Transmission of SARS-CoV-2 in a Scottish hospital

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How is SARS-CoV-2 transmitted between people?

There are three possible ways for the virus to be transmitted:

1) You could touch a sick person or an object that has been contaminated with the virus and transfer it to your eyes, nose, or mouth.

2) Large virus-containing respiratory droplets that fly out of a sick person's mouth could land directly in, or on, your eyes, nose, or mouth.

3) You could breathe in tiny aerosol particles from the air. These are much smaller than respiratory droplets and you cannot see them. They float around in the air like cigarette smoke. These aerosols may contain more virions than the larger droplets.

Linsey C. Marr, Virginia Tech, USA

Nothing has yet been proven! It is very difficult to isolate viable virus from clinically generated aerosols, surfaces, or air. Air samplers, in particular, can inactivate virions through their harsh collection processes.



Is the virus on surfaces that we touch?

Many *in vivo* studies have detected virus on surfaces, mostly hand-touch, but it rarely grows in tissue culture;

This means that it is deemed non-viable and non-infectious;

An experimental lab study showed that viable virus can survive for up to 72 hours on various surfaces.

van Doremalen N, et al. N Engl J Med. 2020;382:1564-1567.



'A systematic review stated that, 'Direct contact and fomite transmission are presumed but are likely only as an unusual mode of transmission.....' Meyerowitz EA et al. Ann Intern Med. 2021;174(1):69-79.

Is the virus in the air that we breathe?

Air samples were collected in the room of two COVID-19 patients using VIVAS air samplers that operate on a gentle water-vapour condensation principle;

Viable virus was isolated from air samples collected **more** than 2 metres (2-4.8m) away from the patient. The genomic sequence of the airborne SARS-CoV-2 strain was identical to that isolated from the patient;

Infected COVID-19 patients produce aerosols when they breathe or speak; these may also be defined as '*aerosol-generating procedures*' and they are a source of transmission.



Lednicky JA, et al. Viable SARS-CoV-2 in the air of a hospital room with COVID-19 patients. Int J Infect Dis 2020; 100: 476-482.

Where do contaminated respiratory particles go?



Respiratory 'droplets' typically >100 um diameter fall to the floor under gravity within 1-2 m of the source (blue particles);

Respiratory 'aerosols' typically <100 um stay suspended for longer, but eventually fall to the ground if the air is still for at least 30 minutes (red particles).

Tang JW, et al. Dismantling myths on the airborne transmission of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). J Hosp Infect. 2021;110:89-96.

Inhaling aerosol is the main route of transmission!

- 1. Super spreading events
- 2. Asymptomatic and pre-symptomatic shedding
- 3. Transmission is higher indoors than outdoors and is substantially reduced by indoor ventilation
- 4. Transmission occurs between people in adjacent rooms but not face-to-face in quarantine hotels
- 5. Viable SARS-CoV-2 has been detected in the air (lab experiments, hospital rooms, and a car)
- 6. SARS-CoV-2 has been isolated from hospital air filters and building ducts
- 7. Transmission occurs between infected animals and uninfected animals in separate cages via air ducts
- 8. No study has yet provided evidence to refute the hypothesis of airborne SARS-CoV-2 transmission
- 9. No evidence for transmission via respiratory droplets or contact with surfaces/fomites
- 10. Hospital outbreaks have occurred despite strict contact-and-droplet precautions including PPE designed to protect against droplets but not aerosol

Measles and tuberculosis, two <u>airborne</u> diseases, have NEVER been cultured from room air!

Greenhalgh T et al, Ten scientific reasons in support of airborne transmission of SARS-CoV-2 April 15th, 2021, The Lancet







STRICTER CORONAVIRUS RULES



The Scottish Sun, 29th October 2020

Hospital W

NHS Lanarkshire is a

semi-rural health board situated between Edinburgh and Glasgow in Scotland. There are three acute hospitals with centralisation of some specialties.



Hospital H (550 beds) offers Vascular surgery, Stroke care and Ophthalmic services, Hospital M (650 beds) has Infectious Diseases, Haematology and Renal services; Hospital W (800 beds) has Paediatric, Maternity, and Orthopaedic Trauma services.

The health board experienced high rates of COVID-19 infection during the pandemic, with the third highest rate of infection in Scotland after Glasgow and Edinburgh. Hospital and care home clusters were defined as two or more patients and/or staff testing positive for SARS-CoV-2 and linked in space and time.



Total cases in Lanarkshire decreased from October 21st until 21st December 2020



1ST OCTOBER 2020 - 31ST MARCH 2021

COVID-19 clusters at community care homes and three acute hospitals in one Scottish healthboard

No. of clusters

30

Oct 1st 2020 – March 31st 2021



Interventions applied

- Outbreak committee
- Ward closures
- Enhanced cleaning
- Patient screening
- Staff screening
- Universal face masking
- Visitor restrictions
- Daily surveillance
- Respirator mask for 'aerosol generating' procedures
- Ward ventilation review
- Hospital walkabout: staff rooms, changing rooms and toilets
- SARS-CoV-2 strains sent for genotyping



WHAT CLEANING DID WE DO?

	Low Risk Pathway	Medium Risk Pathway	High Risk Pathway
First daily clean	Full clean	Full clean	Full clean
Second daily clean	High risk touch surfaces within clinical inpatient areas.	High risk touch surfaces within clinical inpatient areas.	High risk touch surfaces within clinical inpatient areas.
Product	General purpose detergent. (Note that cleaning in this pathway should be carried out with chlorine- based detergent for patient rooms where the patient is known or suspected to have another infectious agent).	Combined detergent /disinfectant solution at a dilution of 1000 ppm chlorine or general purpose neutral detergent in a solution of warm water followed by a disinfectant solution of 1000 ppm chlorine.	Combined detergent /disinfectant solution at a dilution of 1000 ppm chlorine or general purpose neutral detergent in a solution of warm water followed by a disinfectant solution of 1000 ppm chlorine.

Wearing a FACE MASK is mandatory for ALL ward patients



The main **EXCEPTIONS** being:

- if wearing a mask cannot be tolerated (for example, if you have severe respiratory problems); or
- if wearing a mask compromises your clinical care (for example, when receiving oxygen therapy)

Patients may also remove their face masks when:
eating and drinking
showering; and
sleeping

When moving around the room or between other areas within the hospital, patients MUST wear a face mask



How to stay safe from Covid-19 in a toilet

- 1. Wear a face mask
- 2. Open the windows if present
- 3. Put used toilet paper into the toilet or waste bin and not on the floor
- 4. If there is a toilet lid, put it down before flushing
- 5. Wash your hands with running water and soap
- 6. Do not spit into wash basins or anywhere else!
- 7. Dry your hands well, preferably with disposable towels, or use the dryer; don't return to the toilet cubicle for toilet paper
- 8. Place all disposable towels in waste bins
- 9. Help others to wash & dry hands if necessary, e.g. children
- 10.Do not use phones or other mobile devices in the toilet
- 11.Spend as little time in the toilet as possible
- 12.Hold the door open for others on entrance or exit

Dancer SJ et al, What is the risk of acquiring SARS-CoV-2 from the use of public toilets? Science Total Environ 2021, in press

No lid.....

REFRESH THE AIR BECAUSE WE CARE!

Circulating fresh air can reduce the spread of Covid – 19. The windows will be opened regularly. We launched an '**Open The** Windows' policy from <u>25th</u> January 2021

All the windows in naturally ventilated clinical areas were opened for **15 minutes three times a day**

Windows were also opened in the canteen and along corridors

If you are cold, let a member of staff know who will help. Please support our staff to keep you as safe as possible.

Did the COVID-19 clusters resolve?

In total, NHSL identified **40 Covid-19 clusters** between 1st October 2020 until 25th January 2021 (window opening), with another **3 clusters** before March 31st.

There were **17 Covid-19 clusters** involving 14 wards at Hospital W, lasting from 2-42 days (average: 5 days, median:14 days). Each cluster involved an average of 9 patients (range 1-24) and 7 staff (range 0-17).

After 25th Jan (window opening), just **TWO new clusters** occurred at Hospital W: the first occurred 2 days after window opening, lasted 9 days and involved 13 patients and 4 staff, and the second occurred 3 weeks after window opening, lasted 4 days and involved 6 staff and 7 patients.

There was **ONE new cluster** at Hospital M six weeks after window opening; this involved 6 patients only and lasted 12 days.

There were no new clusters at Hospital H after window opening began.

Oct 1st 2020 – March 31st 2021

Did window opening in clinical areas helped to stop further COVID-19 clusters in NHS Lanarkshire hospitals?

Points for:

- 17 clusters vs 2 at Hospital W (40 for all 3 hospitals reduced to 3)
- Higher COVID-19 rate in NHSL at the time of window opening
- More care home clusters at the time of window opening
- Continued high number of patient admissions at Hospital W
- More COVID-19 patients in the hospitals at the time of window opening
- All new patient admissions were screened for COVID-19 throughout study period
- Staff screening from 21st Dec had no discernible impact on Jan clusters
- Link between cold weather and new clusters... not seen after window opening
- Patient movement reduced at Hospital W only

Points against:

- Nationwide 'lock down' from 26th Dec so overall rate was already decreasing
- Care home clusters peaked on 19th Jan (n=25), decreasing slowly over the following 3 months
- Staff vaccination programme may have influenced number of clusters seen after window opening.

NB. Ventilation review: one ward had 2 AC/hr; four toilets had 3-10 AC/hr; treatment room had 1 AC/hr

	Total Patients Admitted in NHS Lanarkshire				
Date	Hospital H	Hospital M	Hospital W	NHSL	
Oct-20	2140 (23%)	3106 (34%)	3960 (43%)	9206	
Nov-20	2117 (25%)	2877 (37%)	3530 (41%)	8524	
Dec-20	2268 (27%)	2957 (35%)	3139 (38%)	8364	
Jan-21	1860 (24%)	2669 (35%)	3188 (41%)	7717	
Feb-21	1903 (25%)	2494 (33%)	3229 (42%)	7626	

Did patient movement contribute to the December clusters at Hospital W?

The number of orthopaedic boarders steadily increased from 2nd Nov until 21st Dec 2020 before stabilising and then decreasing from the middle of Jan 2021.

Genotyping (WGS) data from Hospital W

- 9 Wards
- Date range 9th November 2020 to 26th December 2020
- 64 samples
 - 5 staff
 - 59 patients
- Diversity of SARS-CoV-2 population
 - 3 Global lineages
 - 4 UK lineages
 - 8 Phylotypes

Dominant phylotypes across Hospital W

- 08/11/20-15/12/20
- 09/11/20-16/11/20
- 12/11/20-19/12/20
- 26/11/20-14/12/20
- 03/12/20-19/12/20
- 09/12/20-14/12/20
- 11/12/20-26/12/20
- 12/12/20-18/12/20
- 14/12/20-19/12/20

Ward 14 Ward 10 Ward 17 Ward 16 Ward 4 Ward 8 Ward 12 Ward 5 Ward 9

- UK4817 1.6.1.6.1 UK1506 1.1.1.2.1.1.1.4.2 UK4817 1.6.1.6.1 UK4817 1.6.1.6.1 UK4817 1.6.1.6.1 UK4817 1.6.1.6.1 UK4817 1.6.1.6.1 UK4817 1.6.1.6.1.1
- UK6007_1.1.1.1 (UK4817_1.6.1.6.1)

No VOC-20Dec-01 'Kent' variant: dominant lineage is from the successful European summer lineage

WGS conclusions

- Limitation of a snapshot
 - Missing samples, not the complete picture
- Origins
 - Multiple introductions into the hospital responsible for the clusters
 - Introductions from local population, some from further afield
 - Some of these introductions became established and spread between wards
 - Some of the introductions were limited to individual wards
 - Evidence of non-related HAI cases amongst the ward clusters
- Transmission
 - Within ward transmission
 - Between ward transmission
- Staff cases
 - Community origins
 - Hospital origins
 - Staff samples with the same phylotype found in patients across multiple wards
 - Staff cases after patient cases in some wards

Conclusions

- SARS-CoV-2 was introduced into the hospitals from the community;
- Despite contact/droplet precautions and surgical masks for patients and staff, all three hospitals experienced COVID-19 clusters;
- Transmission occurred between staff and patients on individual wards;
- For Hospital W, patients moving between wards initiated outbreaks on unaffected wards, specifically orthopaedic trauma cases;
- Genotyping confirmed intra- and inter-ward transmission at Hospital W;
- Ventilation at Hospital W was below recommended levels (6-10 AC/hr);
- First sub-zero temperatures of winter preceded the December clusters; freezing temperatures in early January preceded clusters in all three hospitals;
- Introducing an '**Open The Window**' policy for clinical areas may have helped control further clusters in acute hospitals.

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