Minutes of the NERVTAG COVID-19 NIV and Nosocomial Transmission Subcommittee Meeting: 03 March 2020

Date & Location:	09:00 – 09:45, 03 March 2020 Via telecon only
In attendance:	Wei Shen Lim (Chair), Camille Tsang (Secretariat). NERVTAG Members: Ben Killingley (BK) HPS: Lisa Ritchie (LR) Co-opted: Anita Simonds (AS), Allan Bennett (AB), Chris Meadows (CM), Daniel Martin (DM), Ronan 'Driscoll (RD), Charles Gomersall (CG), David Hui(DH)
Apologies:	Peter Horby, Jonathan Van Tam, Cheryl Cavanagh, Luke Collet-Fenson, Gavin Dabrera.

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NERVTAG COVID-19 NIV AND NOSOCOMIAL TRANSMISSION SUBCOMMITTEE MEETING: SUMMARY

KEY PRINCIPLES

1. Non-Invasive Ventilation (NIV) is mainly a droplet (>5 μm) generating procedure rather than an aerosol (<5 μm) generating procedure.
2. Studies of NIV during the SARS outbreak (2003) are not necessarily applicable today due to improvements in mask design and measures to increase patient tolerance with NIV.
3. More recent studies suggest NIV does not pose a much higher risk of droplet or aerosol generation compared to chest physiotherapy.
4. In clinical practice, leakage (around the mask) is common, and contributes to increased dispersion of droplets.
5. There are scant data on High Flow Nasal Oxygen (HFNO) in relation to disease transmission. Available studies are not directly applicable to COVID-19.
6. In particular, there are insufficient data to indicate whether HFNO is as safe as NIV.
7. Theoretically, because HFNO circuits are 'leaky', they may pose a higher risk compared to NIV (especially if the latter is used with full-face, or helmet masks, or with double-limbed circuits +/- filters over expiratory vents/ports)
8. In general, for disease transmission purposes, NIV and HFNO may be similar though with a stronger (more evidence-based) safety signal for NIV.

KEY RECOMMENDATIONS: NIV AND HFNO

In relation to patients with *suspected or confirmed* COVID-19 infection:

1. Indications for the use of NIV should be based on clinical need, taking into account Infection Prevention and Control (IPC) considerations. There are no grounds for an indiscriminate ban on the use of NIV.
2. In general, if invasive mechanical ventilation (IMV) is appropriate, then IMV would be preferred over NIV for IPC reasons.
3. Health care workers looking after patients on NIV should wear full Personal Protective Equipment (PPE) (eye protection, N95 or higher respirators, gloves, long-sleeved gowns).

4. Patients on NIV should be managed in negative pressure facilities whenever possible.

5. If required, patients on NIV may be managed in side-rooms, with the door closed. Air exchanges in side-rooms should be checked and adhere to standard IPC guidelines.

6. Under exceptional circumstances, patients on NIV may be managed in a cohort bay where all cohorted patients have **confirmed** COVID-19 infection. Factors to take into account include, access to toilet facilities, thoroughfare for other patients/relatives/staff, air flow, air exchanges.

7. Use of HFNO should follow similar principles as for NIV. However, NIV is preferred over HFNO in relation to the risk of disease transmission, and lower consumption of oxygen supplies.

8. If a patient is failing to respond to non-invasive support, early transfer from NIV or HFNO, to IMV is advisable to prevent delay in intubation (with the exception of patients with a ceiling of non-invasive respiratory support). Siting of patients (for NIV or HFNO) will need to take into account, where possible, escalation of care, such as need for intubation and patient transfer.

9. These recommendations should be reviewed before surge capacity is reached, or when new evidence becomes available.

Approved by the full NERVTAG committee: 6 March 2020

FULL MINUTES

1 Introductions

1.1 The Chair welcomed everyone to the meeting and apologies were received from those listed above.

1.2 WSL introduced the subcommittee which had been set up to provide written scientific and management advice relating to the risk of nosocomial transmission of Corona Virus 2019 (COVID-19) infection with non-invasive respiratory supportive therapies specifically Non-Invasive Ventilation (NIV) and High-Flow Nasal Oxygen (HFNO) to NERVTAG and ultimately to DHSC and the Chief Medical Officer (CMO).

1.3 No comments had been received regarding the draft TOR that was sent out to members.

1.4 Members were asked to declare any potential conflicts of interest, most had provided declaration forms prior to the meeting, none were relevant to this meeting.

2 *Do we agree that NIV should be considered an APG? What evidence is available to support/refute this position?*

2.1 WSL introduced the question, NIV is generally considered an AGP by most infection control guidance, does the group agree with the statement that "*NIV is an AGPs*"?

2.2 AS commented that WHO call NIV a droplet generating procedure but CDC call it an aerosol generating procedure. There is evidence to suggest that it falls more within the droplet range than the aerosol range.

2.3 DH commented that NIV was listed as one of the factors causing super spreader events during SARS however this was due to the old generation masks that were used for NIV which had poorly designed exhalation ports that leaked profusely. The newer generation masks have these ports redesigned and there is minimal leaking that is well within droplet safety distance of 1m.

2.4 DH commented that if the statement that "NIV is an AGPs" is in relation to the old generation masks, then DH would agree however if the statement is in relation to the new generation masks then DH would not consider it an AGP.

2.5 DM agreed with DH and commented that in the Intensive Treatment Unit (ITU) they generally use the full-face masks rather than the traditional over the nose and mouth mask to reduce pressure areas. DM noted that these full-face masks fit very well with very little leaking compared to the traditional mask.

2.6 DM commented that when considering NIV, the group should also consider ward level areas where they sometimes use wall ports providing Continuous Positive Airway Pressure (CPAP) which use very high flow rates and leak atrociously.

2.7 CG noted the Simonds A, et al. 2010 paper showed quite nicely that the small particles were not an issue with NIV use when the mask is well fitted and the patient is compliant. There needs to be caution exercised when comparing epidemiological studies and experimental studies due to the real-life scenarios when patients are not always fully compliant with wearing the mask.

2.8 AB agreed with the points around well fitted masks and added that there was a study that he was involved in around 10 years ago looking at AGPs and influenza. AB suggested that it would be good if a study could be conducted to identify patients who don't necessarily have COVID-19 but have other respiratory viruses like influenza and see if droplets or aerosols are generated.

2.9 AS noted that they did do a study but there still seems to be a broad assumption that NIV is an AGP as the advice from most government guidelines date from the time of SARS. This is not to say that there is zero risk when using NIVs now but NIV produces larger droplets and the patient themselves are the biggest aerosol and droplet generator with cough peak flows of up to 300 to 400 L/min. AS also noted that they used NIV during swine flu and there were no known super-spreader events linked to NIV.

2.10 Members discussed what should be considered an aerosol and agreed a definition that an aerosol is anything less than 5 µm.

2.11 There was a consensus that there is not a list of masks that are better in terms of manufacturer as it depends on the fit of the mask to the person's face.

2.12 There was a consensus in the group that the use of the full mask or helmet with exhalation filters were better than just the normal facemask as there is a very good seal. However, the helmet can be more complex than the standard masks to set up. There was agreement that it would not be sensible to introduce helmets as a standard recommended practice as not all staff will not be very familiar with this set up and consequently it may not be beneficial overall.

2.13 BK asked whether there was any evidence of aerosols from the machinery mixing with infectious droplets generated from the patient to produce infectious aerosols.

2.14 Members commented that it was difficult to gauge whether agents in the air were viable or non-viable as there are problems with sampling whether using aerodynamic particle sizers (APS); microbiological techniques or PCR.

2.15 AB noted that some APSs are filter based particle counters that will inactivate any viable virus when taking measurements in the room.

2.16 CG conducted a study on gram negative bacteria but commented it is not possible to extrapolate that study to COVID-19 the lack of spread of live bacteria may simply be because some bacteria do not survive aerosolisation.

2.17 AS noted a study by Lindsey WG et al. 2010 that looked at airborne influenza virus in aerosol particles from human coughs; this study noted that influenza viral RNA was detectable in 81% of subjects however only 2 out of 21 subjects had viable influenza viral RNA in cough aerosols.

2.18 WSL summarised from the evidence and discussion that the use of NIV does not pose a higher infection risk than when a patient is coughing, as long as the patient does not take the mask off and is compliant.

2.19 There was a consensus in the group that in NIV, droplets of mainly 5-10μm are produced and the key issue for NIV use (in vented or non-vented systems) is the fit of the mask and the tolerability of the interface rather than the risk of aerosols being generated during proper use of NIV. The main risk of aerosols is when the patient takes the mask off and is non-compliant during NIV treatment.

2.20 Well-fitting oronasal facemasks, masks over the total face, or helmets should produce least droplet dissemination

3 *Do we agree that HFNO should be considered an APG? What evidence is available to support/refute this position?*

3.1 DH noted that HFNO has to be humidified when in use so you can see the droplets forming when the patient breathes out.

3.2 CG sent round an abstract describing a study that only identified large particles generated by HRNO. What was strange about the study compared to DH's experimental studies was that they observed larger particles travelling longer distances than smaller particles.

3.3 Other members commented that the larger particles have greater inertia and so it is possible for larger particles to travel further.

3.4 AS noted that they didn't see any droplets distributed and certainly not aerosols generated when using 60% oxygen- 16l/min which is what one may use before going onto HFNO.

3.5 The consensus within the group was that there is not enough evidence to say whether or not HFNO is an AGP. It would be more practical if guidance was able to separate AGPs into those which are mainly aerosol generating and those which are mainly droplet generating procedures.

4 If NIV and HFNO are considered AGPs, is there a difference in risk? By what order of magnitude?

4.1 Members commented that there is not enough information for an answer to this section but would put HFNO under the same category as NIV.

4.2 Members discussed the HFNO system being a more open system to NIV as there is no mask over the mouth. Positive pressure could be lost if the mouth was open. This would not change the flow rate out of the mouth. e.g. if 50l/min was going into the nose and the mouth was open, 50l/min would come out of the mouth although at a different velocity.

4.3 The consensus within the group was that there is not enough evidence to say whether NIV is safer than HFNO however there are some concerns that HFNO could be less safe than NIV.

5 What infection control recommendations are appropriate for the use of NIV and HFNO in patients with COVID-19 infection?

5.1 WSL introduced the question and stated that in an ideal world, all patients would be treated and managed in a negative pressure room but when there are not enough of these rooms, where would be acceptable to place patients outside of a negative pressure room?

5.2 Members commented that that in Singapore and Hong Kong, it is relatively common practice that patients are placed in side-rooms although side-rooms tend to be more common in these countries than in the UK.

5.3 Members commented that any aerosols generated or droplets produced would not reach as far as the corridor or the main ward provided that the door of a side-room is closed.

5.4 Members discussed the use of respirators and Fluid Resistant Surgical Masks (FRSM) for those managed in side-rooms or in the event of low stocks of respirators.

5.5 LR commented that the Infection Prevention and Control (IPC) pandemic guidance would encourage respirators to be prioritised in AGP hotspot areas such as High Dependency Units (HDUs) and ITUs and where ever there is an AGP. The prioritisation of respirator use will change as the situation changes.

5.6 Members commented on whether air changes within the room needs to be considered. LR noted that in the IPC pandemic guidance, there is a section that takes into account regular air changes.

Post meeting note:

LR shared the following with the group regarding air changes:

> *When a room is vacated by healthcare staff following an aerosol generating procedure, the large particles will fall out within seconds, however, the*

smaller aerosol particles behave almost like a gas. Clearance of small aerosol particles is dependent on the ventilation and air change within the room. A single air change is estimated to remove 63% of airborne contaminants; after 5 air changes, less than 1% of airborne contamination is thought to remain. In an isolation room with 10-12 air changes per hour (ACH) a minimum of 20 minutes is considered pragmatic; in a side room with 6 ACH this would be approximately one hour.

National Infection Prevention and Control Manual (NIPCM) RPE literature review (current version but under review)

https://hpspubsrepo.blob.core.windows.net/hps-website/nss/1722/documents/1_tbp-lr-rpe-v3.1.pdf states:

The rate of clearance of aerosols in an enclosed space (room) is dependent on the extent of ventilation: the greater the number of air changes per hour (ventilation rate), the faster any aerosols will be diluted.1 The time required for dilution of aerosols, and thus the time after which the room can be entered without respiratory protection, can be determined following a risk assessment. The risk assessment should take into account the number of air changes per hour (assuming perfect mixing, a single air change removes 63% of airborne contamination, each subsequent air change removes 63% of what remains; therefore five air changes reduces contamination to <1% of its former level, assuming dispersal has ceased). (AGREE rating: Recommend)

We added more detail to the practice national manual http://www.nipcm.hps.scot.nhs.uk/chapter-2-transmission-based-precautions-tbps/ to say:

Vacated rooms should also be decontaminated following an AGP. Clearance of infectious particles after an AGP is dependent on the ventilation and air change within the room. In an isolation room with 10-12 air changes per hour (ACH) a minimum of 20 minutes is considered pragmatic; in a side room with 6 ACH this would be approximately one hour. Advice should be sought from IPCT.

5.7 There was consensus that NIV use within a side-room (with or without an ante-room) would be appropriate provided that the door remained closed; all PPE is being worn including respirators, gloves, gown and eye protection; and appropriate air cycling was in place in the side-room.

5.8 Members discussed whether NIV use in a cohort bay would be appropriate.

5.9 AS noted that during swine flu, they used NIV in cohorts of confirmed cases who were placed together in open bays and that this was acceptable. During swine flu, there was a staffing advantage as well where the more experienced staff were working with the confirmed patients and many of the patients had experience of using NIV at home. In that situation, members agreed that in principle it would be acceptable but was highly dependent on the environment and set up within the different hospitals.

5.10 The group moved onto HFNO and whether they considered this would be appropriate in a side-room. It was noted that the number of HFNO units per hospital were few. Members noted that it was difficult to say whether or not patients using HFNO should be managed in side rooms as they had previously agreed that the absolute safety of HFNO was unknown. However, in practice, they would use HFNO in a side room provided there were the same considerations as NIV use. i.e. a side room with the door closed, full PPE, and appropriate air cycling.

5.11 The red line for this group is that staff should wear full PPE as outlined above when using NIV or HFNO. The group acknowledged that the next problem would appear if there was no longer a stock of respirators. The question that would arise is whether the group would recommend or not recommend using certain procedures if staff did not have access to respirators. The group agreed that it was not the right time to comment on such a situation.

5.12 CG noted that there are a lot of people working on the issue of HFNO and CG has been coordinating a research group at WHO on this and would be able to share some preliminary results in the near future.

5.13 AB has a team of people who are trained in taking air samples in various hospital environments and they are doing sampling in hospitals with COVID-19 patients. AB offered to test air samples if anyone has a patient who is using NIV or HFNO (including patients with other respiratory infections).

5.14 WSL thanked CG and DH for joining the meeting. The group then moved onto the closed part of the meeting to discuss questions regarding oxygen therapy which are commercially sensitive to the UK.

Post meeting notes:

the following points were discussed by members of the group via email:

CG emailed to say that *"when considering where to care for patients with COVID-19 on NIV you might want to think about the possibility of having to intubate the patient in the room in which they are receiving NIV in the case of unnoticed or sudden decompensation. Also, worth thinking about how to transport the patient to the ICU on NIV if your advice is to intubate there. We are aiming to intubate all our patients in isolation facilities in our ICU to minimize the risk of a "messy" intubation but the incidence of difficult intubation is higher in Chinese patients (more anterior larynx), we have a lot of isolation rooms and even the general areas of our ICU have 12 air changes per hour.*

My simplistic view is that transport automatically involves a lot of air changes per hour (unless you walk very very slowly) so the only real risk is in the lift, and then your exposure time is minimal."

CM noted that in Northern Italy, they have cohorted all cases in one institution, so far 220 ventilated patients. They have a very low threshold for intubation and have completely banned NIV/HFNO and have had zero nosocomial transmission.

AS agreed and emailed to say *"Yes. Agree 'level 3' critical care patients will all be invasively ventilated if facilities and equipment available, and many of the younger patients or those previously fit will either be escalated from NIV/HFNO early, or go straight to intubation.*

There is also a group of more elderly patients and/or those with heart and lung co-morbidity with a ceiling of care of NIV. We have far more of these patients in UK than in Italy and China because we are more explicit with Advance directives here. Of course with an overwhelming pneumonia they will die. Some may survive as this is a potentially reversible condition and I suspect much of what we do in 'level 2 HDU' will revolve around this group."

AS went to say that should the situation deteriorate *"we should extend level 2 beds to effective level 3 and some of the elderly co-morbid patients may be palliated, but I don't think that is what we would do in first instance while some sense of normality remains … This older co-morbid group is the bulk of the patients presenting in Italy and China so we do have to be explicit about ceilings of care.*

I have also discussed plans with colleagues in China (Prof Nanshan Zhong) and Italy (Stefano Nava) and the striking difference from H1N1 is the relatively small

number of children and infants, younger adults and indeed pregnant women, affected. All the cohort studies so far show this.

Quite appreciate the different perspectives of those colleagues in critical care, and those with HDU and respiratory ward responsibilities, but would see role of those in latter group is to where possible free level 3 beds/smooth flow by reducing those stepping up and facilitating patients stepping down."