

DENTAL AEROSOL EVACUATION UNIT WITH HEPA FILTER

Written by Jason Greenwood



Jason Greenwood analyses a dental aerosol evacuation unit's effectiveness of clearing air pollution

I have been using the HVE aerosol suction evacuator from Dental Practice Systems (DPS) since we reopened in July 2020. DPS has been providing HVE systems for 20 years and know what works.

The fallow time of 60 minutes (now less than 30 minutes), mandated by PHE, has very little evidence to support it. In fact, other sectors of medicine use different times. Fallow time



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Jason qualified in 1987 from The Royal London Hospital. He is a general practitioner, opening his own practice in 1991. Starting a master's course (General Dental Practice, Birmingham) developed an interest in CAD-CAM dentistry. He works with dental companies and has been published writing reviews on dental materials. Above all else he is a clinician.

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| Dental Practice Systems, Dental High Volume Evacuator (HVE) |
| (6W UVC lamp, 5 filters inc. H13 HEPA and activated carbon filters 0.3 µm, 99.97%), 300W motor, 300 m³/hr |
| Dental surgery 3.5m x 3.5m x 2.5m = 30.6m³ = up to 10 air changes/hr |

is about to be reassessed by PHE, but for the moment it is having a huge effect on our ability to provide care.

In early August, NHS Scotland, Short Life Working Group (17 July 2020) released the document: 'SBAR Ventilation, water and environmental cleaning in dental surgeries relating to COVID-19'. It strongly suggests that the 60 minutes can be mitigated with use of extra air changes in the surgery; so let's find out.

First of all, it is a good size, about the same as an upended microwave oven. It rides on wheels and has an articulated rigid trunk, so is very easy to fit into your surgery with little bother and to position close to the work area.

The HVE machine does not make too much noise on 50% power, but I will come to that later. With a brushless motor it is no problem to leave

it running all day, as that will give the maximum benefit to your air quality. Pumping 300 m³/hr, in my surgery it will achieve up to 10 air changes per hour.

Using intraoral HVA is routine for us and removes >90% of dental aerosol, and positioning the HVE trunk 150mm from the mouth is ideal for intercepting the rest. This is widely used in the US when removing amalgam fillings. Rubber dam does of course help as well. With the readings on my particle counter being low anyway, I decided to up the ante by loading the room with smoke to test the efficacy.

An assumption was made that 90% reduction in particle count would demonstrate an appropriate air cleansing.

From these results and the simplicity of use we have installed one in each surgery as an essential, additional measure.

'I WAS VERY SCEPTICAL ABOUT THE USE AND EFFICACY OF THE HVE, BUT THE TESTS AND EASE OF USE HAVE CHANGED MY MIND. I HAVE NOW BOUGHT TWO OF THEM'

| Baseline, without HVE |
|---|
| Empty, undisturbed room (60 hrs), but varies ± 30% day by day |
| >0.3 µm = 381 |
| >0.5 µm = 107 |
| >1.0 µm = 12 |
| >2.5 µm = 2 |
| >5.0 µm = 0 |
| >10 µm = 0 |

Tests – windows closed no HVE

| | Start | 15 mins | 30 mins | 45 mins | 60 mins | Time to 90% reduction |
|---------|--------|---------------|---------------|---------------|--------------|-----------------------|
| >0.3 µm | 24,879 | 16,281 35% | 13,180 47% | 11,154 55% | 9,156 63% | >60mins |
| >0.5 µm | 7,243 | 4,659 36% | 3,797 48% | 3,237 55% | 2,657 63% | >60mins |
| >1.0 µm | 1,283 | 736 43% | 591 54% | 591 54% | 398 69% | >60mins |
| >2.5 µm | 155 | 70 55% | 60 61% | 67 57% | 22 86% | >60mins |
| >5.0 µm | 34 | 14 59% | 6 82% | 12 65% | 2 95% | >60mins |
| >10 µm | 8 | 4 50% | 2 75% | 4 50% | 0 100% | >60mins |

HVE @50%

| | Start | 15 mins | 30 mins | 45 mins | 60 mins | Time to 90% reduction |
|---------|--------|---------------|--------------|--------------|--------------|-----------------------|
| >0.3 µm | 26,304 | 11,448 56% | 5,439 79% | 2,217 92% | 1,086 96% | >45mins |
| >0.5 µm | 7,514 | 3,334 56% | 1,517 80% | 649 91% | 281 96% | >45mins |
| >1.0 µm | 1,270 | 576 55% | 27 98% | 89 93% | 30 98% | >30mins |
| >2.5 µm | 138 | 72 48% | 10 93% | 8 94% | 2 99% | >30mins |
| >5.0 µm | 32 | 10 69% | 4 87% | 0 100% | 0 100% | >30mins |
| >10 µm | 4 | 4 0% | 2 50% | 0 100% | 0 100% | >45mins |



METHOD

Smoke produced by burnt cardboard, air agitated by room fan for 60 seconds before the initial measurement taken to encourage an homogenous distribution
Desk fan left running to even out smoke within the room as only one sensor available.

Start time measurements recorded.
Room left undisturbed, with closed door for 15, 30, 45 and 60 minutes retest intervals
Particle detector placed at edge of

Tests – windows open no HVE

| | Start | 15 mins | 30 mins | 45 mins | 60 mins | Time to 90% reduction |
|---------|--------|--------------|--------------|--------------|------------|-----------------------|
| >0.3 µm | 24,396 | 7,515 69% | 2,880 88% | 1,305 95% | 744 97% | >30mins |
| >0.5 µm | 7,013 | 2,089 70% | 792 89% | 364 95% | 216 97% | >30mins |
| >1.0 µm | 956 | 294 70% | 91 90% | 57 94% | 34 96% | <30 mins |
| >2.5 µm | 95 | 46 52% | 6 94% | 4 96% | 4 96% | <30 mins |
| >5.0 µm | 16 | 12 25% | 0 100% | 0 100% | 2 87% | <30 mins |
| >10 µm | 4 | 0 100% | 0 100% | 0 100% | 0 100% | <15mins |

HVE @50%

| | Start | 15 mins | 30 mins | 45 mins | 60 mins | Time to 90% reduction |
|---------|--------|--------------|--------------|--------------|------------|-----------------------|
| >0.3 µm | 24,516 | 6,510 73% | 2,709 89% | 1,041 96% | 441 98% | >30mins |
| >0.5 µm | 6,944 | 1,838 74% | 766 89% | 288 96% | 127 98% | >30mins |
| >1.0 µm | 1,053 | 244 77% | 70 93% | 28 97% | 20 98% | <30 mins |
| >2.5 µm | 108 | 30 72% | 0 100% | 4 99.9% | 0 100% | <30 mins |
| >5.0 µm | 18 | 0 100% | 0 100% | 2 99.9% | 0 100% | <15 mins |
| >10 µm | 2 | 0 100% | 0 100% | 2 0% | 0 100% | <8 mins |

HVE @100%

| | Start | 15 mins | 30 mins | 45 mins | 60 mins | Time to 90% reduction |
|---------|--------|--------------|------------|------------|------------|-----------------------|
| >0.3 µm | 24,084 | 2,079 91% | 402 98% | 309 99% | 264 99% | <15 mins |
| >0.5 µm | 6,819 | 586 91% | 109 98% | 87 99% | 73 99% | <15 mins |
| >1.0 µm | 963 | 96 90% | 10 99% | 14 99% | 8 99% | <15 mins |
| >2.5 µm | 85 | 4 95% | 2 98% | 2 98% | 0 100% | <15 mins |
| >5.0 µm | 22 | 0 100% | 0 100% | 2 100% | 0 100% | <15 mins |
| >10 µm | 8 | 0 100% | 0 100% | 0 100% | 0 100% | <15 mins |

room on a workbench next to where the patient's head would be, HVE nozzle positioned in the middle of the room.
The observer remains in the room, wearing a mask.

Orders of magnitude greater (>40x) levels of pollution are used to demonstrate the air cleaning effect with greater clarity as the lower levels routinely encountered will not register in any meaningful way, due to normal variation.

RESULTS

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| In order of efficacy to remove at least 90% particulate matter: |
| 1. window open → HVE 100%, <15 minutes |
| 2. window open → HVE 50%, <15 minutes |
| 3. window closed → HVE 50%, >30 minutes |
| 4. window open → no HVE, >30 minutes |
| 5. window closed → no HVE, >60 minutes |

The most telling result is that an unventilated room with no additional measures shows limited clearance of smoke particles, even after the PHE mandated 60 minutes of fallow time. This test used a fan to circulate air; with no fan the stagnant air is even worse at clearing particles, as the previous test demonstrated, with very little reduction in measured particle density.

This HVE in a closed room does significantly reduce the particle count within the mandated time; 50% setting being slightly better than leaving a window open, at just over 30 minutes.

In this setting, leaving a window open is just about as effective as HVE alone, but the windows in the test room are relatively large and all three were used. Smaller/fewer windows may affect the efficacy significantly.

Whilst HVE or an open window have similar useful results, having both the HVE in use and the window open, shows a dramatic improvement in clearance: more than halving the time from approximately 40 minutes to <15 minutes.

This brings the time to almost the minimum allowed 10 minutes stated in SBAR Ventilation, water and environmental cleaning in dental surgeries relating to COVID-19 cited at the beginning of this article.

DISCUSSION AND PHE MANDATED FALLOW PERIOD

This experiment is for smoke particles only and should not be a direct comparison with how airborne virus particles could be expected to behave. It does illustrate general airborne contamination for a range of particle sizes.

A desk fan was used only to agitate the air in the test room as it was unoccupied for each test and to avoid hot spots that could give a false reading, as well as for consistency.

In another test, without a fan and in a closed, unventilated room, the reduction was effectively zero after 30 minutes. This was not tested to 60 minutes as it appeared that several hours are required for any meaningful reduction and would make replication into a working dental surgery meaningless and unworkable.

The assumption made at a previous test is confirmed: 60 minutes fallow time after AGP in an unventilated dental surgery is wholly inadequate to clear the air of particulate pollution without additional measures being used. An unventilated room without extra measures should not be used for AGP.

Intraoral high-volume aspiration (HVA) is routinely used for dental procedures, intercepting the aerosol at source. Extraoral HVE is also used to intercept excess aerosol. The more valuable use of the HVE is in volumetric filtration and its continual use throughout the working day.

The results show that actively filtering

and refreshing the air as well as the adjunct of 'leaving the window open' gave by far the best result.

I was very sceptical about the use and efficacy of the HVE, but the tests and ease of use have changed my mind. I have now bought two of them.

Mitigating factors to reduce this time have been suggested and include HOCL fogging during the fallow period, increasing natural ventilation by opening a window and use of air filtration such as the HVE used here. Fogging to deactivate virus particles is not within the remit of this experiment and an HVE used whilst fogging will intercept some of the chemical reducing its effectiveness; when fogging it would be advisable to turn off the HVE unit.

Direct comparison of airborne virus particles with smoke particles should not be used, and more research is clearly needed.

REFERENCE

<https://www.bda.org/advice/Coronavirus/Pages/Updates-from-week-commencing-24-August-2020.aspx>

The Chief Dental Officer Sara Hurley has said that fallow time can be reduced from 60 to 20 minutes with 10-12 air exchanges per hour, which this machine does.

FOR MORE INFORMATION

The DPS HVE, contact DPS on

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