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In this session, I will be talking about the management of children with COVID 19 having moderate to severe illness.

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This presentation will be covering the following aspects

- Case definitions of moderate and severe COVID illness
- Indications for hospital and PICU admission
- General principles of management as recommended by WHO
- How to initiate and monitor – oxygen therapy, HFNC, NIV
- Case definition of critical illness
- How and when to initiate invasive ventilation, explaining the procedure of intubation & general care of ventilated children
- Management of shock
- Supportive measures & prevention of complications in critically ill children

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As per WHO children with following features categorized into moderate illness

- Clinical signs of pneumonia (fever, cough, fast breathing, mild chest retractions)
- Child with no signs of severe pneumonia and $SpO_2 > 90\%$
- Fast breathing (in breaths/min): < 2 months: ≥ 60 ;
2–11 months: ≥ 50 ;
1–5 years: ≥ 40 ;

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- Children with clinical signs of pneumonia (cough or difficulty in breathing) + at least one of the following:
 - Central cyanosis or $SpO_2 < 90\%$
 - Severe respiratory distress (e.g. fast breathing, grunting, very severe chest indrawing)
 - General danger signs: Inability to breastfeed or drink, lethargy or unconsciousness, or convulsions

- Fast breathing (in breaths/min): < 2 months: ≥ 60 ;
2–11 months: ≥ 50 ; 1–5 years: ≥ 40 ;

Are classified into have a severe illness.

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Hospital Admission is considered in children with COVID 19 if any **ONE** of the following criteria met:

- Presence of Respiratory distress or If SpO₂ < 92% on room air
- Presence of Shock/ poor peripheral perfusion/ General danger signs: Inability to breastfeed or drink, lethargy or unconsciousness/ Seizures/ encephalopathy
- Children with high risk for severe disease with mild symptoms: congenital or acquired heart disease, chronic lung, liver, kidney or neurological disease, on immunosuppressive drugs, congenital or acquired immunodeficiency

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Admission into intensive care unit should be considered in children with

- Moderate to severe ARDS requiring mechanical ventilation
- Shock requiring vasopressor support
- Worsening mental status
- Having Multi-organ dysfunction syndrome

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The general principles in the management of children with COVID 19 are as follows

- **COVID-19 care pathway** at all levels, developed and followed
- **Infection prevention and control (IPC)** measures should be adhered for all suspected and confirmed cases
- Endemic infections (such as dengue, malaria) are to be ruled as per clinical setting
- Supportive care consisting of ensuring adequate nutrition, hydration and rest
- Symptomatic treatment with Paracetamol for fever (*10– 15 mg/kg/ dose SOS/ q 4–6 hourly if required*); ibuprofen and other NSAIDs are to be avoided

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- Children with moderate disease are admitted in isolation to contain virus transmission (the admission facility may be a *Dedicated Covid Health Centre (DCHC) or District hospital or Medical College hospitals*)
- Haematology & biochemistry laboratory testing, electrocardiogram and chest imaging should be performed at admission to monitor complications and organ function
- Oxygen supplementation is given to maintain SpO₂ > 92%
- If Inhaled bronchodilators are required then MDI with spacer is preferred over nebulization to reduce aerosolization
- Empirical antimicrobials are not recommended in moderate unless there is strong clinical suspicion of a bacterial infection
- Empiric antibiotic therapy may be considered as per local antibiogram and guidelines in immune-compromised children and children < 5 years of age

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- IV methylprednisolone 0.5 to 1 mg/kg OR Dexamethasone 0.1 to 0.2 mg/kg for 3 days may be considered in children in whom (oxygen requirement is increasing within 48 hrs & inflammatory markers are increased)
- Monitor *vitals Heart rate, Respiratory rate, Blood pressure and SpO₂, work of breathing, oxygen requirement of children* with moderate COVID-19 for signs or symptoms of disease progression
- CBC with differential count, Absolute Lymphocyte count, KFT/LFT are to be done daily and CRP, D-dimer & Ferritin are monitored every 48-72 hourly if resources available
- Monitor for Increased work of breathing, Hemodynamic instability ,Increase in oxygen requirement, If any of the above occurs, consider shifting to Dedicated Covid Hospital with tertiary care set up

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As of now there are no established therapies for covid 19 and also there is no evidence of benefits of giving following drugs to moderately affected

Chloroquine and hydroxychloroquine, Ivermectin

Antiviral agents, Lopinavir/ritonavir, Remdesivir, Umifenovir, Favipiravir

Immunomodulators: Tocilizumab, Interferon B 1 a, and Plasma infusion

Hydroxychloroquine or Lopinavir/ritonavir and Zinc might be used in children with moderate illness

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Supplemental oxygen therapy should be given to children with SARI and respiratory distress, hypoxemia, or shock

- The target SpO₂ is > 94% during resuscitation and > 90% for stable and recovering children
- Nasal prongs or cannula are preferred in children as it may be better tolerated
- A surgical mask or hood covered to decrease the risk of aerosolization and droplet spread
 - If the child is on oxygen through prongs and SpO₂ less than 90% with minimal respiratory distress the options in the next level are
 - Face mask at flow of more than 5 LPM providing FiO₂ of 40 - 60%
 - Oxygen hood at flow of more than 5 LPM providing FiO₂ 30-90%
 - Venturi mask (28-60% FiO₂) or
 - Non-rebreathing mask at flow 10-15 LPM (FiO₂ 80-90%)

These devices can be tried before escalating the respiratory support to HFNC or NIV

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Now we go to the management of severe illness

- Children with severe disease may be cared in center - equipped with pulse oximeters, functioning oxygen systems and disposable, single-use, oxygen-delivering interfaces (*nasal cannula, Venturi mask, and non-rebreathing mask with reservoir bag*)
- Child with severe pneumonia and danger signs should receive emergency airway management and oxygen therapy during resuscitation to target SpO₂ ≥ 94% & Target SpO₂ is > 90% in a stable child.
- Empirical antimicrobials (e.g., Ceftriaxone) should be given within 1 hr of admission (suspected bacterial infection) after sending blood culture and it is based on clinical judgment, patient host factors and local epidemiology

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- Investigations Complete blood count with differential & biochemistry laboratory testing, electrocardiogram and chest imaging should be performed at admission in order to monitor complications and organ function
- Close monitoring of children (*vitals Heart rate, Respiratory rate, Blood pressure and SpO₂, work of breathing and oxygen requirement*) should be done for signs or symptoms of disease progression

- CBC with differential count, Absolute Lymphocyte count, KFT/LFT are to be done daily and CRP, D-dimer & Ferritin are monitored every 48-72 hourly if resources available
- Bubble nasal CPAP may be used with airborne precautions in newborns and children with severe hypoxaemia when resources for invasive ventilation are not available

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Now we see, when and how HFNC is used

- Heated humidified high flow nasal cannula (HFNC) may be used preferably over CPAP/BIPAP if the target saturation is not achieved with oxygen delivery devices
- Switch on the machine only after fixing the nasal cannula
- Start at 0.5 – 1 litre per kg per minute and increase up to 2 litre/kg/minute if needed
- Use minimal flow that makes the baby comfortable, Target SpO₂ 90 - 94%
- Monitor HR, RR, SpO₂ and work of breathing. If no response in 1- 2 hours, then escalation of support required
- Consider providing a 3-ply mask to cover mouth and nose of the child while receiving HFNC to reduce the spread of aerosol

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Coming to the NIV support

- It is offered only in selected children with respiratory distress as the failure rate is very high
- Use conventional ventilators for NIV with non-vented oronasal masks/helmets as NIV with single limb and vented masks have high risk of aerosolization
- Connect a bacterial/viral filter at exhalation port and Use the lowest possible PEEP to achieve targets
- Monitor closely and intubate if the patient deteriorates or there is no improvement in 1 hour

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Children with COVID-19 infection having any one of the following classified as critically ill

- **Acute Respiratory Distress syndrome** as defined by Pediatric ARDS guidelines from Pediatric acute lung injury consensus conference (PALICC)
- **Sepsis** who has Suspected or proven infection and ≥ 2 age-based SIRS criteria

- **Septic shock** (as manifested by hypotension (**or**) Two/three of the following: Altered mental status; Bradycardia or tachycardia; Prolonged capillary refill (> 2 sec) or weak pulse; Mottled or cool skin; petechial or purpuric rash; High lactate; Reduced urine output; Hyperthermia or hypothermia)

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Coming to the management of child with ARDS

- Children with COVID-19 and mild ARDS, a trial of HFNO, non-invasive ventilation – continuous positive airway pressure (CPAP), bilevel positive airway pressure (BiPAP) may be used with strict adherence to airborne precautions
- HFNO or NIV are to be avoided in children with hypoxaemic respiratory failure and haemodynamic instability, multiorgan failure or abnormal mental status
- Children receiving a trial of HFNO or NIV should be cared for and monitored by personnel experienced with HFNO and NIV and capable of performing endotracheal intubation in case of deterioration or non improvement (i.e.after trial of 1 hour)

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In children with COVID 19 who are critically ill, Intubation is considered if any of the following conditions present

- Severe respiratory distress
- Not able to maintain SpO₂ > 90% on non-invasive oxygen supplementation
- When PaO₂/FiO₂ < 200 or PaO₂/FiO₂ < 300 with hypotension requiring vasopressor support
- Having GCS < 8 with threatened airway

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Intubation in COVID 19 children done with all air borne precautions and the following steps are adhered strictly

- The most skilled member of the team should be identified at the beginning of each shift for performing intubations
- Pre-oxygenation with 100% FiO₂ with non-rebreathing mask or nasal prongs
- bag and mask ventilation (risk of aerosol generation) is avoided. If needed, can be used by connecting a viral filter
- If readily available, intubation should be performed using a video-laryngoscope

- Cuffed endotracheal tubes should be used to avoid peritubal leak & dissemination of secretions
- Rapid sequence intubation should be done
- During induction, monitor for hemodynamic instability and use fluids and vasopressors, if required
- X-ray chest is ordered to confirm the position of the tube
- After intubation, appropriate cleaning/disinfection of equipment and environment should be done

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The following are general ventilatory strategies recommended in managing the intubated children

- Target a lower level of plateau pressure (< 28 cmH₂O) , and a lower pH is permitted (7.15–7.30).
- Tidal volumes: 3–6 mL/kg Predicted BodyWeight in the case of poor respiratory system compliance, and 5–8 mL/kg PBW with preserved compliance
- In children with moderate or severe ARDS, a trial of higher positive end expiratory pressure (PEEP) instead of lower PEEP is suggested and the level of PEEP is to be individualized
- Application of prone ventilation (*if PaO₂/FiO₂ < 150; OI ≥ 12; OSI ≥ 10*) preferably for 16 hours per day may be considered for paediatric patients with severe ARDS where sufficient human resources and expertise are available
- Referral of children who have refractory hypoxaemia (e.g. PaO₂:FiO₂ of < 50 mmHg for 3 hours, a PaO₂:FiO₂ of < 80 mmHg for > 6 hours) despite lung protective ventilation for ECLS

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The general care of the ventilated children includes

- USE Fresh, preferably disposable ventilator circuit for every new patient
- Use viral filter in expiratory limb of the circuit
- Heat and moisture exchanger (HME) to be changed every 48 h or when visibly soiled
- Avoid disconnection of circuit (*which causes Loss of PEEP, Atelectasis, Increased risk of infection of HCWs*)
- Use closed suctioning technique and avoid routine suctioning to reduce aerosol generation

- Appropriate sedation should be ensured and intermittent muscle relaxants may be used, although continuous infusion of NMBs are not be routinely recommended
- Conservative fluid management strategy must be followed for ARDS patients without tissue hypoperfusion and fluid responsiveness

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The management of sepsis and septic shock includes

Standard care consisting of early recognition and the following treatment - done immediately, within 1 hour of recognition:

- Initiation of fluid bolus
- Antimicrobial therapy
- Vasopressors for hypotension
- central venous and arterial catheters should be based on resource availability and individual patient needs

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- During resuscitation for septic shock in children, give 10–20 mL/kg crystalloid fluid (normal saline OR Ringer’s lactate) as a bolus in the first 30–60 minutes. Hypotonic solutions and colloids are avoided
- If there is no response to fluid loading or signs of volume overload appear then one has to either reduce or discontinue fluid administration
- During resuscitation Consider using dynamic indices of volume responsiveness such as passive leg raising, fluid challenges with serial stroke volume measurements, or variations in systolic pressure, pulse pressure, inferior vena cava size, or stroke volume in response to changes in intrathoracic pressure during mechanical ventilation to guide volume administration

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- if signs of fluid overload are apparent or the shock persist after two fluid bolus, start vasopressor
- If central venous catheters are not available, vasopressors can be given through a large peripheral vein and closely monitor for signs of extravasation, local tissue necrosis. If extravasation occurs, stop infusion. Vasopressors can also be administered through intraosseous needle
- In children, epinephrine is considered the first-line treatment, while norepinephrine can be added if shock persists despite optimal dose of epinephrine

- If signs of poor perfusion and cardiac dysfunction persist despite achieving MAP target with fluids and vasopressors, then consider starting an inotrope such as dobutamine

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The supportive care of the critically ill child with COVID 19 includes the following measures

- Head end elevation; may be avoided if child has poor perfusion/ shock
- Oral hygiene with antiseptic mouthwash twice daily
- Early enteral nutrition starting within 24-48 hours of admission
- Glycemic control to maintain blood glucose in range of 100 - 180 mg/dl
- Insertion of Foley's catheter for accurate urine output monitoring
- Insertion of appropriate size feeding/Ryle's tube for enteral feeds and medications
- Care of Central venous catheter to prevent CRBSI
- position change every 2 hours to prevent bed sore

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The following measures are followed to prevent complication in critically ill children

- Daily assessment for readiness of extubation and Sedation window to reduced the days of mechanical ventilation
- Head end elevation, closed suctioning, change circuit if soiled, change HME when malfunctions, when soiled, or every 5–7 days to reduce the incidence of VAP
- Anti coagulant prophylaxis with LMWH or heparin to prevent DVT
- Sterile insertion techniques must be followed while placing the central catheter and removal of CVCs considered if no longer needed to reduce CRBSI
- Positioning every 2 hrs to prevent bed sores
- Early enteral nutrition (within 24-48 hours of admission), administer H2 blockers or PPIs in patients with risk factors for GI bleeding to reduce ulcers and bleeding. The risk factors include mechanical ventilation \geq 48 hours, coagulopathy, renal replacement therapy, liver disease, multiple co-morbidities, and higher organ failure score
- Actively mobilize early in the course of illness as soon as the child is stable to prevent ICU related weakness

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Summarizing

- Children should be categorized based on signs & symptoms and management protocol to be followed according to the severity of illness
- **Infection prevention and control (IPC)** measures should be followed for all suspected and confirmed cases
- Oxygen therapy, HFNC are tools for respiratory support in children with moderate illness, NIV and invasive ventilation for ARDS and airborne precautions have to be followed in all
- Low tidal volume, low Pplat, moderate to high PEEP, permissive hypercapnia and prone ventilation are the main ventilation strategies
- Antimicrobials are administered only if bacterial infection suspected or in children with sepsis and septic shock
- Close clinical monitoring of *vitals: Heart rate, Respiratory rate, Blood pressure and SpO₂, work of breathing and oxygen requirement* in any category is paramount importance in the management of COVID 19
- Antivirals (Remdesivir), Tocilizumab and plasma therapy are to be used only in clinical trial settings