15mm circuit connector. Care should be taken not to clamp the tracheal tube repeatedly at the same location, which may cause kinking. For tracheal tubes with subglottic suction ports, clamping at 90° to the plane of the sub-glottic channel may reduce therisk of sub-glottic channel fracture.
- Any adverse incidents should be reported through local and national reporting systems to spread learning from events across the healthcare system and to help prevent future incidents.
- The type and location of respiratory support after extubation, e.g. CPAP, high or lower flow O_2, should be informed by clinical assessment and balance the risks of cross-infection with the benefits of different approaches.
- Consideration should be given to cohorting extubated patients according to SARS-CoV-2 status both in ICUs and step-down units in line with national Infection Prevention and Control and local guidelines.

Mechanical ventilation

- Humidification and antimicrobial filters
- Ensure use of an antimicrobial filter within the circuit or placed on the expiratory limb or ventilator exhaust. **Note that filters can represent an airflow obstruction risk if saturated, and frequent assessment and replacement is advised.**
- Heated humidifiers are recommended where local equipment allows. However, clinicians should be aware they can cause rapid saturation of inlinefilters and the combination should be used with caution. If possible, when using a heated humidifier circuit, attach the antimicrobial filter to the ventilator exhaust.

- **Airflow obstruction due to saturation of antimicrobial filters, particularly whenused with heated humidifiers or nebulisation, may be indicated by sudden orprogressive deterioration in:**
    - **minute ventilation**
    - **capnography**
    - **airway pressures**
- Alternatively, use of dry circuits with HME filters can cause secretion build-up and obstruction of tracheal tubes. Regular nebulised saline (normal or hypertonic) ± mucolytics (inline with respiratory circuit) may be useful BUT maycontribute to circuit obstruction through saturation of filters and salt crystal build-up within ventilator expiratory blocks.
- Use closed suction systems where possible.
- Avoid inadvertent ventilator circuit disconnections by ensuring all connections are 'tight'. Manual ventilation, e.g. 'hand-bagging' an intubated patient should be avoided where possible.
- Consider clamping the tracheal tube (not in spontaneously breathing patients) and set the ventilator to pause/standby during any planned circuit disconnection, e.g. switching between ventilators, during proning/deproning manoeuvres, replacing the antimicrobial filter, or inserting a bronchoscope into the catheter mount.
- A number of new, perhaps unfamiliar, ventilators may be present. Use of available educational resources, training and a period of familiarisation should take place.

Anaesthetic machines are not recommended for ventilation of critical care COVID-19patients unless there is a specific indication.

Ventilatory management

- COVID-19 respiratory failure requiring ventilation may present on a spectrum that extends from an early phase of pulmonary vasculopathy/thrombosis, focal ground glass inflammation, and possible loss of hypoxic pulmonary vasoconstriction to a laterphase of atelectasis, increase in non-aerated pulmonary units and deterioration in pulmonary mechanics with low compliance. Ventilatory management will depend on the phenotype (determined by imaging, pulmonary mechanics and response to ventilation manoeuvres).
- Standard protective lung ventilation guidelines used for ARDS should be deployed: aim for tidal volumes of 6 mL/kg and driving pressure <15 cmH_2O (driving pressure =plateau pressure – PEEP).
- When compliance is normal, PEEP ≤10 cmH_2O is often sufficient, and a high PEEP strategy may be harmful. As compliance deteriorates, higher PEEP levels may be appropriate. PEEP ladder assessment exercises are recommended on initial ventilatorset-up and following a change in the patient's condition.
- Neuromuscular blockade to avoid high transpulmonary pressures and further lung injury should be considered if there is ventilator dysynchrony or a high spontaneousminute ventilation.
- Patients receiving sedation, with or without neuromuscular blockade, should be carefully assessed for level of pain (CPOT), sedation (RASS) and when neuromuscularblockade is used, this should be monitored (ToF).
- Where daily interruption of sedation/paralysis is not possible, alternative methods of assessing sedation should be considered (e.g. Bispectral index monitoring, BIS) whilst accepting that such use remains unvalidated.
- Recruitment manoeuvres have not been shown to improve outcome but may improve gas exchange in low compliance lungs and can be used to assess recruitability.
- Where available, inhaled pulmonary vasodilators, e.g. nitric oxide, nebulised iloprostor epoprostenol, may improve V/Q mismatching although use will likely be less effective with increased deadspace due to pulmonary thrombi. Inhaled nitric oxideshould be administered through approved systems.
- Care must be taken to wean pulmonary vasodilators according to clinical response (avoid abrupt withdrawal).
- Improvements in oxygenation can often be achieved with prone positioning.
- Conservative fluid management strategies may be beneficial.
- If other strategies fail, consider seeking advice from specialist severe respiratory failureor ECMO centres.

Prone positioning

- Awake prone positioning may improve V/Q mismatch, oxygenation and workof breathing and may be combined with HFNO, CPAP or NIV.
- Early application of prone positioning in severe ARDS is associated with a significant reduction in both 28 and 90-day mortality (Guérin, NEJM). Studiesare not yet available demonstrating an outcome benefit from prone positioning in COVID-19 patients.
- However, an improvement in gas exchange is often seen in ventilated patients in both early and later phases of the disease. The benefit may wearoff after several hours or days for some patients.
- Proning should take place in an appropriately monitored care environment with trained staff and local protocols with regard to skin/eye/mouth care, nutrition and line management. Turn head regularly, e.g. 3 hourly, and be careful about potential injury to eyes, pressure areas, shoulders and obstruction/displacement of tracheal tube/tracheostomy. Pressure damageto soft tissue areas is a risk of prolonged proning regimens.
- Significant haemodynamic and/or respiratory decompensation can occur during the act of proning or deproning. While patients generally recover aftera short period, clinicians should be prepared for these complications and treat accordingly. If necessary, the procedure may need to be abandoned.
- If proning is used, it is recommended for 16-18 hours per day (longer may beacceptable) and may continue to show benefit for > 7 days.
- 'Proning Teams' will improve efficiency when substantial numbers of patientsare being turned. The Proning Team may comprise staff from non-ICU backgrounds under supervision of a suitably skilled member of ICU staff. However, use of Proning Teams will depend on local staffing resources.
- The optimal timing for starting prone positioning and optimal duration of a proning course remain uncertain. It is reasonable to continue daily in responders until there has been a significant and stabilised improvement in P/F ratio, whereas it can be discontinued in non-responders.
- Awake patients may experience symptomatic benefit without necessarilyshowing improvements in gas exchange.
- Non-responders to proning will need an alternative ventilatory strategy.Discussion with a specialist severe respiratory failure centre should be considered.

Tracheostomy and weaning

- Advice for care of patients currently with a tracheostomy is available.
- Timing of tracheostomy formation should follow standard local guidelines,although this may be influenced by, e.g. prolonged need for proning.
- Tracheostomised patients who remain SARS-CoV-2 +ve potentially carry anongoing risk of viral aerosolisation. If there is doubt about risk, quantitative assay of SARS-CoV-2 activity can be considered.
- Decision making in relation to new tracheostomies needs to balance the risk of infection (aerosol spread of SARS-CoV-2) with the best management for thepatient. Prolonged orotracheal intubation is associated with tracheal mucosalinjury.
- These available resources may help:
  - https://associationofanaesthetists-publications.onlinelibrary.wiley.com/doi/10.1111/anae.15120
  - https://icmanaesthesiacovid-19.org/considerations-for-tracheostomy-in-the-covid-19-outbreak

- Tracheostomy may:
  - facilitate weaning from mechanical ventilation and patient comfort
  - allow reduced use of sedation and, consequently, pressor medication
  - enable safe management with lower staffing and equipment levels.
- Staff must have the training and experience to care for tracheostomisedpatients.
- If patients are isolated or cohorted, deflation of the cuff of the tracheostomyto facilitate weaning from mechanical ventilation and return of upper airway function is recommended
- NIV machines should be used in place of ICU ventilators for weaning whenthere are equipment shortages.

Extubation

- Need for reintubation is associated with airway swelling, tenacious secretions, weakness and delirium.
- To minimise reintubation rates, careful and comprehensive clinical assessment should be undertaken before planned extubation.
- Post-extubation plans should be defined before extubation takes place, including management in cases of failed extubation.
- Extubation should be delayed until there is a consistently improving trajectory in the following:
  - Breathing pattern, including markers of respiratory and cough strength
  - Ability to self-clear secretions
  - Mental state and ability to cooperate with care
  - Chest radiology
  - Markers of inflammation and thrombosis
  - Oxygenation and mean airway pressure and PEEP.

- Use of a spontaneous breathing trial with monitoring of RSBI, NIF and P0.1 may be useful in assessing adequacy of ventilation and likelihood of successful extubation.
- 'Cuff leak' tests may be useful for assessing airway swelling. Be aware that there may be an associated aerosol generation risk.

Extracorporeal membrane oxygenation (ECMO)

- Follow published guidance and thresholds for referral to the ECMO service.
- ECMO referrals can be made via this platform here.
- ECMO may be indicated in patients with potentially reversible acute severe respiratory failure (e.g. intractable profound hypoxaemia, uncompensated hypercapnia or life-threatening airway disease such as asthma, airway trauma, or airleak)
- In general, ECMO should only be offered after failure of conventional support (e.g. prone position and optimal conventional respiratory management with least damaging lung ventilation) but before irreversible changes have set in.
- In the absence of definite evidence, institution of ECMO is a clinical decision made after discussion between referring and ECMO clinicians, and guided by nationally setcriteria.
- Patients who do not fulfil national criteria for ECMO may still survive their ICU admission through maximal conventional management. Declining ECMO cannulation does not necessarily determine prognosis.
- ECMO service centres can be contacted for specialist severe respiratory failure advice and guidance.

6 Management of non-respiratory organ failure

Cardiovascular

- Cardiovascular disease and its antecedent risk factors are associated with greater risk of death from Covid-19.
- Raised cardiac troponin T (TnT) and/or NT-proBNP levels may occur and are strongly associated with poorer outcome.
- Histologically-proven myocarditis can occur in severe Covid-19, but appears uncommon. Raised TnT alone is not sufficient for this diagnosis, which is made by exclusion. When it occurs, it appears to do so 10-15 days after symptoms first appeared.
- Right sided cardiac dysfunction due to pulmonary hypertension and/or pulmonary embolism may occur. It is associated with increased mortality risk and appears morecommon than left sided heart failure.
- Acute pericarditis can occur but cardiac tamponade is rare.

- Remember: acute coronary syndromes can still occur. Diagnosis can be difficult given that raised TnT is common. Echocardiography (regional wall motion abnormality) and ECG may help. Seek expert cardiology advice.
- Arrhythmias are common, e.g. AF and bradycardia, and should be managed in a normal fashion.
- In case of cardiac arrest, chest compressions should be started immediately.
- In case of cardiac arrest in the prone position with an advanced airway already in place, and where immediate supination is not feasible or poses significant risk to the patient, initiating CPR while the patient is still prone may be a reasonable approach. Invasive blood pressure monitoring and continuous $ETCO_2$ monitoring may be useful as a guide to the effectiveness of prone compressions and thereby inform decision making on when to prioritize supination.
- For patients with a shockable rhythm who are in the prone position and cannot be supinated immediately, attempting defibrillation in the prone position is a reasonable approach
- Where cardiac arrest occurs in the prone position without an advanced airway already in place, turn the patient supine as quickly as possible and begin CPR.
- NERVTAG and UK Infection Prevention and Control guidelines do not consider that chest compressions pose a greater risk of COVID-19 infection of attending staff than does an ordinary exhaled breath. UK IPC Guidance does not list chest compressions as an AGP. In contrast Resuscitation Council UK recommends PPE consistent with Aerosol Generating Procedures for chest compressions.
- Survival to discharge from in-hospital cardiac arrest in critically ill COVID-19 patients who do not have prior DNACPR orders is 12.0%, but 21.2% in patients aged <45 years and 2.9% in those aged >80 years.
- Definitive airway management may generate aerosols and should not be performed until all staff are wearing appropriate PPE. Resuscitation team rehearsal can help with the speed of response. Airway interventions must be carried out by experienced staff.
- Hypotension or circulatory shock should be managed according to usual practice. A fluid strategy in favour of clinical euvolaemia is recommended.

Renal

- AKI requiring renal replacement therapy (RRT) appears less common in the UK 2nd wave, being reported in >25% of COVID-19 patients admitted to critical care before September 2020, but in 14.5% since. Average duration of RRT has fallen from 8 to 5 days.
- Management should follow current consensus recommendations for AKI in critically ill patients. To date, there is no evidence in support of any specific therapies to reverse AKI.
- Whilst a degree of relative water depletion might be sought or tolerated in order to improve pulmonary gas exchange in some, care should be taken to ensure that renal perfusion is maintained.
- Renal perfusion may be compromised by high airway pressures and high PEEP.
- In patients receiving RRT, anticoagulation to prevent filter clotting should be augmented due to the prothrombotic nature of COVID-19. Several strategies are available, including switch to intravenous unfractionated heparin infusion, increased dosing of sub-cutaneous

low-molecular weight heparin or a combination of regional citrate with heparin (iv infusion or low molecular weight heparin).

- Continuous RRT (CRRT) is the preferred modality. If demand for CRRT machines exceeds capacity, consider alternative modalities including prolonged intermittent RRT using CRRT machines, acute peritoneal dialysis (when local expertise and issues such as proning allow) or intermittent haemodialysis (if the patient is stable enough in terms of cardiovascular and respiratory status), and/or mutual aid.
- Guidance on RRT can be found here.
- Guidance on renal follow-up after discharge from ICU can be found here:

Thromboprophylaxis and treatment of thromboembolus

A prothrombotic phenotype (high fibrinogen and D-dimer) is common with COVID-19. Even with standard thromboprophylaxis, pulmonary thromboembolism is identified in about one quarter of COVID-19 patients admitted to ICU. D-dimer concentrations of 500 and 1000 mg/L showed high sensitivity (96% and 91%) but low specificity (10% and 24%, respectively) for PE. DVT is found in perhaps ¼ of those with PE. Stroke may affect 1-4%.

- Pay great attention to thromboprophylaxis including non-pharmacological methods (intermittent pneumatic compression, TEDS).
- Low-molecular weight heparin thromboprophylaxis can be administered at 1.5 to 2 times the standard prophylactic dose. Where available, monitoring of thromboprophylaxis with anti-Xa levels is NOT needed unless in the presence of significant renal impairment (creatinine clearance 100 kg). The same is true for treatment of thromboembolism.
- Have a high index of suspicion for the presence of thromboembolic disease and investigate urgently where clinical suspicion is raised, e.g., if a sudden deterioration in gas exchange occurs, or if D-dimers remain increased or show a stepwise rise.
- If full anticoagulation is considered in the absence of proven thromboembolism, carefully consider the risks and benefits: there is likely to be an increased risk of bleeding and no evidence of improved outcome is currently available.
- Surveillance for bleeding, which may be concealed, is important in anticoagulated patients.

Feeding

- COVID-19-related GI symptoms are rarely an issue in ICU patients.
- Failure of enteral nutrition is likely due more to the use of drugs (such as opioids) and this factor - together with possible intra-abdominal pathology - should be considered.
- Misplacement of nasogastric tubes may occur in ventilated patients, particularly after proning maneuvers and should be monitored for.
- Nutritional care should be provided as per GPICS and BAPEN guidance.
- Best practice guidance for feeding in the prone position should be followed.
- There is no evidence that vitamin D supplementation improves COVID-19 outcomes, although may be considered supplementation in those who are deficient.

Skin

- Skin involvement is commonplace and manifests most commonly as a chilblains/pernio-like lesions, maculopapular rash or viral exanthem.
- Spreading fungal infections should be excluded when this diagnosis appears possible.
- The risk of skin breakdown is increased due to the use of steroids, high dose vasopressors, proning and other factors associated with critical illness (eg catabolism, oedema, diarrhoea). Tissue viability specialists should be involved in care planning where appropriate.

Liver

- About half of COVID-19 patients may get raised ALT/AST/GGT/bilirubin levels – no specific intervention is advocated.

Neurological

Neurological complications of COVID-19 are common. Their presence can be masked by the use of paralysing agents and analgosedation, and a high index of suspicion should be maintained. Where these are suspected, investigation can prove difficult and an expert neurological opinion should be sought.

- Seizures may occur in about 0.5% of hospitalised patients.
- Stroke (perhaps 1%, due largely to large vessel thrombotic/embolic occlusion) tends to occur late in the disease. Haemorrhagic stroke may also occur.
- Encephalopathy and acute disseminated encephalomyelitis (ADEM) can occur in severe COVID-19. Standard investigations where possible (MRI- haemorrhage-sensitive sequences, and with contrast to delineate inflammation, EEG and CSF examination) can help in diagnosis and in exclusion of other causes (stroke, other infection). Specific therapeutic interventions remain to be defined. The use of high dose corticosteroids may be considered (3–5-days methylprednisolone 1 g/day iv). If symptoms persist intravenous immunoglobulins may be administered but should be guided by discussion with relevant experts.
- Critical illness *per se* can cause an axonal motor neuropathy, but cases of Covid-related Guillain Barre syndrome are also reported. Nerve conduction studies show demyelinating patterns are most common, but axonal pathology is also reported. CSF examination should be performed. Serological testing of ganglioside antibodies is recommended. Treatment using intravenous immunoglobulins or plasma exchange should be instigated.
- Delirium or changes in executive function are common. In part, this may relate directly to SARSCoV-2 infection but also to loss of circadian rhythm and use of analgosedation.
- Short acting sedatives and analgesics should be used as in standard practice if available.
- Daily interruption of sedation and assessment of neurocognitive state is recommended where appropriate.
- There should be consideration for reporting the short, medium and longer term neurological complications of COVID-19 infection.
- Non-pharmacological interventions should be used: family contact, individualized care (e.g. choice of radio station), ear plugs at night, eye pads to limit light exposure at night, orientation, sleep hygiene (including normalisation of day/night cycle), objective pain assessments and mobilisation.
- Transverse myelitis can occur but is uncommon.

Musculoskeletal

- Muscle wasting is common.
- Skeletal CK may be elevated. Origin should be confirmed (compare with cardiac troponin levels and determine CK isoforms when indicated and readily available).
- ICU Acquired Weakness affects all ventilated ICU COVID-19 patients to some degree, impacting on weaning and rehabilitation.
- Once off sedation, perform daily Chelsea Critical Care Physical Assessment (CPAX) Score.
- Use Medical Research Council Sum Score (MRC-SS: p3) to diagnose ICU-AW.
- Mobilise according to local practice
- Cases of sustained or late CK rises, sometimes associated with autoantibodies, are reported.
- Muscle wasting leads to reduced creatinine production. In patients with muscle wasting,low serum creatinine values may overestimate renal function and should be interpreted with caution.

Hyperglycaemia

- Insulin resistance is common in COVID-19. Glucose-lowering strategies may need to be intensified, including the administration of long-acting insulin. In the recovery phase, carefully monitor and respond to changing insulin requirements. Guidelines for managing hyperglycaemia in COVID-19 patients can be found here:

  https://abcd.care/sites/abcd.care/files/resources/COvID_ Hyper_v4.2.pdf

After-care needs

- A framework for assessing the early rehabilitation needs of post-COVID-19 ICU patients isnow available.
- 'Long COVID' is distinct from 'post-ICU syndrome', although the two may overlap and mayshare symptoms. The commonest features include fatigue, headache, upper respiratorytract symptoms and headache, although many others are reported (including, amongstothers, cognitive, psychological and neurological problems). Pathogenesis is not understood but is likely multifactorial, with a prolonged proinflammatory state reported in some. There should be early involvement of the multidisciplinary team to ensure that treatable causes of symptoms of long COVID (e.g. pulmonary [thromboembolic, inflammatory] or cardiac disease) and of those relating to ICU care (such tracheal stenosis, PTSD and more) are identified and treated.' NICE long-COVID Guideline.

7 Further guidance

Pregnancy

Women who are pregnant do not appear to be more likely to contract COVID-19 than the general population. Specific guidance for the management of COVID-19 in pregnancy can be found here.

Vaccine associated thrombocytopenia and thrombosis (VATT)

Guidance is available here