GUIDELINES ON THE PAEDIATRIC INTENSIVE CARE UNIT (PICU) MANAGEMENT OF CHILDREN WITH COVID-19

1. INTRODUCTION

- 1.1. SARS CoV-2 (which causes COVID-19 disease) can result in severe respiratory infection and multi-organ dysfunction in some patients, especially among older patients with comorbidities.
- 1.2. The symptoms of COVID-19 are similar in adults and children and can look like other common illnesses, like colds, strep throat, or allergies. The most common symptoms of COVID-19 in children are fever and cough, but children may have any of these signs or symptoms of COVID-19:
 - i. Fever or chills
 - ii. Cough
 - iii. Nasal congestion or runny nose
 - iv. New loss of taste or smell
 - v. Sore throat
 - vi. Shortness of breath or difficulty breathing
 - vii. Diarrhoea
 - viii. Nausea or vomiting
 - ix. Abdominal pain
 - x. Tiredness
 - xi. Headache
 - xii. Muscle or body aches
 - xiii. Poor appetite or poor feeding, especially in babies under 1 year old
- 1.3 Based on the scientific brief from World Health Organization (WHO) July 2020, the possible modes of transmission for SARS-CoV-2, including contact, droplet, airborne, fomite, faecal-oral, bloodborne, mother-to-child, and animal-to-human transmission. Infection with SARS-CoV-2 primarily causes respiratory illness ranging from mild disease to severe disease and death, and some people infected with the virus but never develop symptoms. COVID-19 has been declared as a pandemic by the WHO, and an excellent up-to-date information on the disease burden and the spread of the disease throughout the world is available on this website:

https://www.who.int/westernpacific/emergencies/covid-19

2. SCOPE AND PURPOSE

- 2.1. This document provides guidance and information on infection prevention and control (IPC) measures, recommended personal protective equipment (PPE) and critical care considerations in managing seriously ill children with COVID-19 disease. It can be adapted based on clinical judgement and local circumstances.
- 2.2. This guidance has been written for the Malaysian Ministry of Health (MOH) hospitals, but the same principles also can be applied to other settings where healthcare is delivered. It is issued jointly by the Malaysia Paediatric Intensive Care support group which includes MOH National Head of PICU Services, Hospital Tuanku Azizah Kuala Lumpur, Hospital Umum Sarawak, Hospital Raja Permaisuri Bainun Ipoh, Hospital Pulau Pinang, University Malaya Medical Centre and Faculty of Medicine UiTM.

3. DEFINITION

Case definitions for children with COVID-19 should follow Annex 1 Case Definition of COVID-19. Refer COVID-19 Management Guidelines in Malaysia http://covid-19.moh.gov.my/garis-panduan/garis-panduan/garis-panduan-kkm

4. CLINICAL DISEASE IN CHILDREN

- 4.1. As of 1 July 2021, data from WHO showed the number of new COVID-19 cases and deaths continued to rise to 181,930,736 cumulative cases and 3,945,832 deaths globally since the start of the pandemic. International data on confirmed COVID-19 disease in children shows less prevalence as compared to adults, contributing to between 1 5% of total case numbers. The true incidence of SARS-CoV-2 infection in children is probably under-represented due to lack of widespread testing and the prioritisation of testing for adults and those with severe illness. As countries move to community testing, the proportion of cases detected in children is expected to increase.
- 4.2. During the first wave of pandemic in February 2020, 2.4% of the 75,465 cases (confirmed and suspected) in China had occurred among persons younger than 19 years old. Out of this 0.9% was less than 10 years old and 1.3% was aged 10-19 years old.²⁰ An analysis from one large city in southern China suggested that, among all cases, the proportion of children younger than 15 years old may have increased from 2% to 13% from the early phase to later in the outbreak.

- 4.3. A publication by Lu et. al⁶ out of 171 children with confirmed COVID-19 reported, only three cases required intensive care unit admission and only one death was observed. Fever was present in 41.5% and other common signs and symptoms included cough and pharyngeal erythema. 15.8% were asymptomatic and no radiology feature of pneumonia. 12 patients have radiologic features of pneumonia but did not have any symptoms of infection. The most common radiologic finding was bilateral ground-glass opacity (32.7%). Lymphopenia was present in 6 patients (3.5%) in which lymphocyte count was less than 1.2 X 10⁹ per litre.
- 4.4. In late April 2020, reports from the United Kingdom surfaced describing a new hyperinflammatory disease that is temporally associated with SARS-CoV-2 infection. Since then, several other countries have also reported patients exhibiting similar features, and this phenomenon has subsequently been coined as Multisystem Inflammatory Syndrome in Children (MIS-C) or Paediatric Inflammatory Multisystem Syndrome temporally associated with SARS-CoV-2 (PIMS-TS)¹¹. A table comparing MISC-C to paediatric COVID-19 infection can be found at Appendix 1.

4.5. Multisystem Inflammatory Syndrome in Children (MIS-C) CDC Case Definition:

- a. An individual aged <21 years presenting with fever #,
 - laboratory evidence of inflammation ¤,
 - and evidence of clinically severe illness requiring hospitalization, with multisystem (>2) organ involvement (cardiac, renal, respiratory, haematologic, gastrointestinal, dermatologic or neurological);

AND

b. No alternative plausible diagnoses;

AND

c. Positive for current or recent SARS-CoV-2 infection by RT-PCR, serology, or antigen test; or COVID-19 exposure within the 4 weeks prior to the onset of symptoms

#Fever >38.0°C for ≥24 hours, or report of subjective fever lasting ≥24 hours

¤Including, but not limited to, one or more of the following: an elevated CRP, ESR, fibrinogen, procalcitonin, D-dimer, ferritin, LDH, or IL-6; elevated neutrophils; reduced lymphocytes; and low albumin

Some individuals may fulfil full or partial criteria for Kawasaki disease but should be considered to have MIS-C if they meet the case definition for MIS-C¹²

- 4.6 Possible vertical transmission was reported recently in newborns to COVID 19 mothers¹⁰. There are also reports on COVID 19 infection in neonates. However, the symptoms were mild, and the outcomes were favourable.
- 4.7 In Malaysia, as of November 17, 2020; the percentage of paediatric patients less than 18 years old with confirmed COVID 19 disease was 13.8% of total number of confirmed COVID-19 of the country (6585 out of 49730 total patients). Critically ill paediatric patient requiring PICU admission was 0.12%. The case fatality rate was 0.058%.

In summary, from the vast majority of available data were indicative of lower disease severity in children, and critical illness is extremely rare.

Figure 1. Suggested Clinical Classification of disease and timeline for COVID 19 infection in children.



4.8 Clinical Symptom	s and staging	of COVID-19 ¹⁸
----------------------	---------------	---------------------------

Clinical staging	Description
Stage 1 Asymptomatic	Laboratory confirmed COVID 19 infection but do not have any symptoms at all.
<i>Stage 2 Symptomatic, No pneumonia</i>	 Uncomplicated upper respiratory tract viral infection with nonspecific symptoms including: Fever, cough, sore throat, nasal congestion, malaise, headache, muscle pain Without signs of dehydration, sepsis, or shortness of breath
Stage 3 Symptomatic Pneumonia	 Non-severe pneumonia presenting with cough or difficulty breathing and tachypnoea Without signs of severe pneumonia
Stage 4 Symptomatic Pneumonia, requiring supplemental oxygen	 Adolescent: fever or suspected respiratory infection + one of the below: Respiratory rate (RR) > 30 breaths/min Severe respiratory distress Oxygen saturation,SpO₂ < 90% on room air Child: cough of difficulty breathing + one of the below: Central cyanosis SpO₂ < 90% Severe respiratory distress Clinical signs of pneumonia + inability to breast feed or drink, lethargy, convulsions
<i>Stage 5 Critically ill with Multiorgan failure</i>	Following the definition of Surviving Sepsis 2020 guideline and PALICC guideline

5. GOOD PRACTICE FOR PAEDIATRICIANS AND HEALTHCARE WORKERS

- 5.1. Only clinically essential meetings should occur.
- 5.2. Telephone and videoconferencing facilities should be used whenever possible in place of face-to-face meetings, between healthcare professionals and in conducting patient consultations when clinically necessary.

6. CRITICAL CARE CONSIDERATIONS:

- a. CRITERIA FOR PICU ADMISSION
- b. SEVERE ILLNESS (Category/ Clinical stage 4 or 5)*refer to Figure 1

c. CLINICAL

Child with cough or difficulty in breathing, plus at least one of the following:

- i. Central cyanosis or SpO₂ <90%
- ii. Severe respiratory distress (e.g. grunting, very severe chest indrawing)
- iii. Signs of pneumonia with general danger signs (inability to breastfeed or drink, lethargy or unconsciousness or seizures
- iv. In very young child: respiratory exhaustion or apnoea
- v. +/- Gastrointestinal symptoms

OR

Shock in children: any hypotension (SBP< 5th centile for age) with at least 2 of the following features:

- i. Altered mental status
- ii. Tachycardia or bradycardia (HR<90 bpm or >160 bpm for infants:
 o HR <70 bpm or >150bpm in children)
- iii. Prolonged capillary refill time OR
- iv. Vasodilation with bounding pulses; tachypnoea;
 - o mottled skin or presence of petechiae/purpura; increased lactate;
 - o decrease urine output or temperature instability.



d. LABORATORY

- i. Lymphopenia and progressive reduction of lymphocyte count (ALC) <1.5 x 10^{9} /L
- ii. High LDH and D-dimer
- iii. Acidosis pH <7.3 or PaCO₂ > 50mmHg
- iv. Serum lactate >2.0mmol/L

7. SEGREGATION/ COHORTING PATIENTS

7.1. PICU bed capacity:

- 7.1.1. The designated COVID-19 PICU or combined Adult-Paediatric-Neonatal COVID-19 ICU will be the designated ward for cohorting these patients.
- 7.1.2. Surge capacity will need to be arranged using any available space, such as High Dependency Wards, General Wards and Carers' Rooms, depending on the extent of clinical need.
- 7.1.3. Additional equipment, consumables and manpower will be required if expansion is implemented- this will be planned by the attending Consultant / Intensivist and PICU Ward Managers.

7.2. Suspected patients with COVID-19:

- 7.2.1. Place patient in a negative-pressure isolation room whenever available. In the absence of negative pressure, patients will be cared for in isolation rooms, and finally in a dedicated open ward if no rooms available.
- 7.2.2. In a limited resource setting, highest risk patients should be given priority for negative pressure rooms, followed by isolation rooms and cohort open wards.
- 7.2.3. Assigning a dedicated team of healthcare workers to care for patients in isolation/cohort rooms is an additional infection prevention and control measure. This should be implemented whenever there are sufficient levels of staff available (so as not to have a negative impact on non-affected patients' care).

- 7.2.4. For a suspected patient who has not yet been tested, perform an Oropharyngeal/ Nasopharyngeal swab or Nasopharyngeal Aspirate for COVID-19 PCR, and Respiratory Virus Panel as per national guidelines¹.
- 7.2.5. For intubated patients, a lower respiratory sample, e.g., Endotracheal Aspirate for COVID-19 PCR is preferred over upper respiratory sampling⁴.
- 7.2.6. For guidance on definition, sampling technique, notification etc please refer to the same document¹. Consult Paediatric Infectious Disease Specialist if any additional input needed.
- 7.2.7. For SARI patients, suggest to cohort the patients and screen for SARS Cov-2 virus. Please wear the appropriate PPE while handling the patients [Annex 35: Guidelines of Infection Control and Clinical Management of Severe Acute Respiratory Infections (SARI) / Pneumonia TRO COVID-19].
- 7.2.8. Respiratory considerations:

All patients requiring respiratory support with possibility of aerosol generating procedures (AGPs, refer to Appendix 2) are recommended to be placed in a negative pressure room whenever available.

- a. Oxygen therapy (nasal cannulae, face mask, high flow mask) with target SpO₂ of 92-96% is preferred in patients with no increased work of breathing but requiring O₂ to achieve targeted saturations.
- b. Humidified High Flow Nasal Cannulae (HFNC) can be considered with the additional measure of placing a 3-ply surgical face mask on top of the HFNC to reduce aerosol spread and reduce the risk of virus transmission⁸.
- c. Children who are receiving HFNC should be monitored closely for worsening respiratory distress¹⁴.
- d. Non-invasive ventilation (NIV) modes such as Continuous Positive Airway Pressure (CPAP) or Bilevel Positive Airway Pressure (BiPAP) is recommended as a first line of respiratory support if SpO2/FiO2 > 221 and < 264. To minimise the aerosol spread from NIV, the patient should be nursed in isolation ideally in a negative pressure room.

e. Proceed with early intubation if there are signs of worsening respiratory distress (SpO₂/FiO₂ > 221) or no improvement with HFNC or NIV within 60-90 minutes (maximum 2 hours).

7.3. Designated COVID-19 PICU:

- 7.3.1. **NO** visitors in the rooms.
- 7.3.2. For young stable children, ONE parent/carer may be required to care for them. Carer should be isolated together with child until discharge. Parent/carer should wear a 3-ply face mask. If both parent and child are positive, a mask is not required.
- 7.3.3. All staff must document their details for contact tracing when they first come into contact with a suspected/ confirmed COVID-19 patient using the standard MOH listing document.
- 7.3.4. Minimise the number of personnel and time spent in a COVID-19 patient's room. For stable patients, accompanying parents/carers can be taught to perform vital sign measurements and basic nursing care, to reduce the need for healthcare worker (HCW) contact and conserve PPE. If a chaperone is needed, he/she should be outside the Isolation Room chaperoning the doctor whenever presence in the room can be avoided.
- 7.3.5. Personal Protective Equipment (PPE): When entering a patient's room who is suspected, probable or confirmed to have COVID-19, staff should wear OT scrubs and the following PPE MUST be worn [refer Annex 8: The Infection Prevention and Control (IPC) Measures in Managing Patient Under Surveillance (PUS), Suspected, Probable or Confirmed COVID-19]:
 - a. N95 mask
 - b. Goggles or Face Shield
 - c. Shoe Covers
 - d. Isolation Gown (fluidrepellent long-sleeved gown)
 - e. Plastic Apron
 - f. Head Cover
 - g. Hand hygiene

Notes:

Fit testing is required. N95 masks should be available in the PICU. If impossible to obtain N95 mask, 3-ply face mask should be used.

Ministry of Health Malaysia Updated on 12 July 2021 Proper donning and doffing technique with an **observer** to ensure compliance- follow the national guidance¹.

Change to new isolation gown and new outer gloves when transporting patient to a new location.

7.3.6. Equipment (i.e., ultrasound, video laryngoscope, etc):

- a. Drape non-essential parts of equipment with waterproof drapes to minimise exposure.
- b. All equipment brought into the patient's room must remain there and shall not be used until appropriately disinfected.

7.3.7. **Respiratory considerations:**

- a. All patients requiring respiratory support with possibility of aerosol generating procedures are recommended to be placed in a negative pressure room whenever available.
- b. Oxygen therapy (nasal cannulae, face mask, high flow mask) with target SpO₂ of 92-96% is preferred in patients with no increased work of breathing but requiring O₂ to achieve targeted saturations.
- c. HFNC can be considered with the additional measure of placing a 3-ply surgical face mask on top of the HFNC to reduce aerosol spread and reduce the risk of virus transmission⁸.
- d. Children who are receiving HFNC should be monitored closely for worsening respiratory distress¹⁴.
- e. Non-invasive ventilation (NIV) modes such as Continuous Positive Airway Pressure (CPAP) or Bilevel Positive Airway Pressure (BiPAP) is recommended as a first line of respiratory support if SpO₂/FiO₂ > 221 and < 264. To minimise the aerosol spread from NIV, adequate interface seal should be assured (e.g., non-vented oronasal or full-face mask). For non-vented mask interface is to be used with dual-limb ventilator circuits. Bacterial/viral filters (HEPA filter) or Heat Moist Exchange Filter (HMEF) must be placed at least on the expiratory limb of the patient circuit for non-invasive mechanical ventilation ¹³⁻¹⁴.

- f. Proceed with early intubation if there are signs of worsening respiratory distress (SpO₂/FiO₂ > 221) or no improvement with HFNC or NIV within 60-90 minutes (maximum 2 hours). However, higher intubation thresholds may be reasonable in proven COVID-19 hypoxic respiratory failure with low work of breathing and/or no pathologic hyperventilation ¹³⁻¹⁴.
- g. Use disposable stethoscopes if available, and clean earpiece thoroughly with alcohol swabs before use.
- h. Metered Dose Inhaler (MDI) should be used as an alternative to flow driven nebulisation whenever possible to minimise aerosol generation.

7.3.8. Monitoring

- a. Patients need to be monitored for clinical wellbeing and vital signs as per required.
- b. Paediatric Early Warning Score Chart (PEWS) charting (Appendix 3) is recommended to ensure early recognition of patient deterioration and steps need to be taken by the attending HCW.

7.4. INTUBATION PROTOCOL:

Intubation should be done safely with the aim of **minimising aerosolisation of virus** (prevent spread), **maximising first-pass success** (patient safety) and **reducing personnel exposure** (limit contamination). The use of a checklist and closed loop communication are essential. Simulation training should be done on a regular basis.

- 7.4.1. Early elective tracheal intubation is preferred with the goal of avoiding emergency intubations.
- 7.4.2. Briefing of the strict protocolised intubation process, identification of roles and confirmation of airway plan should be done prior to entering the room.
- 7.4.3. Staffing:
 - a. Person to intubate the most experienced staff on duty (senior registrar/paediatrician or intensivist).

- b. If the patient is deemed at risk for difficult intubation, and in centres without Paediatric Intensivists, an experienced Anaesthesiologist and/or ENT Specialist should be called as needed.
- c. Limit clinicians in room for intubation: Maximum 3 people inside the room. Additional staff may be gowned in full PPE and waiting outside to help if needed, depending on the patient's condition.
- 7.4.4. Intubation and extubation should be performed in a **negative pressure room** depending on availability. An isolation room is a less favourable option.
- 7.4.5. Wear enhanced droplet personal protective equipment (PPE) as described above, and have a colleague check adequacy of PPE whenever possible.
- 7.4.6. **Powered Air Purifying Respirators (PAPRs)** will be available either in the PICU, Emergency Department, Operation theatre, Adult ICU or Forensic Department if needed. PAPR should be used if available, ideally by all personnel in the room during intubation. If limited PAPR available, priority will be for the staff performing endotracheal intubation.
- 7.4.7. Video laryngoscope is preferred (if available) for intubation to minimize the risk of contracting the infection for the person performing the intubation.
- 7.4.8. Equipment/Supplies:
 - a. Use dedicated COVID Video Laryngoscope (if available). If no video laryngoscope, use disposable laryngoscope.
 - b. Use the dedicated COVID Emergency Bag (Appendix 4) for airway supplies, but **LEAVE BAG OUTSIDE OF PATIENT ROOM**.
 - c. Use disposable equipment whenever possible and wipe down all other equipment with disinfectant.
 - d. Drape non-essential parts of carts (i.e. ultrasound, video laryngoscopes) when in the room.

7.4.9. Procedures:

- a. Leave personal belongings outside.
- b. Consider additional personnel in full PPE outside the patient room in anticipated difficulty with securing the airway or need for complex airway manoeuvre.
- c. Preparation:
 - i. Refer to Pre-Intubation Checklist (Appendix 5).
 - ii. Equipment at bedside: Use COVID video laryngoscope if available, cuffed ETT (age appropriate) with stylet. Prepare personnel, patient, equipment and medication as per checklist.
 - iii. Induction agents: Use IV Fentanyl 1mcg/kg + Ketamine 1mg/kg + Rocuronium 1mg/kg unless contraindicated (rapid-acting agents with minimal hypotensive effects preferred).
 *For those who are not familiar with Rocuronium use, Suxamethonium 1-2mg/kg is an option for patients with stable haemodynamics with no contraindications.
 - iv. Avoid atomised local anaesthetic and nebulised medication administration.
- d. Modified Rapid Sequence Intubation (RSI) is recommended, without cricoid pressure.
- e. Minimise suctioning or other airway manipulation.
- f. Use aerosol box to minimize aerosol dissemination during intubation.
- g. If aerosol box is not available, use plastic cover over the face area and place appropriately sized mask + HMEF + Self-inflating bag/ T-piece with flow running at 6-10L/min as shown in the picture (Appendix 6).
- h. **Pre-oxygenation for 3-5 minutes via:** (option of 3 methods)
 - i. **Rebreathing face mask** with 100% oxygen at flow rate of 10-15L/min (*for non-experts*).

ii. **Flow-inflating bag (Ayre's T-piece)** attached to an HMEF and a tight-fitting mask with 100% oxygen at flow rate 6-10L/min *(for experts).*

HFNC with FiO₂ of 100% (if patient had already been using HFNC) and proceed with apnoeic oxygenation. Apply a 3ply mask on top of nasal canulae to reduce aerosol spread. Switch off the machine during intubation *(for experts).*

- i. Avoid bag-mask ventilation unless patient desaturated. If needed, always use an HMEF at the end of the bag. If possible, use a two-handed technique to maintain seal (2-person technique) (Appendix 6).
- j. Appropriate induction and paralysing agents need to be used to avoid patient coughing and struggling during intubation. Allow adequate time for onset of paralysis prior to attempting intubation (at least 1 minute for Rocuronium).
- k. Proceed with intubation if there are signs of respiratory failure.
- I. If you have a clear view of ETT passing through vocal cords, and the ventilator is set up with ETCO₂ monitoring (if available), consider connecting directly to ventilator (to minimise disconnects).
- m. Change connector of ETT and connect closed suction system and HMEF as in the diagram, before connecting to ventilator (Appendix 7).
- n. Look for chest rise, improving saturations and confirm CO₂ tracing with the ventilator.
- o. Cover the disposable laryngoscope blade with outer glove immediately after confirming placement of ETT before discard.
- p. In the event of failed intubation, consider inserting a Laryngeal Mask Airway.
- q. Use a Paediatric HMEF between ETT and Y-piece or expiratory limb of ventilator circuit. Make sure CO₂ sampling line is post-filter (Appendix 7).

r. **IF THE HEATED ACTIVE HUMIDIFIER** (e.g., heated plate humidifier) is used. No HME require at the end of the endotracheal tube but instead a HEPA filter need to be placed at the end of the expiratory limb before the air is dispersed to surrounding. The HEPA filter need to be changed if it soaked with water. The changing of the HEPA filter require the medical staff to be suited with full PPE and the ventilator should be put on Standby until the new HEPA filter is safely attached.

7.4.10. Post-Procedure

- a. All disposable airway equipment should be gently placed in a biohazard bag and sealed after intubation and outer glove of hand that touches ETT should be discarded as well.
- b. Adhere to doffing procedures with an observer, including hand washing.
- c. Follow steps according to this video (minor modifications may be necessary depending on local setting): need new updated video <u>https://www.youtube.com/watch?v=yytVJzTgV_c</u>
- d. All equipment brought into the patient's room must remain there and will be unusable until appropriately disinfected.

7.4.11. Management:

a. General

- i. For now, care is mainly supportive in nature.
- ii. Most of the experience managing critically ill COVID-19 paediatric patients use trial medications with limited evidence.

b. Ventilation

- i. Give supplemental oxygen immediately to patients with SARI and respiratory distress, hypoxaemia or shock.
- ii. The use of moderately elevated PEEP, controlled tidal volumes (4-8ml/kg), and high FiO2 (0.6-0.7) has been used in critically ill paediatric patients.

- iii. Early prone positioning for at least 12-16 hours a day has shown beneficial results, and should be considered in persistently hypoxaemic children.
- iv. Ventilation strategy should be implemented in accordance to current PALICC PARDS guidelines² (Appendix 8).
- v. When managing an invasively ventilated child with suspected or confirmed COVID-19, early consultation with a Paediatric Intensivist or Consultant Paediatrician with PICU experience is recommended.
- vi. Circuit disconnection should be avoided as far as possible. If disconnection is necessary, the circuit should be disconnected proximal to the HMEF, to reduce risk of virus transmission.
- vii. When changing the HMEF, the ventilator should be put on Standby and the ETT carefully clamped until the new HMEF is safely attached.

c. Circulation

- i. For children in shock, a targeted fluid strategy with isotonic solutions with the guidance of point of care ultrasound is preferred.
- ii. If inotropes are required for septic shock, Adrenaline and Noradrenaline are the inotropes and vasopressors of choice.
- iii. In the presence of hypoperfusion and significant cardiac dysfunction noted during ECHO, after fluid resuscitation and initiation of Noradrenaline and Adrenaline, we suggest adding dobutamine or milrinone.
- iv. Steroids can be considered in catecholamine-resistant shock or suspected/confirmed adrenal insufficiency¹⁹.

d. Fluids and Medication

i. A restrictive fluid strategy should be used in euvolaemic children, with fluid restriction to 2/3rd maintenance and avoidance of excessive positive balance. Fluid overload may worsen oxygenation especially in settings with limited availability of mechanical ventilation.

- ii. Early enteral nutrition is preferred over intravenous fluids whenever possible.
- iii. As the evidence base for COVID-19 and MIS-C treatment and care management is evolving rapidly, medication used should be based on the individual clinical circumstances of their own patients and the resources available to the treating clinicians.
- iv. The therapies offered for consideration are hypothesized to be effective against severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) infection or its sequelae, but most of the evidence on treatment are still evolving.
- v. Steroids were thought to be not beneficial in improving ventilation and may also increase the duration of viral shedding. Therefore, the use of steroid in COVID-19 has been used on a case-to-case basis.
- vi. However, the recent UK RECOVERY Trial provides evidence of the use IV Dexamethasone (6mg OD for up to up to 10 days) improved 28 days mortality in patients who needed respiratory support in COVID-19 infection. Extrapolating from the RECOVERY study, IV Dexamethasone 0.1mg 0.15 mg/kg/day (max 6mg) for up to 10 days is also used for children with respiratory failure (SARI) who require O₂ or mechanical ventilation in many centres worldwide. The steroid can be discontinued earlier for patient who improves rapidly and no requires O2 supplement. The consensus from the world experts who shared about their experience in treating paediatric COVID-19 in the recent Asia Pacific Intensive Care Symposium (APICS) 2020 also advocates to use the same strategy^{12,16,18}.
- vii. Treatment recommendation for MIS-C is mainly supportive, however, antiviral therapy (such as Remdesivir D1: 5mg/kg/dose, D2-10; 2.5mg/kg/day; if PCR positive for SARS-CoV-2) or immunotherapy (IVIG 1-2 gm/kg/dose), or both are found to be beneficial. Steroids (prednisolone or methyl prednisolone) of 1-2 mg/lg/day in 2 dividedoses up to 10 days is also suggested ^{12,16-19}.
- viii. Immunomodulatory treatment options for example tocilizumab (anti IL-6 monoclonal antibody) or anakinra (recombinant antagonist of IL-1 receptor) can be further discussed with Paediatric Infectious Disease Specialist or Paediatric Intensivist.

- ix. Any patient presented with Kawasaki-like disease, should be screened for COVID 19 (PCR and serology test).
- x. Consult Paediatric Infectious Disease specialists and national guidance for role of antiviral therapies and novel therapies.

The treatment regime as suggested in the latest MOH guideline (<u>http://covid-19.moh.gov.my/garis-panduan/garis-panduan-kkm</u>). Kindly discuss with ID Consultant/ Paediatrician for specific treatment. Dose range as per drug dosage recommended for children.

e. Sepsis

- i. If sepsis is clinically suspected or child requires mechanical ventilation, early empirical antibiotic therapy should be considered within **ONE hour** of identification of sepsis or respiratory failure, and appropriate cultures taken. Assess for de-escalation daily. Empiric therapy should be deescalated based on the microbiology results and clinical judgement³.
- ii. Management of sepsis and septic shock should be done in accordance with the current Surviving Sepsis Campaign Paediatric guidance³. See weblink in the 'References' section for the full guidance.

f. Transfer of Patients

- i. Avoid disconnect circuit during transfer.
- ii. Maintain HMEF during transport. Use Isopod for transfer depending on availability.
- iii. Consider using PICU ventilator by transporting patient to Operating Theatre or other destination. Use planned routes that minimize exposure.
- iv. Consider paralysis with rocuronium infusion for transport.
- v. HCWs transporting patients must wear appropriate PPE.
- vi. Assign a dedicated transporter in PPE for opening doors, pushing elevator buttons without touching the patient
- vii. Remove PPE in anteroom upon arrival at destination (i.e., OT or PICU)

g. Extubation

- i. Wear appropriate PPE in a negative pressure room if available [refer Annex 8: The Infection Prevention and Control (IPC) Measures in Managing Patient Under Surveillance (PUS), Suspected, Probable or Confirmed COVID-19].
- ii. You may place low flow nasal cannula oxygen prior to removal of ETT to ensure good oxygenation. A face mask oxygen can be applied post extubation to enhance oxygenation. Once patient is stable, apply a 3ply surgical mask on top of the oxygen support.
- iii. Dispose of ETT gently in biohazard bag and seal.

8. CARDIAC ARREST / CPR:

Special Considerations in CPR for Suspected or Confirmed COVID-19 Children:

8.1. Pre-Arrest

- 8.1.1. Address advance directives and goals of care with all suspected and confirmed COVID-19 patients on admission, and with any change / deterioration in clinical condition.
- 8.1.2. Closely monitor for any signs of deterioration, to avoid the need for emergent intubations and resuscitation, and allow more time for preparation.
- 8.1.3. Patients at risk of cardiac arrest should be electively moved to a negative pressure isolation room, if available, to minimize risk of exposure to rescuers during resuscitation.
- 8.1.4. Take patient risk factors for survival into account, e.g., comorbidities and severity of illness.
- 8.1.5. If resuscitation is futile or inappropriate, provide comfort care.

8.2. Measures to Reduce Provider Exposure

8.2.1. Don PPE before entering the room. Ensure protection against both airborne and droplet particles (full PPE for Aerosol-Generating Procedure). **DO NOT ATTEMPT TO RESUSCITATE WITHOUT ADEQUATE PPE.**

- 8.2.2. Limit personnel to only those essential for patient care.
- 8.2.3. Communicate COVID-19 status clearly to all team members and new personnel attending the child.

8.3. Prioritise oxygenation and ventilation strategies with lower aerosolisation risk

- 8.3.1. Use a viral filter or HMEF, if available, for all ventilation.
- 8.3.2. Intubate according to the intubation protocol.
- 8.3.3. Pause chest compressions during intubation.

8.4. Ventilator Settings During CPR

- 8.4.1. If child is intubated at the time of cardiac arrest, consider leaving child on ventilator with viral filter or HMEF to maintain closed circuit and prevent aerosolization.
- 8.4.2. Suggested ventilator settings:
 - a. Increase FiO₂ to 1.0.
 - b. Change to Pressure Control Ventilation (Assist Control) and adjust to achieve adequate chest rise and tidal volume of 6ml/kg (4-6ml/kg in neonates).
 - c. Turn off ventilator trigger to avoid auto-triggering and reduce risk of hyperventilation and air trapping.
 - d. Adjust respiratory rate to 10 for paediatrics and 30 for neonates.
 - e. Adjust PEEP to achieve adequate lung volumes without compromising venous return.
 - f. Adjust alarms to avoid alarm fatigue.
 - g. Ensure ETT and ventilator circuit are secure, to avoid unplanned extubation or disconnection.
 - h. If return of spontaneous circulation is achieved, change ventilator settings to meet the patient's needs, and proceed with post-resuscitation care as per APLS guidance.

9. EXTRACORPOREAL ORGAN SUPPORT

- 9.1. Adult guidance suggests use of veno-venous ECMO in adults with refractory hypoxaemic respiratory failure despite optimizing ventilation, lung recruitment and proning. There is upcoming data on the role of ECMO in children, and it is unlikely to be an option in most MOH centres due to lack of availability.
- 9.2. There is no published data on the role of CRRT or TPE in the management of COVID-19 in children. Risks and benefits must be considered on an individual basis and the advice of an experienced Paediatric Intensivist or Paediatric Nephrologist should be sought.

10. DEATH

In the event of a death from COVID-19, a paediatrician / intensivist must notify Forensic services and the CPRC as per national guidelines¹.

M. Ahmed et al. / EClinicalMedicine 26 (2020) 100527

TABLE 6

Differences between children with MIS-C and COVID-19.

	MIS-C	COVID-19
CRUTRAL BIFORMATICS	MID-C	COAID-12
GENERAL INFORMATION	662	7780
Dates included	January 1, 2020 - July 25, 2020	December 1, 2019 - May 14, 2020
Number of studies	39	131
Data source	Multi-national	Multi-national
DEMOGRAPHICS		
Age	9.3 ± 0.5	8.9 ± 0.5
mean ± SD	[n = 528]	[n = 4517]
Male gender%	52.3 [n = 662]	55.6 [n = 4640]
Comorbidity%	48.0	35.6
	[<i>n</i> = 558]	[<i>n</i> = 655]
LABORATORY MARKERS Complete blood count		
$mean \pm SD$	122.00	71.00
Leukocytes (10 ³ /µL)	15.2 ± 0.8 (n = 205)	1.1 ± 0.3
Neutrophil (%)	80.7 ± 7.8	44.4 ± 2.7
	[<i>n</i> = 276]	[n = 512]
Lymphocyte (%)	9.8 ± 0.8	39.9 ± 2.0
Hanna alakin (a/42)	[n = 306]	[n = 672]
Hemoglobin (g/dL)	10.2 ± 0.8 (n = 211)	12.9 ± 0.9 [n = 211]
Platelets $(10^3/\mu L)$	215 ± 11.4	273 ± 8.5
	[<i>n</i> = 394]	[n = 115]
Liver and renal function mean ± SD	50.0 + 4.1	105 + 10
manine transaminase (U/L)	55.8 ± 4.1 [n = 226]	[n = 656]
Aspartate aminotransferase (U/L)	57.3 ± 5.3	29.4 ± 2.2
	[<i>n</i> = 145]	[<i>n</i> = 469]
Creatinine (mg/dL)	0.9 ± 0.1	0.3 ± 0.0
Inflammatory markers mean ± SD	[n = 198].	[ii - 443]
C-reactive protein (mg/L)	160 ± 7.0	9.4 ± 0.5
Provide (a start)	[n = 439]	[n = 643]
Ferritin (ng/mL)	977 ± 55.8 [n = 303]	51.6 ± 13.2
Procalcitonin (ng/mL)	30.5 ± 2.1	0.25 ± 0.0
(-0//	[n = 312]	[<i>n</i> = 259]
Lactate dehydrogenase (U/L)	478 ± 45.4	277 ± 25.9
Creating kinase (U/U)	[n = 300]	[n = 404]
Creatine kinase (U/L)	155 ± 40.0 [n = 49]	[n = 193]
Interleukin-6 (pg/mL)	184 ± 15.6	26.1 ± 3.7
	[<i>n</i> = 257]	[<i>n</i> = 92]
Coagulation		
$mean \pm SD$ D-dimer(mg/L)	35 ± 0.4	07+01
o anner (mg/c)	[n = 349]	[n = 285]
Fibrinogen (mg/dL)	499 ± 58.3	224 ± 1.3
	[<i>n</i> = 267]	[<i>n</i> = 179]
Erythrocyte sedimentation rate (mm/h)	59.4 ± 9.1 [n = 191]	14.1 ± 3.4 [n = 134]
	[0-191]	to - real
OUTCOME		
Length of hospitalization mean \pm SD	7.9 ± 0.6	11.6 ± 0.3
Intensive care unit admission	470 (71.0)	116 (3.3)
In (%)	[<i>n</i> = 662]	[<i>n</i> = 3564]
Shock	398 (60.1)	19 (0.24)
In (%)	[n = 662]	[n = 7780]
Mechanical ventilation	147 (22.2) [n = 662]	42(0.54) [n = 7780]
Aneurysm	47 (7.1)	[11 - 7700]
In (%)	[n = 662]	_
Death	11 (1.7)	7 (0.09)
In (%)	[<i>n</i> = 662]	[<i>n</i> = 7780]
TREATMENT		
IVIG	506 (76.4)	19 (3.1)
In (%)	[n = 662]	[n = 614]
Lorticosteroid	347 (52.5) [n = 662]	25(4.1) [n = 614]
iii (/0)	[n = 002]	lu - oral

Data presented as mean \pm standard deviation (SD). Brackets under data signify sample size for that variable. Refer to reference Hoang et al. [Ref. 24] for data source for COVID-19. COVID-19-coronavirus disease 2019, IVIG-intravenous immunoglobulin, MIS-C-multisystem inflammatory syndrome in children.

Common Aerosol-Generating Events

- High-flow nasal cannula
- Continuous positive airway pressure or non-invasive ventilation without an adequate seal
- Bag-mask ventilation
- Intubation
- Any advertent or inadvertent circuit or endotracheal tube disconnection
- Tracheal suction (without a closed system)
- Extubation
- Coughing/sneezing or any procedure inducing this
- Chest physiotherapy
- Delivery of nebulized medications (unless via closed circuit)
- Cardiopulmonary resuscitation (prior to intubation)

Age	PEWS SCORE	3	2	1	0	1	2	3	Score
	RR	<15	<20)	30 - 60	>60	>70	>80	
	RE				normal	mild	mod	severe	
	0 ₂ T			≤2L			>2L		
S	SpO ₂	≤85	86 – 89	90 – 93	≥94				
nth	Systolic BP	<45	<50	<60	60 - 80	>80	>100	>110	
mc	HR	<80	<90	<110	110 - 150	>150	>180	>190	
ε Γ	CRT			>2 sec	\leq 2 sec				
0	AVPU				А	V		P/U	
	RR	<15		<30	30 - 50	>50	>60	>70	
	RE				normal	mild	mod	severe	
	0 ₂ T			≤2L			>2L		
hs	SpO ₂	≦85	86 – 89	90 – 93	≥94				
ont	Systolic BP	<60	<70	<80	80 - 100	>100	>110	>120	
ŭ	HR	<60	70-100	100-110	110 - 150	>150	>170	>180	
- 11	CRT			>2 sec	\leq 2 sec				
4 -	AVPU				А	V		P/U	
	RR	<15		<20	20 - 40	>40	>50	>60	
	RE				normal	mild	mod	severe	
	0 ₂ T			≤2L			>2L		
10	Sp0 ₂	≦85	86 – 89	90 – 93	≥94				
ears	Systolic BP	<70	<80	<90	90-110	>110	>120	>130	
4 ye	HR	<60	60-80	<80	80 - 130	>130	>150	>170	
1	CRT			>2 sec	≤2 sec				
	AVPU				А	V		P/U	
	RR	<10		<15	15 - 30	>30	>40	>50	
	RE				normal	mild	mod	severe	
	0 ₂ T			≤2L			>2L		
Ņ	SpO ₂	≤85	86 – 89	90 – 93	≥94				
ear	Systolic BP	<80		<90	90 - 120	>120	>130	>140	
11 y	HR	<50	50-70	<70	70 - 110	>110	>130	>150	
I	CRT			>2 sec	≤2 sec				
L)	AVPU				А	V		P/U	
	RR	<10		<15	15 – 20	>20	>25	>30	
	RE				normal	mild	mod	severe	
	0 ₂ T			≤2L			>2L		
	SpO ₂	≤85	86 – 89	90 – 93	≥94				
ars	Systolic BP	<90		<110	110 - 120	>120	>130	>150	
+ ye	HR	<40	40-60	<60	60 - 100	>100	>120	>140	
12-	CRT			>2 sec	≤2 sec				
	AVPU				А	V		P/U	

Example of Paediatric Early Warning Score

Anis Zainal&See Jing Kai 2017. Hospital Selayang. Locally adapted from Royal College of Ireland.

Checklist for COVID Emergency Bag (for resuscitation outside PICU)

No.	Item	Tick		
1	2 full sets of PPEs			
2	Oropharyngeal airways- various sizes			
3	In-line suction catheter and ETT connector			
4	Yankauer suction device			
5	Suction catheters			
6	Disposable Laryngoscope + blades			
7	Handheld Video laryngoscope (if available)			
8	Stethoscope			
9	ET tubes (cuffed preferred)-various sizes			
10	ETT Stylet			
11	Disposable Laryngeal mask airway- various sizes			
12	Syringes			
13	Nasogastric tube			
14	ETT tape + Scissors			
15	Self-inflating Bag			
16	Face Mask- various sizes			
17	HME/Bacterial+Viral Filter (HMEF)			
18	IV Cannulae and IV infusion tubing			
19	Alcohol swabs			
20	Drugs for Intubation (Fentanyl + Rocuronium + Ketamine)			
21	Adrenaline			

COVID-19 Pre-Intubation Checklist



PICU HTA 20/3/ 2020, updated 20 December 2020

Allocate roles (intubator,

assistant, medications)

Check equipments,

medications, fluid

Intubation Steps in COVID-19 Patients – Pictorial Guide

Intubation Steps in COVID 19 patients



Take respiratory samples (BAL/ Tracheal Aspirate)

Continue with procedures needed (CVL)

Doffing PPE

Address contingency plan for emergency (person to call)

Ensure 2 patent IV lines

Preoxygenate with 100% oxygen via non-rebreathing mask for 5min

Optimise patient condition (position, fluid, =/inotropes)

suction and viral filter

Give medication + intubate

Video laryngoscope if available

Establish ventilation

Setup of Ventilator Tubing with HMEF for a Transport Ventilator and NIV





Use of a Plastic Sheet to Cover Patient's Face during Bag Mask Ventilation, and 2-Hand Technique to Hold Face Mask. Use aerosol box whenever available.





Ministry of Health Malaysia Updated on 12 July 2021

Photo: Setup of Self-Inflating Bag, ETT and Ventilator with ETCO₂ sampling line, HME/Filter and Closed Suction System

Note that End-tidal CO2 sampling line is connected **PROXIMAL to the HME/Filter**, to avoid virus contamination of the sampling line.



Ministry of Health Malaysia Updated on 12 July 2021

Please follow the web link below for the Paediatric Acute Respiratory Distress Syndrome Consensus Recommendations from the Paediatric Acute Lung Injury Consensus Conference https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5253180/

Age	Exclude patients with peri-natal related lung disease					
Timing	Within 7 days of known clinical insult	Within 7 days of known clinical insult				
Origin of Edema	Respiratory failure not fully explained b	y cardiac failure	or fluid overload			
Chest Imaging	Chest imaging findings of new infiltrate(s) consistent with acute pulmonary parenchymal disease					
	Non Invasive mechanical ventilation Invasive mechanical ventilation					
	PARDS (No severity stratification)	Mild	Moderate	Severe		
Oxygenation	Full face-mask bi-level ventilation or CPAP ≥ 5 cm H ₂ 0 ²	8 ≤ OI < 16	OI ≥ 16			
	PF ratio \leq 300 SF ratio \leq 264 ¹	5 ≤ OSI < 7.5 ¹	7.5 ≤ OSI < 12.3 ¹	OSI ≥ 12.3 ¹		
	Special Popula	tions				
Cyanotic Heart Disease	Standard Criteria above for age, timing, origin of edema and chest imaging with an acute deterioration in oxygenation not explained by underlying cardiac disease. ³					
Chronic Lung Disease	Standard Criteria above for age, timing, and origin of edema with chest imaging consistent with new infiltrate and acute deterioration in oxygenation from baseline which meet oxygenation criteria above. ³					
Left Ventricular dysfunction	Standard Criteria for age, timing and origin of edema with chest imaging changes consistent with new infiltrate and acute deterioration in oxygenation which meet criteria above not explained by left ventricular dysfunction.					

Table 1: Definition	of Paediatric ARDS
---------------------	--------------------

Table 2: Patients at Risk of PARDS

Age	Exclude patients with peri-natal related lung disease			
Timing	Within 7 days of known clinical insult			
Origin of Edema	Respiratory failure not fully explained by cardiac failure or fluid overload			
Chest Imaging	Chest imaging findings of new infiltrate(s) consistent with acute pulmonary parenchymal disease			
Oxygenation	Non Invasive	e mechanical ventilation	Invasive mechanical Ventilation	
	Nasal mask CPAP or BiPAP	Oxygen via mask, nasal cannula or High Flow	Oxygen supplementation to maintain $SpO_2 \ge 88\%$ but $OI < 4$ or	
	FiO ₂ ≥ 40% to attain SpO ₂ 88- 97%	SpO ₂ 88-97% with oxygen supplementation at minimum flow ² : < 1 year: 2 L/min 1 – 5 years: 4 L/min 5 – 10 years: 6 L/min >10 years: 8 L/min	USI < 5"	

References

- 1. Guidelines COVID -19 Management in Malaysia No 05/2020 (EdisiKelima) http://www.moh.gov.my/index.php/pages/view/2019-ncov-wuhan-guidelines
- Pediatric Acute Respiratory Distress Syndrome: Consensus Recommendations from the Pediatric Acute Lung Injury Consensus Conference PediatrCrit Care Med. 2015 Jun;16(5):428-39. doi: 10.1097/PCC.000000000000350.
- Weiss SL, Peters MJ et al. Surviving Sepsis Campaign International Guidelines for the Management of Septic Shock and Sepsis-Associated Organ Dysfunction in Children. Pediatric Critical Care Medicine: February 2020 - Volume 21 - Issue 2 - p e52-e106doi:10.1097/PCC.00000000002198 https://journals.lww.com/pccmjournal/Fulltext/2020/02000/Surviving_Sepsis_Campa

ign_International_Guidelines.20.aspx 4. Alhazzani W, Moller MH et al. Surviving Sepsis Campaign: Guidelines on the

- Management of Critically III Adults with Coronavirus Disease 2019 (COVID-19). ESICM / SCCM, 2020. Unedited accepted proof. https://www.esicm.org/wpcontent/uploads/2020/03/SSC-COVID19-GUIDELINES.pdf
- 5. WHO Interim Guidance: Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected. 13 March 2020. WHO reference number: WHO/2019-nCoV/Clinical/2020.4.
- 6. Xiaoxia Lu, Liqiong Zhang, Hui Du. SARS-CoV-2 Infection in Children. NEJMhttps://www.nejm.org/doi/full/10.1056/NEJMc2005073
- Dong Y, Mo X, Hu Y, et al. Epidemiological characteristics of 2143 pediatric patients with 2019 coronavirus disease in China. *Pediatrics*. 2020; doi: 10.1542/peds.2020-0702
- 8. Liang Ting Bo. Handbook of COVID-19 Prevention and Treatment. Zhejiang University School of Medicine. March 2020.
- 9. Kotoda M. et al. Assessment for the potential pathogen dispersal during high flow nasal therapy. J Hospital Infect. 2019; S0195-6701(19)3047-7.
- 10. Lingkong Zeng, Shiwen Xia et al. Neonatal Early-Onset Infection With SARS-CoV-2 in 33 Neonates Born to Mothers With COVID-19 in Wuhan, China. JAMA Pediatrics. Doi:10.1001/jamapediatrics.2020.0878.
- 11. Ahmed et al. Multisystem inflammatory syndrome in children: A systemic review EclinicalMedicine Sep 26 (2020) 100527 . doi.org/10.1016/j.eclinm.2020.100527
- 12. Boston Children's Hospital COVID-19 Treatment: Internal Guidance. Version 9/11/20
- Rimensburger PC et al. Caring for Critically III Children With Suspected or Proven Coronavirus Disease 2019 Infection: Recommendations by the Scientific Sections' Collaborative of the European Society of Pediatric and Neonatal Intensive Care. Pediatr Crit Care Med. 2020 Sep 29.
- 14. Kneyber MCJ et al. Practice recommendations for the management of children with suspected or proven COVID-19 infections from the Paediatric Mechanical Ventilation

Consensus Conference (PEMVECC) and the section Respiratory Failure from the European Society for Paediatric and Neonatal Intensive Care (ESPNIC). A consensus statements.

- 15. Royal College of Paediatrics and Child Health. Guidance: Paediatric multisystem inflammatory syndrome temporally associated with COVID-19. 2020.
- 16. Dexamethasone in Hospitalized Patients with Covid-19 Preliminary Report. Thye RECOVERY Collaboratory Group.
- 17. Li Jian et al. COVID-19 and multisystem inflammatory syndrome in children and adolescents. *Lancet Infect Dis* 2020; 20: e276–88.
- 18. Children's Hospital of The Kings Daughters Covid-19 Treatment Guideline-08-2020
- 19. COVID Disease Steroid Use in Patients with COVID-19 Disease Clinical Pathway: All Settings | Children's Hospital of Philadelphia (10/26/2020)
- Wu Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) Outbreak in China. JAMA. 2020;323(13):1239. <u>https://doi.org/10.1001/jama.2020.2648</u>