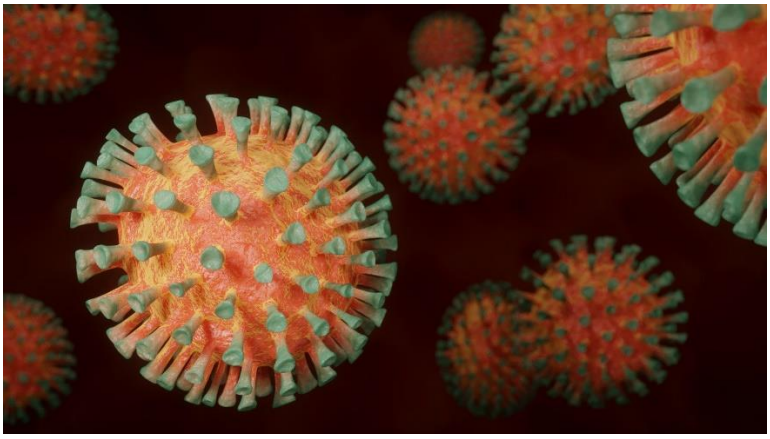
Specialised Ventilation for Healthcare Society

Updated Briefing & Guidance on Considerations for the Ventilation Aspects of Healthcare Facilities for Coronavirus



8th June 2020

Document SVHSoc.03-V5.

The Specialised Ventilation for Healthcare Society (SVHSoc.)

The Society was formed in November 2014 with the aim of bringing together those who were practicing or wished to become Authorising Engineers (Ventilation) (AE(V)) or who have a more general interest in Ventilation in the Healthcare setting.

- The SVHSoc. meet several times a year at various locations around the UK.
- Full membership of the Society is open to registered AE(V)'s.
- The Society "Code of Conduct" is issued with all quotations for AE(V) services.
- The Society maintains a register containing details of practicing AE(V)s.
- A set of competencies have been drawn up for prospective AE(V)s.

- Associate membership is open to anyone interested in Ventilation for Healthcare.
- A significant portion of the Society meetings is given over to discussing and clarifying interpretation of HTM03-01 and other healthcare ventilation standards.

Further information concerning the SVHSoc. may be obtained from:-

Malcolm Thomas - President SVHSoc. - malcolmthomas.vent@btinternet.com
+447814077474

Graham Powell – Chair SVHSoc. – grahampowell@grahampowellconsultants.co.uk
07958627587

John Rayner – Secretary SVHSoc. – john.rayner@turnerPES.co.uk
07714523131

The following documents have been issued by SVHSoc. to help clarify Healthcare Ventilation requirements

SVHSoc.01-V3.0 **Operating Theatres -**
Energy Control Strategies and the Surgeon's panel

SVHSoc.02-V1.0 **Change in Air Filter Test and Classification standards**

SVHSoc.03-V5.0 **Coronavirus COVID-19 Guidance**

Coronavirus COVID-19

Acknowledgments

Lead Author - Andrew Poplett
Principal contributor - Graham P. Taylor

The following individuals and organisations were consulted during the preparation of this document. Their contribution is gratefully acknowledged.

SVH Society Members & Associates

Consultant Microbiologists
Professor Rob Townsend
Dr Robert Porter

University of Birmingham
Mr Andrew Thomas Orthopaedic Consultant

The document has been reviewed and endorsed by the Institute of Healthcare Engineering and Estate Management.

Specialised Ventilation for Healthcare Society

SVHSoc.03-V5.0 (8th June 2020)

Contents

Introduction

Following peer review, recent feedback and experience from SVH Society members, the briefing and guidance from the SVHSoc has been updated to reflect the current guidance and to provide a range of supplementary additional options and areas for consideration for healthcare estates professionals to provide enhanced levels of protection for patients, staff, and visitors.

The briefing is intended to provide an overview of the issues and points to consider when assessing the ventilation strategy and options. It has also been updated to provide some initial maintenance considerations and precautions which may need to be considered. It is intended that this briefing and guidance will be subject to regular review and updates as details, information, and the situation continues to develop.

Current guidance on the lifespan of the virus once outside the body is still to be fully established, however current estimates are that it could survive anywhere between a few hours up to 3 to 4 days on hard surfaces and is spread by both primary direct exposure (breathing in droplets expelled from an infected person from coughing or sneezing) and secondary contact by touch (touching a surface which has been contaminated and transferring this contamination by touch to the mouth, nose or eyes). The PHE view is that "Coronaviruses are mainly transmitted by large respiratory droplets and direct or indirect contact with infected secretions. They have also been detected in blood, faeces and urine and, under certain circumstances, airborne transmission is thought to have occurred from aerosolised respiratory secretions and faecal material". That level of airborne transmissibility is specifically associated with certain aerosol generating procedures (AGPs).

That COVID-19 has been termed an airborne infection is an indication that it is capable of transmitting via an airborne route in certain circumstances, not that its mode of spread is primarily airborne nor that any aerosol remains sufficiently concentrated to be infectious over longer distances other than in the immediate vicinity of a dispersing patient.

Guidance is under constant review and updated as necessary. The current guidance 'COVID-19: infection prevention and control guidance' can be found at:

https://www.gov.uk/government/publications/wuhan-novel-coronavirus-infection-prevention-and-control

The guidance is issued jointly by the Department of Health and Social Care (DHSC), Public Health Wales (PHW), Public Health Agency (PHA) Northern Ireland, Health Protection Scotland (HPS), Public Health Scotland, Public Health England and NHS England as official guidance.

Ventilation can contribute to an isolation or protection strategy to assist in minimising the spread of the virus, however a number of factors need to be considered, not least of all the provision of adequate ventilation to provide dilution of any airborne contamination, with other factors including;

- Area / rooms where isolation can be established
- Physical / fabric of the room construction / air permeability rates (e.g. solid ceilings)
- Surrounding areas of clinical activity
- Room volume and airflow / room pressure differentials (dilution effects)
- Provision and location of ventilation (e.g. ceiling mounted supply with low level extract)
- Point of discharge and filtration of any extracted air
- Levels of isolation and practical considerations
- Decontamination of the area between patients
- Protection of all potentially exposed staff groups (clinical, cleaning, and estates)
- Potential risks associated with oxygen enriched atmospheres

Standards and Technical Specifications

HTM 03-01 sets out the overall guidance for ventilation of healthcare premises with addition specific guidance on isolation facilities being contained within HBN 04-01 Supplement and HBN 04-02 for critical care units (it should be noted that the HBN's can be interpreted as containing some conflicting advice for ventilation strategies, however the objectives are similar). These documents should be used as the basis for all ventilation strategies in conjunction with advice from the Infection Prevention Control (IPC) team, WHO, ECDC (European Centre for Disease Prevention and Control) & PHE support. Overall it needs to be an issue where clinicians set the room criteria and then estates can look to see how it can be provided.

Notwithstanding the above, in the SVHSoc's opinion, a standard for any facility used, should strive to achieve the following performance criteria;

- The room/area should achieve between 6 to 12 air changes per hour. The greater the air changes provided the more effective the dilution effect provided that it does not interfere with other critical elements. Total air volume and room size are critical to effective dilution.
- The room/area ideally should be at least neutral to the surrounding areas (0 to -10 Pa)
- If achievable the room/area should have sufficient air supply and extract to achieve open door protection, however this may not be possible other than in a PPVL room or air-locked facility.
- The room should ideally have a protected lobby (if possible) with barrier or isolation nursing care and PPE worn by all staff
- Immediately outside but adjacent to the room there should be a wash hand basin and an area for de-gowning. If the room has a lobby (PPVL) then de-gowning should take place within the lobby.

Droplet Transmission & Airborne Dilution / Clearance

PHE have stated that in their opinion there is very little to no risk of any viable virus transfer beyond the immediate clinical area through air gaps in doors or via pressure stabilisers as the water droplets would not survive the distance or routes without very significant dilution and desiccation. This is especially true for a patient who is anesthetised and on a closed breathing circuit. All staff within a critical care environment should be wearing full PPE. There is however emerging anecdotal evidence that the concentration of exposure may have a direct correlation to the severity of any surface contamination and subsequent infection and therefore dilution of aero-microbiological contamination is considered an essential precaution, even where PPE is worn.

Definitive scientific evidence that the infection is not airborne is not yet clear, and on a precautionary principle it should be assumed that it can be airborne on droplet nuclei, until proved otherwise, certainly for short distances within confined or poorly ventilated environments. Droplets expelled during AGP's can be anywhere from 1 µm to 2mm in size with an estimated average size of 50 µm. A droplet of 100 µm will fall to the floor at around 30cm/s and a droplet of 30 µm will fall at a rate of around 3cm/s, so droplets ejected from a patient by coughing/breathing are estimated to travel around 1 – 4 metres. With a downward displacement ventilation system in operation are likely to fall/be pushed to the floor very quickly. Added to this is the fact that patients are in a horizontal position typically 1m above the floor level and if ventilated on a closed breathing circuit making release of droplets less likely.

After any treatment or surgical procedure any residual airborne particles are cleared from a room at a rate of 63% per air change, therefore within 6 air changes 99.8% of any airborne contaminates will have been removed. In an operating department achieving the recommended air change rate of 25 air changes per hour (HTM 03-01 standard) the room will be effectively clear of residual airborne particles within 15 minutes or 20 minutes if achieving 20 air changes per hour (HTM 2025 standard). A similar effect will be achieved within a

treatment or CCU space although these will typically achieve between 15-10 ACH and will correspondingly achieve the required 6 air changes within 24-36 minutes.

The rate of clearance of aerosols in an enclosed space is dependent on the extent of any mechanical or natural ventilation and the size of the droplets created – the greater the number of air changes per hour (ventilation rate), the sooner any aerosol will be cleared. The practical implication of this guidance is that the current supply and extract ventilation systems offer an essential and significant dilution effect to a facility and should remain in use and are unlikely to offer any risk to building occupants / users.

General Options and Considerations

A negative pressure or PPVL room with lobby is the likely ideal option. Extract filtration, provided the air is discharged in an appropriate location, is not likely to be required as it is likely to significantly impact on the airflow performance and it will be necessary to undertake a risk based assessment on the use of extract filtration and consider system upgrades to maintain overall airflow performance. The point of discharge of any extract ventilation system should be assessed to ensure that it does not provide a route of cross contamination.

If however multiple PPVL rooms are not available then a side room with a lobby and its own en-suite is likely to be the next best option. The extract from the en-suite will provide some degree of pressure cascade / regime although it is unlikely to provide open door protection and the point of discharge location will again require to be assessed. If a side room has supply air then this should provide a minimum fresh air rate of at least 6 ACH but ideally be less than the extract air volume which should be increased (if possible) to maintain the room at a neutral/negative pressure, whilst not compromising dilution effect.

In most clinical care environments the vast majority of openable windows have security/restrictor arrangements to enhance user safety. In order to improve ventilation, it may be possible to undertake a risk assessed review to enable some windows to open more fully.

If an air scrubber/filtration unit is considered it will not provide any dilution or fresh air supply into the room, but may remove some contamination from the air, however the issue of how to de-contaminate and dispose of the filter unit between patients will need consideration (see maintenance considerations below).

As the spread of the virus has continued hospitals have been required to identify and consider designating entire ward areas or even buildings as isolation facilities. This cohorting of cases has been driven by clinical risk assessment based upon risk of cross contamination (between patients within the isolation space) and the need for clinical support/treatment.

In these circumstances it is likely that the capacity of the electrical and medical gas infrastructure (oxygen, medical air, and vacuum) systems has been the greatest challenge and ventilation has been a secondary issue, however some basic principles should still be considered;

- Wards with single bedrooms with en-suite facilities are likely to offer the best solution.

- Maintaining a good air change rate of between 6 - 12 ACH is considered appropriate to maintain a dilution effect for both patients and staff protection.
- The extract rate should ideally be greater than the supply where practical, to create an appropriate pressure cascade to surrounding areas, ideally with supply in corridors and extract by means of en-suite facilities and dirty extract systems, in all cases ward doors to circulation spaces MUST be kept closed as far as reasonably practical.
- If open plan/multi-bed bay wards are used then a clinical assessment of risk relating to cross contamination will be needed, however areas with low level extract by each bed space are preferable.
- If the ventilation system (AHU) serves more than a single ward then the supply aspect is less critical as the airflow direction provides a level of protection, however an ACR of around 6 ACH should be considered as a minimum. Shared extract systems are less ideal and consideration should be given to separating or closing off non-essential extracts if practical, for example if extract systems serve non related or non-clinical areas they may be able to be isolated to increase extract rates from critical areas. Extract systems should be inter-locked with supply systems to ensure that if the supply fails the extract continues to operate, however if the extract fails then the supply should also switch off, only as a short term measure until the extract system can be repaired / re-instated. If a failure is likely to be over 1 hour then the supply can be reinstated to provide both thermal comfort and dilution provided that it does not create a cross contamination risk.
- If an area or room is identified as being potentially suitable to be used as a temporary isolation facility it is advisable if possible to undertake a 'room air permeability or leakage test' to ensure air is contained within the room and does not leak to adjacent areas through suspended ceiling or service penetrations, (this may not be practical to achieve, given the urgency of demand).
- Any room used as a temporary holding or isolation facility should be stripped of all non-essential materials and soft furnishings.
- If a temporary extract unit is used to provide a negative pressure environment then care will be needed when considering the distribution ducting and the exhaust air discharge point. Ducting and extract grilles should be located to ensure an even draw of air from around bed spaces and not rely on a single point at the end of the unit which draws air over adjacent patients and staff. The exhaust discharge however providing it is discharging to a safe external space (ideally at high level 3m above roof level) then HEPA filtration is unlikely to be required. Consider sealing any openable windows in the immediate vicinity (around 4m) of any low level discharges and avoid discharge over pedestrian paths/walkways.

Use of Theatres as CCU's

As the need for critical care beds has increased some hospitals have identified areas which are suitable and have the required engineering and medical services to provide an appropriate and safe clinical environment. In many cases where patient ventilation / life support is required the theatre and associated recovery suites (freed up from elective procedures from mid-April) are considered as ideal. If kept for the exclusive use by non-infected patients the ventilation system is likely to need little modification or adjustment,

however consideration may be given to lowering both supply and extract rates to save energy and ensure patient comfort (reducing ACRs to around 10 ACH would be appropriate).

Recovery areas are preferable to theatres in the first instance as the ventilation strategy of these spaces provides a good air change rate (15ACH) with neutral pressure cascade to surrounding areas and bedhead low level extract to provide a clean air path for staff protection.

Typically 2 CCU bed spaces could be provided per theatre with an addition bed located in the anaesthetic room if needed, (medical gases, adequate ventilation and electrical outlets are typically all present in these rooms). Recovery spaces are designed to provide 12-15 ACH and should be neutral to surrounding areas so no modifications to the ventilation system should be needed.

If it is proposed to use theatres as spaces to treat COVID 19 infectious patients then the airflows would need to be very carefully reviewed and adjusted to maintain a safe air change rate and provide an ideally neutral pressure regime to surrounding clinical and staff areas.

Use of Theatres for Surgery for COVID 19 infected or Suspected patients (where they continue to be used for surgery)

The following information reflects the current guidance from the centre for the use of theatres for known or suspected infected (COVID19) patients;

https://www.gov.uk/government/publications/wuhan-novel-coronavirus-infection-prevention-and-control

It is recommended that ventilation in both laminar flow and conventionally ventilated theatres should remain fully on during surgical procedures where patients may have COVID-19 infection. Air passing from operating theatres to adjacent areas will be highly diluted and is not considered by PHE to represent a significant risk.

- Theatres must be informed in advance of a patient transfer of a confirmed or possible COVID-19 positive case, the patient should be transported directly to the operating theatre and should wear a surgical mask if it can be tolerated.
- The patient should be anaesthetised and recovered in the theatre. Staff should wear protective clothing but only those at risk of exposure from aerosol generating procedures, i.e. during intubation need to wear FFP3 respirators and full gowns. Those closest to aerosol generation procedures are most at risk. The rapid dilution of these aerosols by operating theatre ventilation should minimise the exposure to operating room staff.
- Instruments and devices should be decontaminated in the normal manner in accordance with manufacturers' advice
- Both laryngoscope handle and blade should either be single use or reprocessed in the Sterile Supply Department. Video laryngoscope blades should be single use and scope/handle decontaminated as per manufacture instructions.
- Instruments must be transported safely to decontamination, following use.

- The theatre and all associated support areas should be cleaned as per local policy for infected cases, paying particular attention to hand contact points.
- Theatres should not be used by staff or patients for 20 minutes after the patient leaves.
- Possible or confirmed cases of COVID-19 should be placed at the end of the list where feasible

The follow information is provided to support or supplement this initial guidance.

Neutral Pressure Theatres

With the current COVID19 infection issues there may be a requirement to designate a particular operating theatre or operating suite to be used for intubation, or other high-risk AGP's inpatients who are known to be COVID19 positive.

If airborne micro-organisms liberated from a patient during the intubation or surgical procedure are allowed to cascade out into the adjacent corridors, they could contaminate surfaces or infect other patients or the staff within the surrounding operating department. Although air passing from operating theatres to adjacent areas will be highly diluted and this is not considered by PHE to represent a significant risk.

The concept of a neutral pressure or infectious theatre is to maintain an appropriate and safe air change rate to the theatre space but instead of the traditional cascade arrangement of air from the theatre suite to the surrounding areas it is based on a balanced air flow of both supply and extract from ideally within the theatre itself or as a minimum within the individual theatre suite.

Setting up a neutral pressure theatre is a significant technical exercise, which is not without some disadvantages. In most hospitals a mixed flow of emergency patients, who may or may not be COVID19 positive, are probably best handled in normal operating theatres, with high levels of attention to infection prevention, particularly cleaning surfaces.

If neutral pressure theatres are not used it may be useful to designate one particular theatre, within a complex, which is relatively isolated, has good quality extract systems outside it and which does not have high levels of traffic outside it to use for high-risk patients.

The room provision and layout will be as for a conventional operating suite with the following variation to the ventilation scheme:

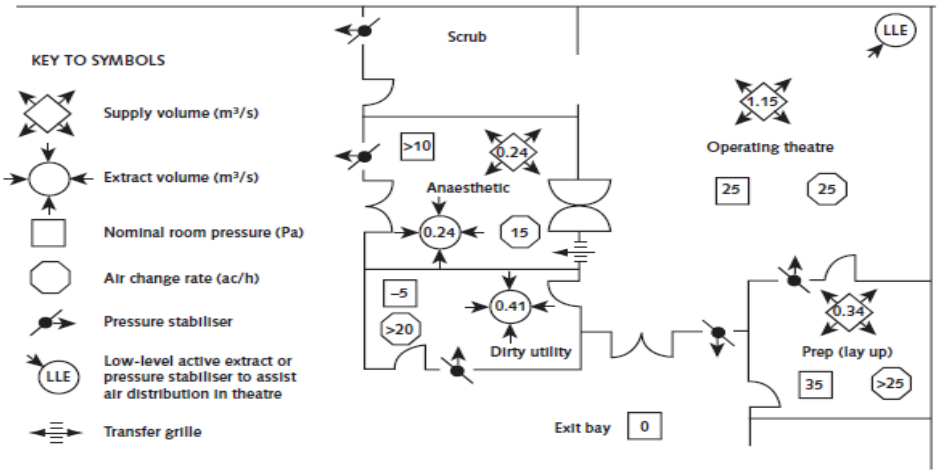
- The operating theatre will have a balanced supply and extract so that it is at the same pressure as the corridor.
- Air should not cascade from the theatre to the surrounding rooms so pressure stabilisers and / or transfer grilles will not be fitted.
- The preparation room could be dispensed with to avoid having stock that could become pre-contaminated. Sterile packs, instruments and consumables would be delivered to the theatre on a case by case basis. If a preparation room is required, then it should be maintained at 10Pa to both the theatre and corridor.
- The anaesthetic room should have a supply in excess of extract so that is maintained at 10Pa above both the corridor and theatre. There should be a

pressure stabiliser between the anaesthetic and corridor but no transfer between the anaesthetic and theatre.

- The scrub should have an active extract as for a conventional operating suite but no pressure stabiliser between it and the corridor.
- The utility should be at -5Pa to the theatre and its corridor.
- The corridor extract will be sized to cater for the air leakage from the anaesthetic room only.

Overall the ventilation scheme should ensure that all air supplied to the operating theatre is removed in the theatre suite. The theatre should be neutral (at the same pressure) to the corridor so that when the theatre exit door is open there is effectively no interchange of air between them. Ideally when the preparation or anaesthetic doors are opened airflows from them into the theatre and not the other way.

The traditional theatre suite layout typically as below (or a variation thereof);



If sites are required to endeavour to transform existing positive pressure cascade theatres to create a neutral pressure theatre the following areas will need to be considered.

In line with guidance the patient should be brought into and out of the theatre through the anaesthetic room, but anaesthetised and recovered in theatre. The doors and any pressure stabilisers from the theatre to the corridor should be sealed and not used.

The lay-up prep area should only hold the minimum stock required for the given procedure, however the air cascade from the lay-up prep to theatre should be maintained as a positive differential.

The pressure stabilisers from both the scrub area to the corridor and the anaesthetics room to corridor should be sealed.

The dirty utility room should remain at a negative pressure differential to both the theatre and corridor.

Ideally the anaesthetics room should be positive pressure to the theatre, however this may not be practical, in which case the anaesthetics room should only have all surfaces as clear as practical and all surplus or spare equipment held elsewhere.

A full re-balance of the supply and extract systems will be required and the provision of addition theatre extract is also likely. This will have to be assessed and designed on a theatre by theatre basis.

The same considerations apply to both conventional and UCV theatres. The UCV canopy is a re-circulation canopy and as such should have minimal impact on the theatres pressure regime, however due care should be taken not to disturb the canopies clean airflow area with excessive localised air movement and prevent perturbation of the UCV canopy air pattern.
It may be necessary to consider a relaxation of minimum air change rates to achieve a neutral pressure cascade however these should not be lower than 18ACH and MUST be agreed with clinical and IPC teams based on clinical risk assessment.

All non-essential materials and equipment should be removed from the theatre and surrounding corridor areas to ensure all cleaning can be undertaken as easily as possible.
Specific patient and staff procedures and flows will need to be considered and agreed.

An alternative approach may be to designate a suite of theatre suites within a single location (floor or building) as infectious at which point the entire theatre complex could be isolated from any surrounding clinical areas and used exclusively for only infectious patients. In this case provided the extracted air was discharged to a safe location and all staff wear PPE whenever within the theatre area no or limited modification to ventilation strategies would be necessary.

De-commissioning / reinstatement of original design ventilation strategies

At some point it is reasonable to presume that any modifications made to clinical areas and environments will need to be returned to their original use / ventilation strategy, with the additional consideration that they may need re-modification if a future surge in demand reoccurs. With this in mind and subject to agreement by the local Ventilation Safety Group and individual AE(V) it is recommended that a full re-verification be completed with a full record of all modified settings and performances taken prior to adjustment and a full verification be completed to confirm a return to the original compliant performance standards.

Temporary / Mobile Air Conditioning

In the majority of critical healthcare areas where environmental conditions require to be controlled, remote heating and cooling is achieved with the use of a central air handling plant which provides conditioned air to the clinical area whilst retaining the mechanical plant outside the immediate area, for ease of hygiene and maintenance. However if these remote units fail or during periods of high ambient air temperatures some critical areas may require supplementary or temporary cooling solutions to maintain a safe and suitable patient or clinical environment. In such circumstances and as a last resort mobile air conditioning (AC) units could be considered as a short term option. Current guidance does not recommend these types of unit for critical care areas, however if the risk of excessive heat is considered to outweigh the potential microbiological risks they can offer a temporary solution.

Temporary or mobile air conditioners may be installed in non-clinical areas, but they should be positioned to ensure that cold draughts are avoided. The control settings should ensure that the external elements of the units are always above dew-point. Manufacturers of these devices can provide specific advice on the siting and design limits of their equipment. It must be remembered that these units only recirculate air, and therefore, a fresh air supply of at least 20% of the room air change rate, or that required by the Building Regulations, or 10 L/s/person − whichever is the greatest − should be provided.

Guidance & Background

As stated above the use of portable air conditioning is not considered appropriate for critical care areas, however in emergency situations they may offer the only practical solution to an immediate and urgent need and as such there is a need to minimise the potential increase in clinical and estates related risk.

HTM 03-01 Part A

2.51 Recirculated room air affects indoor air quality and may increase the risk of healthcare-associated infection (HCAI). Split units should therefore not be used in critical care areas.

2.52 The units should be easily accessible for cleaning and maintenance.

HTM 03-01 Part B - Portable room air-conditioning units

5.28 Portable units are sometimes kept in-store or hired-in to cope with temporary local situations giving rise to excessive temperatures. They typically incorporate internal recirculation air filters and a drainage system to remove condensate from the cooling coil. The infection control team must be consulted before these types of unit are deployed.

5.29 The units should be inspected and thoroughly cleaned before being taken into use. Units that are to be used in areas containing immunocompromised patients will, unless new, need to be fumigated before use.

5.30 All portable units should be inspected and cleaned every week that they remain in use.

5.31 Units that have been used in isolation rooms or areas containing infective patients will need to be fumigated before being used in other locations, or returned to store or to the hirer.

5.32 Units employing an internal water reservoir and wick to promote evaporative cooling must not be used in healthcare premises.

Clinical Risk Assessment

As advised within the HTM 03-01 guidance prior to the deployment of these types of unit the Infection Prevention Control Team and Clinical leads for the area should undertake and record an assessment of risk from both the use and potential impact of not utilising a portable AC unit. If no other practical solution is available then a portable AC unit can be considered as a temporary solution.

Estates Assessment

In addition to the clinical assessment the Estates team will need to undertake an assessment of where and how any portable unit can be located. Areas to assess will include electrical load and capacity, location of both the internal (evaporator) unit to ensure that air discharge does not interfere with any other ventilation systems or equipment, pipework or ducting route to the outside (condensing) unit, condenser unit location and heat dispersion potential, condense drainage options and routes.

Location / Access to the unit

Both the clinical and Estates risk assessment should consider the physical location of the cooling unit to minimise anyone being directly within the outflow air path to avoid both draughts and to maintain a clear zone at the point of discharge. The unit should be clearly labelled to discourage touching or moving the unit unless during cleaning/maintenance works and then it must be put back into the agreed / specified location within the risk assessment. If an adjustable fan speed is available on the unit the risk assessment should specify a maximum setting to minimise air currents within the breathing zones of staff.

Maintenance Standards

These types of unit require frequent inspection and checking to both ensure appropriate performance and minimise infection risks and maintain good hygiene standards.

User Daily checks and cleaning

The clinical area users should inspect and check the unit of correct operation daily including a wipe down of external surfaces with a damp, clean cloth and ensure that no signs of leakage are present. Any issues or concerns should be reported immediately to the Estates department.

Use in areas of infectious or immune-compromised patients

If the units are located in areas where patients may be transient and have either potentially infectious or neutropenic conditions then a thorough clean of both internal and external surfaces should be done between each patient. The extent and nature of the cleaning should be agreed by the IPC team, however will usually follow the same criteria as the weekly estates inspection and servicing (see below).

Estates Weekly Inspection and Servicing

EXTENT OF WORK TO BE INCLUDED

- Check operation of the system in both heating and cooling modes
- Check operation of all functions of the controller
- Examine and clean external surfaces of all motors, compressors, fans, finned heat exchangers, grilles and louvers.
- Check and clean or renew air filters as necessary
- Spray indoor heat exchanger with Biocide cleaner
- Clean and flush all condensate and drain lines.

- Check operation of the condensate pump, if fitted.
- Check interconnecting pipework.
- Check electrical connections
- Record the ambient temperature in the vicinity of the condensing (outside) unit.
- Check all covers are secure.

Portable / Temporary Re-circulation Filtration Units (Inc. HEPA)

If an air scrubber/filtration unit is considered it will not provide any dilution or fresh air supply into the room, but may remove some contamination from the air, however the issue of how to de-contaminate and dispose of the filter unit between patients will need consideration (see maintenance considerations below).

The primary consideration when considering these types of units should include;

- The total volume of air circulated over a given time period (litres/hour) when compared to the overall room volume.
- The efficiency of the filter and estimated lifespan and maintenance requirements of the filters.
- The independent test data and evidence based research which has been undertaken and peer reviewed to demonstrate the efficacy of the units in use.
- The cost benefit analysis of the units as a solution as opposed to mechanical ventilation (supply and extract) provision.

Temporary UV Light units (fixed and Mobile)

UV light units are generally only suitable for room decontamination when not in use or following occupation by an infectious or suspected patient. These units can be considered as an alternative to the use of a peroxide fogging systems, but have a number of potential issues to consider;

- Exposure or 'kill' time to effectively clear surface contamination.
- Typically the disinfection efficiency is directly related to the time-length of exposure to the UV source,
- What is the distance of the target from the UV source, and
- Ensuring all surfaces are accessible and no shadowing issues exist.
- The efficiency of the UV bulbs / light source and estimated lifespan and maintenance requirements of them.
- The independent test data and evidence based research which has been undertaken and peer reviewed to demonstrate the efficacy of the units in use.
- The cost benefit analysis of the units as a solution as opposed to mechanical ventilation (supply and extract) provision.

Note- Duct mounted Ultra Violet (UV) Light units for supply air systems

Treating the incoming air has little effect on the bio-burden inside a building. Air change rates are used to provide dilution to the internal space from the occupants of the space. The other way to control the bio-burden level is to restrict the number of people, the less densely occupied the lower the bio-burden, the better the dilution effect that results from the air change rate.

Review and Reassessment

Any deployment of portable air conditioning, filtration or UV systems should only be considered as a last resort and MUST be kept under constant review.

As a minimum a 4 weekly formal review should be undertaken and recorded for each area where the units are used and progress on permanent repairs or solutions should be recorded to ensure that these types of units do not become long term. In practical terms the use of these units should never need to exceed 3 months (unless specific identified issues exist).

NHS Nightingale Units - Potential Viral load risk and test methodologies

One of the founding principles of healthcare ventilation is the dilution and removal of airborne contaminants from the patient environment with particular requirements for the air change rates, by room volumes (as specified in HTM 03-01 (2007), via clean airflow paths. In addition to the issue of aero-microbiological loading, there is also the additional risk of oxygen enrichment of the general environment due to the potentially high concentration of patients on ventilators or receiving oxygen based therapy/ treatments.

Both of these issues are addressed by the use of good general ventilation through air changes of the occupied volume of the treatment/ patient space.

The spaces being used generally appear to benefit from very high ceiling void spaces and there is likely to be a high degree of thermal air movement from the bed areas into the open void above, where the existing ventilation system will be located.

It is not possible to know what specific ventilation strategy is deployed into any proposed space, however it is likely that the facility will have some degree of forced mechanical ventilation (both supply and extract). In HTM 03-01 (2007) under normal conditions, the general criteria for the performance of supplied air is recommended to be 10 to 12 Air Changes per hour (ACH) for Critical Care facilities.

The brief to date for NHS Nightingale facilities has been to use as much of the existing infrastructure as possible. In the majority of NHS Nightingale facilities, which were converted exhibition halls, air is generally provided from high-level ducts. In some cases, this may be in excess of 11.5 m above ffl, and the air is discharged through high-velocity jet nozzles. In these venues, the main criteria used to achieve the desired airflow at bed height was a velocity of 0.5 m/s at 2.5m above ffl to achieve the optimum velocity of 0.2 - 0.35 m/s at bed height. The overriding design consideration was to provide a sufficient air velocity and therefore dilution, around all beds. To ensure the thermal comfort of the critical care team, due to the enhanced PPE worn, the temperature of the supply air can be set to ensure the environment does not exceed 21°C ambient (where practical).

Wherever possible full fresh air is to be provided avoiding the use of re-circulation airflows. This may be achieved by converting the AHUs to full fresh air by physically blanking off the recirculation provision. If recirculation is to be considered it must be accepted by the Trust's lead Infection Prevention and Control person.

It is essential that the occupying Trust's NHS Fire team are involved in aligning the existing building fire strategy with the newly created facility and the interface with the ventilation system considering the enhanced risks of evacuating the building and potential increased concentrations of oxygen. For these reasons, it is recommended that Oxygen concentration calculations, be carried out.

In order to test and certify the effectiveness of the patient environment, it would be ideal if a two stage approach were adopted;

- Stage 1: pre-occupation
- Stage 2: appropriate intervals during the operational phase of the facility.

Stage one (pre-occupation) ventilation test approach.

Active air sampling for microbiological activity will be of little use prior to patient occupation, it is therefore suggested that a simple test of air movement and dilution be completed at a number of sample bed spaces. This would involve:

- Use of cold smoke (Draeger Smoke Test Puffer) to demonstrate the time taken to clear and general direction of airflow paths - ideally this should occur within a few seconds of release.
- Additionally, a Kata Test Thermometer can be used to produce an accurate air velocity performance reading at the bedhead - ideally this should be in excess of 0.2m/s.

A vane or thermal anemometer is unlikely to produce a reliable test reading at these low velocity levels.

Stage two (occupied) ventilation test approach.

Once occupied, a regular air monitoring regime could be employed to establish and monitor both 'oxygen concentration' levels (using a suitably calibrated and certified oxygen monitor, to BS EN 50104:2019), to enable action to be taken if high levels are found and, 'active air sampling' in the form of occupational environmental air sampling (HSE G409 and Monitoring strategies for toxic substances HSG173 (Second edition) HSE Books 2006 ISBN 0 7176 6188 1) of staff to ensure adequate dilution is being achieved in use.

Non Residential Community Healthcare Ventilation systems (e.g. Health centres)

The practical implication of the guidance is that the current supply and extract ventilation systems offer a dilution effect to the facility and should remain in use and are unlikely to offer any risk to building occupants / users.

Recirculating air conditioning units (also known as split systems) should not be used within clinical care environments as they incorporate both air filtration and water / condensation 'open' trays. These units can provide a location where micro-organisms can become concentrated and proliferate. This is not a specific COVID-19 risk but a general consideration for the use and installation of these units.

Environmental cleaning following a possible case

Once a possible case has been transferred from the primary care premises, the room where the patient was placed should not be used, the room door should remain shut, with windows opened and the air conditioning switched off until it has been cleaned with detergent and disinfectant. Once this process has been completed, the room can be put back in use immediately.

Note - The air conditioning referred to is understood to be any room mounted 'split' air conditioning unit which only circulates the air within the space and cools or in some models heats the air. As this does not provide fresh air, nor does it remove air to outside the advice to switch it off is related to it not being used whilst windows are open.

Non ventilation Considerations

In addition to the ventilation issues associated with the current COVID 19 pandemic, other healthcare related engineering services and operational considerations will need to be assessed and considered. These are likely to include;

- Medical gas capacities and flow rates to deliver required clinical treatments (oxygen, medical air & vacuum).
- Number and location of electrical outlets on essential power supplies, for clinical and medical electronics.
- Provision of suitable emergency lighting
- Patient access and egress / transportation routes through other clinical / public areas.
- A minimum separation distance of between 1 – 2 metres should be maintained between beds
- If temporary separation / partition walls or barriers are constructed to create segregated bed spaces, the fire strategy and fire evacuation plans MUST be reviewed to ensure they remain appropriate. This should involve identification of evacuation routes and places to provide both an immediate safe refuge and a place to continue care and treatment.
- Provision of adequate hand washing facilities.
- Waste collection and storage capacities and locations and transfer routes.
- Surrounding clinical services to avoid close proximity to other 'at risk' patient groups.
- Adequate staff welfare and rest areas if staff numbers are increased to meet clinical needs.

Estates staff are recommended to give consideration to all of the above and where considered necessary review the PHE guidance and consult with their appropriate Authorising Engineer for the associated engineering specialty.

Additional guidance is available in the NHS&I – Novel coronavirus (COVID-19) standard operating procedure – Design Note: COVID-19 ward for intubated patient's version 1.0 published 22/03/2020 (Publications approval ref 001559).

Ventilation Maintenance Considerations

Ventilation breakdowns and repairs

Any potential contamination risk associated with extract ductwork, fans and filters is likely to be very low. The ventilation system acts to dry out any droplets that are drawn out of a room and if these droplets settle on ductwork or fan surfaces they will very quickly desiccate and are likely to be inactive. Notwithstanding this it is advised that enhanced precautions should be taken by maintenance staff when working on such systems both as a precautionary measure and to provide re-assurance to those undertaking the work.

If a breakdown or internal inspection is required to an extract system from a potentially contaminated area then the following issues should be considered;

- Minimise the tools taken into the area during any period when a system is 'opened up' for maintenance or inspection.
- Following work being completed old or redundant materials / components should be bagged and removed as clinical waste.
- Tools used during the work should be washed / disinfected where practical or wiped down with alcohol based steri-wipes or similar.
- Minimise the number of workers in the immediate area of the work, whilst maintaining safe working conditions and staffing levels (two man working may be necessary if working at height or if moving and handling issues exist).
- All staff should wear appropriate PPE and dress, remove, and dispose of it as detailed below.

Other maintenance activities not directly relating to extract ventilation maintenance such as fire damper drop testing, or ductwork cleanliness inspections will need to be managed so as to ensure that no potential contaminated extract ductwork is opened accidentally. Smoke and fire dampers on extract systems will need to be assessed to ensure routine fire alarm testing does not interrupt or involve extract ductwork ventilation system operation, if being used for isolation protection.

The precautions and method statement detailed above should be adapted / applied to all maintenance staff working in areas where potentially or known infectious patient are or have been located whether working on ventilation systems or any building / estates related element / equipment.

Filter changing

There are two typical types of filters installed in extract ventilation systems, Safe change types in systems designed to handle toxic or contaminated air (LEV's or HCID units) also known as Bag In Bag Out BIBO type filter units and general filtration (primarily designed to protect fan components and heat exchangers).

Safe change filter units as specifically designed to enable removal and replacement without exposing the maintenance worker to direct contact with the dirty filter. The design of these units can vary so the manufacturers' guidance notes and method statements should be followed to ensure safe removal and disposal.

General filters will not be of a grade that is designed to capture all particles, but will capture some and should be treated carefully. Prior to opening up a unit to remove a general filter a disposal bag should be available. The unit should be switched off and any backflow dampers allowed to close (or if manual – closed) prior to opening up the filter access door. The filter should be removed carefully to minimise the release of any dust/contamination on the filter surfaces and placed directly into the disposal bag. The filter frame should be cleaned ideally with a HEPA filter vacuum cleaner or wiped down with and alcohol based steri-wipe, the used wipes should also be disposed of in the filter disposal bag.

Once clean the new replacement filter can be installed, the unit re-assembled and the fan switch on, once any manual dampers have been re-opened.

PPE - Putting on and removing personal protective equipment

Putting on PPE

Before donning, healthcare maintenance workers should, remove all nonessential items and tools from overalls and tool bags, ensure they are hydrated, and perform hand hygiene.
Staff should wear the following PPE, put on in the following order:

- Disposable boiler suit/coveralls
- FFP3 respirator and fit check
- eye protection (goggles or face shield)
- disposable gloves

The order given above is practical but the order for putting on is less critical than the order of removal given below. During donning each item must be adjusted as required to ensure it fits correctly and interfaces well with other PPE items.

Removal of PPE

PPE should be removed in an order that minimises the potential for cross-contamination.
If working within a clinical space after leaving the side room gloves, disposable boiler suit and eye protection should be removed (in that order, where worn) and disposed of as clinical waste. The respirator can be removed and the filters disposed of as clinical waste with the mask being wiped clean with alcohol based steri-wipes or similar.
If working in a plantroom or service area (on remote located ventilation equipment associated with an isolation facility then the PPE should be removed and bagged prior to leaving the plantroom area. Other staff should not be working in the area whilst the maintenance work to extract ventilation systems is being undertaken.
The order of removal of PPE is suggested as follows, consistent with WHO guidance:

- peel off gloves and dispose in clinical waste
- perform hand hygiene
- remove boiler suit by using a peeling motion, fold in on itself and place in clinical waste bin
- remove goggles or visor only by the headband or sides and dispose in clinical waste
- remove respirator from behind and dispose of filters as clinical waste
- Clean respirator mask housing using alcohol based steri-wipes or similar.
- perform hand and face hygiene

For additional guidance see the PHE COVID-19: Guidance for infection prevention and control in healthcare settings. Version 1.0. Appendix 3 – Best Practice - Putting on and taking off PPE.

Endnote

Any healthcare organisation which is undertaking works or modifications to their ventilation systems should seek to obtain specialist advice both internally from the organisations own multi-disciplinary team (estates (AP(V)), IPC, Clinical leads, Decontamination leads, Medical Gas AP(MPGS), etc.…) but also from an appropriately qualified and experienced Authorising Engineer (Ventilation) or other suitable professional design consultant.

References

Health Technical Memorandum 03-01 specialised ventilation for healthcare premises Parts A & B (2007)

Health Building Note 04-01 Supplement 1 Isolation facilities for infectious patients in acute settings

Health Building Note 04-02 Critical Care Units (2013)

2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings - *Jane D. Siegel, MD; Emily Rhinehart, RN MPH CIC; Marguerite Jackson, PhD; Linda Chiarello, RN MS; the Healthcare Infection Control Practices Advisory Committee*
Guidance Wuhan novel coronavirus (nCoV) infection prevention and control guidance Updated 31st January 2020 - Gov.UK Public Health England

Guidance COVID-19: infection prevention and control guidance PHE.Gov.UK
NHS&I – Novel coronavirus (COVID-19) standard operating procedure – Design Note: COVID-19 ward for intubated patients version 1.0 published 22/03/2020 (Publications approval ref 001559).

COVID-19 Guidance for infection prevention and control Guidance (Version 3.1 - 21 May 2020) issued jointly by the Department of Health and Social Care (DHSC), Public Health Wales (PHW), Public Health Agency (PHA) Northern Ireland, Health Protection Scotland (HPS), Public Health Scotland, Public Health England and NHS England as official guidance.

REHVA COVID-19 guidance document March 17, 2020 – Federation of European Heating, Ventilation and Air conditioning Association

The Use of Engineering Measures To Control Airborne Pathogens In Hospital Buildings, Dr Clive Beggs, School of Civil Engineering, University of Leeds, Leeds LS2 9JT, UK