Pediatric RESEARCH

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REVIEW ARTICLE

European consensus recommendations for neonatal and paediatric retrievals of positive or suspected COVID-19 patients

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BACKGROUND: The 2020 novel coronavirus (SARS-Cov-2) pandemic necessitates tailored recommendations addressing specific procedures for neonatal and paediatric transport of suspected or positive COVID-19 patients. The aim of this consensus statement is to define guidelines for safe clinical care for children needing inter-facility transport while making sure that the clinical teams involved are sufficiently protected from SARS-CoV-2.
METHODS: A taskforce, composed of members of the European Society of Paediatric and Neonatal Intensive Care (ESPNIC) Transport section and the European Society for Paediatric Research (ESPR), reviewed the published literature and used a rapid, two-step modified Delphi process to formulate recommendations regarding safety and clinical management during transport of COVID-19 patients.
RESULTS: The joint taskforce consisted of a panel of 12 experts who reached an agreement on a set of 17 recommendations specifying pertinent aspects on neonatal and paediatric COVID-19 patient transport. These included: case definition, personal protective equipment, airway management, equipment and strategies for invasive and non-invasive ventilation, special considerations for incubator and open stretcher transports, parents on transport and decontamination of transport vehicles.
CONCLUSIONS: Our consensus recommendations aim to define current best-practice and should help guide transport teams dealing with infants and children with COVID-19 to work safely and effectively.

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IMPACT:

- We present European consensus recommendations on pertinent measures for transporting infants and children in times of the coronavirus (SARS-Cov-2 /COVID-19) pandemic.
- A panel of experts reviewed the evidence around transporting infants and children with proven or suspected COVID-19. Specific guidance on aspects of personal protective equipment, airway management and considerations for incubator and open stretcher transports is presented.
- Based on scant evidence, best-practice recommendations for neonatal and paediatric transport teams are presented, aiming for the protection of teams and patients. We highlight gaps in knowledge and areas of future research.

INTRODUCTION

As of 8 April 2020, the novel coronavirus (SARS-CoV-2) causing coronavirus-disease (COVID-19) has affected over 1.4 million individuals and resulted in more than 80,000 deaths worldwide.[1] The pandemic poses unprecedented pressures on all health-care services. As a consequence, the urgent need to generate "surge" bed space for adult critical care patients on paediatric wards has resulted in additional inter-hospital transfers of suspected or confirmed COVID-19 infants and children. While fewer cases of COVID-19 are being reported for infants and children, infected

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individuals represent a risk to their environment, in particular for health-care workers (HCW), especially during the proximity of patient transport.[2,3] Thus, clear guidance for providing safe and effective neonatal and paediatric critical care during inter-hospital transfer and during retrievals is mandatory to prevent the spread of COVID-19. This holds especially true for settings where paediatric transport is centralized and large volumes of patients are being transferred.

Given the highly contagious nature of SARS-CoV-2, special consideration needs to be given to infection control and monitoring during inter-hospital transport and retrieval of critically ill patients. The dearth of specific guidance regarding the transport of paediatric and neonatal COVID-19 patients prompted the Transport Section of the European Society for Paediatric and Neonatal Intensive Care (ESPNIC) and members of European Society of Paediatric Research (ESPR) to convene a special taskforce to rapidly develop such consensus-based recommendations. The aim of the taskforce was to describe preventative measures and procedures for safe neonatal and paediatric inter-hospital transfers and retrievals where the patient is COVID-19 positive or suspected. Care was taken to make recommendations that apply to all neonatal and paediatric staff involved in ground or air transports, staff at both the referring and receiving hospital, retrieval teams, ground and air ambulance staff and security staff at both hospitals and airports.

METHODS

Through the neonatal and paediatric working groups of the transport section of the European Society of Paediatric and Neonatal Intensive Care (ESPNIC) and representatives of the European Society for Paediatric Research (ESPR), a panel of 12 experts was identified. The panel was supported by key opinion leaders within the highly specialized field of neonatal and paediatric inter-facility transport. The group of experts consists of specialists in Neonatology and/or Paediatric Intensive Care and one registered nurse (RN), all with many years of experience in ground and air neonatal and paediatric medical retrieval medicine, most of them in leading positions for their local transport team and/or national advisory function.

The panel performed a rapid two-step modified Delphi process to reach consensus on recommendations within a short timeframe (3 weeks; 11 March to 8 April 2020). In the first step, the expert panel met six times over a 2-week period by video-conferencing. They discussed and agreed on core elements of the recommendations that were considered important, based on their review of the existing literature and the evolving experience of the panel members in dealing with COVID-19. In the second step, a list of 17 recommendations was circulated to all panel members. Each panel member anonymously rated their agreement with each recommendation on a 5-point scale (1—strongly disagree, 5—strongly agree). For each recommendation, the average of the individual ratings was calculated and expressed as a percentage indicating the degree of agreement between panel members (e.g. average rating of 4 indicating 80% agreement). Previous work has shown that >70% agreement between experts compares favourably with a more comprehensive systematic review-based process of selecting recommendations, and agreement can be achieved within a much shorter timeframe.[4] Therefore, a "strong recommendation" was defined as >70% agreement between experts and a "weak recommendation" as agreement ≤70%.

RESULTS

A summary of the key recommendations together with the level of agreement between panel members is provided in Table 1.

Case definition for COVID-19

To ensure clear communication between teams prior to retrieval of infants and children, the need for a clear case definition of suspected (and proven) COVID-19 is acknowledged. Recognizing that case definitions may currently vary between countries, the panel suggests to adopt the case definition proposed by Dong et al.[5]

Confirmed cases. A patient with a positive COVID-19 test result must be considered infected. Regardless of the fact that we acknowledge the relatively high incidence of false-positive results in the early months of 2020.

Suspected cases.

1. Any infant or child isolated at the referring hospital for suspected or confirmed COVID-19, especially:

- Infants and children who have had contact with suspected or confirmed COVID-19 patients at home or in hospital within the last 14 days.[6]
- Newborn infants of mothers with suspected or confirmed COVID-19.[7,8]

2. Consider COVID-19 in any infant or child needing hospital admission AND showing any of the following symptoms[9–11]:

- respiratory distress;
- shortness of breath or tachypnoea;
- sneezing;
- nasal discharge or congestion;
- cough;
- hoarseness, sore throat;
- fever;
- recent loss of smell and/or taste.

3. Consider COVID-19 in any infant or child needing hospital admission for an unexplained multisystem inflammatory condition (persistent fever, raised inflammatory markers and cardiac involvement) fitting the case description from the CDC, WHO and/or UK RCPCH.

The panel recommends that the status of all patients, whether suspected or confirmed COVID-19 (as per the above case definition), is discussed and determined at the initial referral (strong recommendation).

If the COVID-19 status of a patient for any reason cannot be determined before transport (i.e. acute trauma, no COVID-19 test result, unresponsive child, unknown history, parents not present), the child should be considered as a potentially positive case and be handled as suspected COVID-19 case.

Personal protection equipment (PPE) for the team during transport

For *HCWs providing clinical care* during the transport of patients with suspected or confirmed COVID-19, the panel recommends wearing the following PPE[12–15] (strong recommendation):

- water repellent full protective suit *or* gown and apron covering lower legs;
- double gloves;
- wipeable shoes or shoe covers;

Table 1. Expert panel recommendations for neonatal and paediatric retrievals of positive or suspected COVID-19 patients, panel members' average rating for each recommendation (1—strongly disagree, 5—strongly agree) and the degree of agreement between panel members expressed as a percentage. A percentage of above 70% agreement was considered strong.

Panel recommendations		Average rating of agreement	Rating expressed in % of agreement
1	Determine status of the patient, COVID-19 positive or suspected, at referral of the patient	5.0	100
2	Full PPE for transport staff involved in clinical patient care during the transport	5.0	100
3	Reduced PPE for assisting transport staff not involved in patient care but within <2 m of patient	4.9	98
4	Transport teams to train and simulate donning and doffing procedures of PPEs	5.0	100
5	Patient should whenever feasible wear a surgical mask to minimize aerosol spread	4.7	93
6	Use cuffed endotracheal and tracheostomy tubes, including for newborn infants, to avoid aerosol spread by air leak	4.9	98
7	Use video-laryngoscopy whenever possible for intubation	4.5	90
8	Use strict protocol/checklist for the airway management/intubation	4.9	98
9	Use HEPA filters on the inspiratory limb of the ventilation circuit	4.1	82
10	Use HEPA filters on the expiratory limb, to avoid spreading contaminated air from the patient	5.0	100
11	No recommendation for or against the use of humidified air or heater/humidifier	4.7	93
12	Provide non-invasive ventilation with the use of a ventilator and a dual-limb system and filters as recommended above	4.9	98
13	Any incubator transport is to be handled like an open stretcher transport from a PPE point of view	4.1	82
14	Place newborn infant in suitably sized plastic bag to prevent heat loss and to reduce the need for incubator humidification	4.8	97
15	Transport infants and children without parents or relatives, regardless if symptomatic or not.	4.7	93
16	Assure secure and dedicated pathway for entering the receiving unit	5.0	100
17	Decontaminate any exposed transport equipment including equipment left within the transport vehicle.	4.9	98

PPE personal protection equipment, *HEPA* high-efficiency particulate air, *HME* Heat-Moisture-Exchanger.

- FFP2, FFP3 or N95 mask (fitted for each team member);
- visor/goggles;
- head cover.

For *HCWs (i.e ambulance drivers, paramedics)* not directly involved in the care of the patient, but coming into close proximity of the patient (<2 m) i.e. during loading/unloading of the stretcher, the panel recommends wearing the following PPE[12–15] (strong recommendation):

- gown and apron covering lower legs;
- surgical mask;
- gloves.

For *patients* not requiring respiratory support, the panel recommends wearing a surgical mask, whenever feasible, to minimize aerosol spread (strong recommendation).

To prevent potential transmission from transport staff to patients, we recommend for all transport staff to wear a surgical mask and adhere to strict hand hygiene on any transport, regardless of patient status. It seems advisable to adopt a policy for screening transport staff for COVID-19 (i.e. temperature screening) before reporting to work. The panel recognizes that this has already been adapted by many hospitals where transport facilities and staff are housed on NICU or PICU. Local policies might vary and should be adhered to.

We recommend transport teams to train and simulate donning and doffing procedures of PPEs (strong recommendation).[16–18] See attached chart for donning and doffing procedure: https://www.cdc.gov/hai/pdfs/ppe/PPE-Sequence.pdf.

In addition, the policy and guidelines from local ground and air ambulance services should be followed by the transport personnel.

Airway management and other aerosol-generating procedures (AGP)

Any AGP (specifically intubation) has to be considered a high-risk procedure given the likelihood of aerosol spread from the patient[19–24] (Table 2).

The panel recommends transport teams should use a strict protocol/checklist for airway management/intubation of patients with suspected or proven COVID-19 infection[25] to reduce the risk of aerosol spread[26] and adverse events associated with intubation (strong recommendation).

Respiratory support of COVID-19 patients

General remark. This recommendation will not go into specific details on how to provide respiratory support. We will, however,

Table 2. As any aerosol-generating procedure (AGP) (specifically intubation) has to be considered a high-risk procedure, given the likelihood of aerosol spread from the patient. The panel provides the following recommendations for airway management and other AGP.

Airway management and other AGP
• Strict adherence to PPE.
• Consider early intubation (i.e SF ratio < 221) to avoid crash intubation.
• To minimize the risk of aerosol spread during NIV have a low threshold for intubation.
• Consider using cuffed endotracheal and tracheostomy tubes, including for newborn infants (whenever possible), to avoid aerosol spread by air leak (strong recommendation).
• Most experienced person handles the airway.
• Use video-laryngoscopy whenever possible (strong recommendation).
• Perform Rapid Sequence Induction (RSI).
• Reduce the amount of hand-bagging as much as possible. If needed, small tidal volumes should be used.
• Avoid open suctioning after intubation; use closed suction circuits instead.
• Any chest-drain equipment has to be either a closed circuit without contact to ambient air or equipped with an HEPA filter.
• Discharge all not-for-single-use airway management equipment in plastic bags for decontamination.

PPE personal protection equipment, *HEPA* high-efficiency particulate air.

highlight specific aspects to be considered during respiratory support of patients suffering from COVID-19.

Non-invasive respiratory support. While early intubation may reduce the risk of virus-spreading into the transport environment, not all patients will be in a condition justifying the risk of invasive ventilation. A decision on the use of non-invasive ventilation should involve an active risk assessment by the transport team.

We do consider any form of non-invasive ventilation to be associated with a higher risk of virus-aerosol spread into the environment.[27–29] This risk is affected by two factors: *the flowrate* and *how open the system is*. Using a system which is as closed as possible (i.e. an infant oxygen hood as opposed to low flow oxygen via nasal cannula) is likely to reduce the risk of aerosol spread.

The panel recommends non-invasive ventilation to be provided with the use of a ventilator and a dual-limb system and filters as recommended above (strong recommendation). In that regard, providing PEEP with CPAP via the ventilator is likely to be less aerosol producing as opposed to using high flow nasal cannula.

Invasive mechanical ventilation. Even with invasive ventilation, aerosol spread cannot be entirely excluded given that in certain circumstances there might be leakage around the cuff of the endotracheal tube (ETT), and hence a direct exposure to the ambient air. However, the panel recommends the use of a cuffed ETT (or cuffed tracheostomy) whenever possible, including for neonates (strong recommendation). Current evidence suggests that it is safe to use Microcuff ETT even in newborns below 3 kg and that this practice is not associated with airway complications.[30,31]

Bacterial/viral particle filters during invasive ventilation: In patients who are intubated and on mechanical ventilation, the panel recommends using high-efficiency particulate air (HEPA) filters[32] with a filtration efficiency of above 99.99% on the expiratory as well as on the inspiratory limb of the ventilator:

1. on the expiratory limb to avoid spreading contaminated air from the patient (strong recommendation)[33];
2. on the inspiratory limb of the ventilator to protect the patient from getting exposed to contaminated ambient air when using a turbine-driven ventilator (which uses ambient air to ventilate the patient as opposed to compressed air from closed cylinders), as this would increase the viral load in the lung (strong recommendation).

Although some turbine-driven ventilators are equipped with an in-built HEPA filter protecting the patient from potentially contaminated ambient air, others are not. In addition, the filter on the inspiratory limb protects the patient from contamination by reversed airflow in case of powerful coughing, specifically when using a Y-piece between inspiratory and expiratory limb. Care needs to be taken to ensure that ventilators with addition of viral filters will provide similar driving pressures, tidal volumes and gas exchange.

For specific details on invasive ventilation of COVID-19 infants and children, we recommend to review the PEMVECC recommendations made by an ESPNIC panel experts.[34]

Humidification of air

As there seems to be no evidence in the superiority of either method, the panel cannot recommend for or against the use of humidified air by Heat-Moisture-Exchanger (HME) or heater/humidifier when transporting ventilated COVID-19 patients[35] (strong agreement).

CPR during transport

In the event of cardiac arrest in an intubated and mechanically ventilated patient with suspected or confirmed COVID-19, the child should not be disconnected from the ventilator when starting CPR to avoid aerosol spread.[36] Oxygen supply should be increased to FiO_2 1.0 and chest compressions should be commenced immediately as per ERC resuscitation algorithm.[37] The ventilator and circuit should be examined to ensure they have not contributed to the cardiac arrest.[36] Early identification and proper treatment of potentially reversible causes during CPR is paramount. The HCW providing CPR should wear full PPE as described above, for any team member providing clinical patient care in suspected or confirmed COVID-19 cases.

Specific considerations for incubator transports

As it cannot be guaranteed that during any incubator transport the newborn will remain in its encapsulated space without any outside contact (i.e. emergency medical procedures), the panel recommends any incubator transport to be handled like an open stretcher transport (strong recommendation) and therefore necessitating wearing PPE, as recommended.

The panel recommends to place the newborn infant in a suitably sized transparent plastic bag,[38–40] sparing the face only, before transferring into the incubator or pod (strong recommendation). This way the need for incubator heating (and

humidification) can potentially be reduced, allowing the incubator fan to be switched off, minimizing air and particle circulation inside the incubator as well as air leakage into the environment.[41] However, adequate temperature control should take precedence (normothermia 36.5−37.5 °C), unless the patient receives therapeutic hypothermia.

To minimize air leakage from the incubator during interventions, we recommend to use port hole covers (i.e incubator/chamber gloves or iris covers). In addition, the need to open the incubator during transport should be minimized by placing all equipment potentially needed during transport inside the incubator (i.e. drugs, pacifier, breast milk, suction hose, hose for oxygen flow).

Specific considerations for open stretcher transports

We recommend to use closed transport capsules for paediatric stretcher transports, if the clinical condition of the child allows, as aerosol spread can be reduced using these. However, the use of paediatric transport capsules requires training and should not compromise necessary clinical management or patient safety during transport. When using transport capsules, the same principles and precautions apply as for neonatal incubators with regards to reducing air leakage.

Air conditioning or ventilation of vehicles should, if at all possible, be set to extract and not recirculate the air within the vehicle.

Before the transport is commenced all non-essential equipment should be removed from the vehicle, as all equipment within the vehicle that cannot be stored in fully enclosed compartments must be considered contaminated after completion of the transport.

Parents during transport

Parents and relatives of infants and children with suspected or confirmed COVID-19 have a very high likelihood of being infected. This increases the risk for the transport team to become infected during the transport. We therefore recommend transporting infants and children without parents or relatives, regardless if symptomatic or not (strong recommendation). This recommendation, which is not in alignment with the principles of family-centred care,[42,43] has been made to protect the transport personnel.

If under special circumstances (i.e. life-threatening condition of the child, extremely agitated child, very long distance to destination in fix wing transport), the team would decide to take a parent on transport, the decision should follow a thorough risk assessment including taking the medical history of the parent and a screening (i.e. temperature) and the parent should be asked to wear a surgical mask and adhere to strict hand hygiene rules.

It is at the discretion of the receiving unit when and how to reunite the child with their family at destination, in accordance with the current indications of public health authorities.

Retrieval of children who are awake and might be scared by staff wearing PPE requires special consideration, methods to alleviate adverse effects of isolation in hospitalized patients are evolving during this current pandemic and should be considered.[44,45]

Arrival at the receiving unit

The panel recommends to coordinate with the receiving unit about a secure and dedicated pathway for entering into the hospital and the intensive care unit for COVID-19 patients before starting the transport. The logistics of avoiding contamination of clean areas of the receiving hospital should be discussed (strong recommendation). The patient should be isolated immediately upon arrival, either in a single room, or if not available, in a cohort unit with physical separation from other patients and departments.

After verbal handover to the receiving team, documented medical records should be transmitted electronically.

On their way back to the base the transport team should take good care not to contaminate clean areas in the receiving hospital.[46] If the same transport vehicle is being used to transport the team back to the base, full PPE should be worn unless the vehicle has been fully decontaminated before the team re-enters the transport vehicle. If the transport vehicle will be decontaminated at destination, the receiving hospital has to create a dedicated doffing area available to the transport team.

Decontamination of transport vehicle and equipment

Any exposed transport equipment including equipment left within the transport vehicle (which was not within closed compartments) will require decontamination with a universal detergent (i.e. ethanol, perifrom or vircon) followed by cleaning of the entire interior of the vehicle with a chlorine-based solution at 1000 parts per million (strong recommendation).[47,48] Starting from the ceiling of the vehicle and working from top to bottom following a systematic process, all exposed surfaces will require decontamination. All linen and waste should be disposed of as infectious waste, as per local policy.

Transport register

A database to collect pertinent transport and health information from all infants and children transported with suspected or confirmed COVID-19 is currently being developed by the ESPNIC transport section. As soon as this database is established, it will be made accessible for all transport teams to supply their data.

CONCLUDING REMARKS

The taskforce suggests adhering to general considerations for the clinical management, stabilization and monitoring during transport of infants and children, which should remain unchanged as per local policies. However, given the highly contagious nature of SARS-CoV-2, additional specific considerations should be taken into account during transport of patients with suspected or confirmed COVID-19.

While we consider it essential that teams strictly adhere to using the recommended PPE, we acknowledge occasional local shortages of stock for certain PPE. The taskforce cannot make specific recommendations on alternative PPE, but we encourage transport teams to closely follow updates and specific guidance from national health authorities concerning supplies or lack of PPE, in order to protect their staff and to avoid further spread of SARS-CoV-2 with highest priority.

The taskforce considers it crucial to identify all personnel who may be involved in such a transport and clearly communicate the plan for the transport. While the key to successful inter-facility transport of sick infants and children lies in the combination of having the correct equipment, skills and competence, the team's ability to communicating effectively should be regarded as an equally important skill, especially when meticulous attention should be paid to adhering to strict hygiene rules when the patient is suspected of having a highly contagious condition.

Whereas our recommendations are aimed at inter-facility transports, we appreciate that many aspects are equally applicable for intra-facility transport of children with suspected or confirmed COVID-19 (i.e. transfer to other wards, OT or MRI). Specifically, recommendations made regarding PPE for staff and usage of secure, dedicated pathways to avoid cross-contamination should be adhered to and require careful planning with other affected departments of the hospital.

Reviewing the existing literature on this topic has clearly emphasized that so far there is very little scientific evidence supporting any recommendations on neonatal and paediatric transport of COVID-19 patients, including the above. In that regard our recommendations reflect a consensus on a specific topic that we agreed upon through a system of evidence review, professional debate and agreement. Given the acuity of the SARS-CoV-2 pandemic, our recommendations are very much based on the yet evolving experience of experts in the field dealing with a new situation. The choice of our rapid methodological approach, even though adhering to a rigorous voting process, was in part made in light of the fact that recommendations on this acute topic are urgently needed in the field, and further delay in providing such would defeat the purpose. We are certain that over time there will be more evidence evolving and appreciate that our current recommendations are likely to be adapted accordingly. The taskforce also recommends to critically appraise upcoming data and recommendations from transport experience of adult patients with COVID-19 before incorporating these in paediatric and neonatal transport protocols.

Looking ahead, this taskforce has made it their aim to compile a more comprehensive international consensus practice guideline for neonatal and paediatric critical care transport and include an even larger panel of experts.

Electronic supplemental material

- Airway management in COVID-19 patients: https://picsociety.uk/wp-content/uploads/2020/04/COVID-19-Paediatric-Airway-Checklist-04042020.pdf.
- Correct donning and doffing of PPE: https://www.cdc.gov/hai/pdfs/ppe/PPE-Sequence.pdf.

This recommendation is per 10/04/2020 and updates will be published with new experience and evidence via the ESPNIC webpage—Section Transport. This statement has been reviewed and endorsed by ESPNIC and ESPR.

AUTHOR CONTRIBUTIONS

All authors contributed equally to this work.

ADDITIONAL INFORMATION

Competing interests: The authors declare the following competing interests: U.T. receives funding from AJCH for teaching and promoting paediatric care transport in UAE and serves as Deputy Chair of EPSNIC Section Transport to establish international guidelines, sponsoring for talk on mechanical ventilation by Hamilton and received an SNF research grant in 2016. C.H. receives travel grants from Chiesi Pharmaceuticals. F.H. receives lecture fees from Philips Respironics. M.K. receives funding from NIH/NHBLI, ZonMW, Stichting Beatrix Kinderziekenhuis, Fonds NutsOhra, UMC Groningen, TerMeulen Fonds/Royal Dutch Academy of Sciences and VU University Medical Center and serves as Consultant for Vyaire and receives fees for technical research support from Vyaire and Applied Biosignals. C.C.R. serves as President of ESPR and attended a Ventilation meeting, sponsored and reimbursed for expenses by Hamilton-Medical. G.J. receives travel grants from Chiesi Pharmaceuticals and accommodation grants from Teleflex. M.B. is patent holder of NeoHELP, produced and marketed worldwide by Vygon.

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