

Mercury vapour release from a dental aspirator

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Objective To investigate the release of mercury vapour from a dental aspirator which vented its waste air through its base directly into the surgery environment.

Methodology Mercury vapour in air concentrations were measured at the breathing zone of the dentist during continuous operation of the aspirator. Further series of mercury vapour measurements taken at the aspirator exhaust vent were carried out to determine the sources of mercury vapour from this particular device.

Results At the dentist's breathing zone, mercury vapour concentrations of ten times the current occupational exposure limit of 25 µg/m³ were recorded after 20 minutes of continuous aspirator operation. A build up of amalgam contamination within the internal corrugated tubing of the aspirator was found to be the main source of mercury vapour emissions followed by particulate amalgam trapped within the vacuum motor. As the vacuum motor heated up with run time, mercury vapour emissions increased. It was found that the bacterial air exhaust filter (designed to clean the contaminated waste air entering the surgery) offered no protection to mercury vapour. In this case the filter trapped particulate amalgam which contributed to further mercury vapour contamination as high volume air was vented through it.

Conclusion It is not known how many dental aspirators are in use that vent their waste air directly into the surgery or if this aspirator is representative of others in existence. The safety of dental aspirating systems with regard to mercury vapour exposure requires further investigation.

This paper reports on the investigation of a single dental aspirator that was found to emit significant concentrations of mercury vapour. Levels in the breathing zone in excess of ten times the occupational exposure limit of 25 µg/m³ were recorded after only 20 minutes of operation. The mercury vapour emissions were discovered unexpectedly during the course of a laboratory based research project into the effect of coolant on the release of mercury vapour during cutting of dental amalgam. This incidental finding led to the further investigation of this particular aspirator.

The investigation seeks to identify the various sources of mercury vapour from the device as well as the mechanism of vapour release. The implications for dental personnel are discussed.

Method

The aspirator under investigation was a model Tridac Aspiraide 2, serial number 1846H; year of manufacture 1978 (Figure 1). It had been purchased from a dental equipment dealer in April 2000 and had reportedly been removed relatively recently from a clinic in the South London area. This aspirator was in working order and on cursory examination did not appear to be unduly contaminated; the clinical tubing and internal separator canister being relatively clean. In this particular device waste aspirated air is expelled through four holes in the base directly into the surgery.

Mercury vapour detection was by cold vapour atomic absorption spectroscopy (CVAAS) model Varian AA 475 series using a 10 cm silica vapour cell. Calibration was by injection of known quantities of saturated mercury vapour.

The laboratory used for the investigation housed two high vol-

Mercury vapour exposure in dental practice is significant to the health of the dental team. Chronic long-term neuro-behavioural effects of low-level mercury vapour are the main concern.^{1,2}

Mercury vapour exposure in dental practice results from poor mercury hygiene procedures within the practice environment and also during the preparation placement and removal of amalgam restorations.¹ High volume aspiration is recommended during the removal of old amalgam restorations to remove detritus and water coolant but also to remove mercury vapour emitted from the vicinity of the operator and patient.^{3,4} Dental aspirators in themselves have not however been regarded as a major source of exposure in dental practice even though the question of safety of some old aspirators with respect to mercury hazards has previously been reported.⁵

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Fig. 1 Photograph of the aspirator under investigation. This particular model was of the self contained and semi-mobile trolley type that is designed to be plumbed-in next to the dental chair. This aspirator expelled its waste air through four holes in the base of the unit and consequently released mercury vapour into the breathing zone.

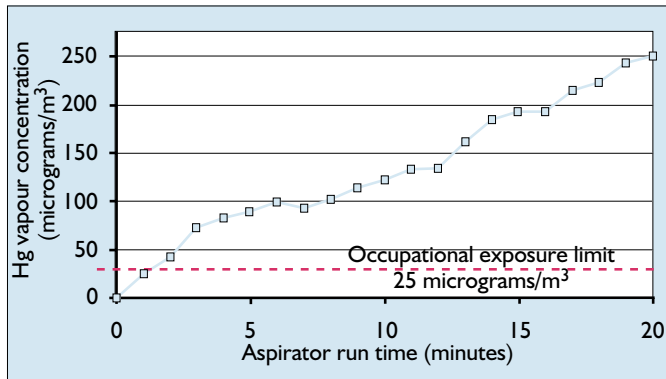


Fig. 2 Mercury vapour in the breathing zone of the dentist with aspirator run time. The aspirator was switched off after about 20 minutes as mercury vapour levels of ten times the occupational exposure limit had been reached.

ume fume cupboards that enabled efficient evacuation of the laboratory of mercury vapour before and after test runs.

Mercury vapour levels were recorded in the test laboratory at the simulated breathing zone of the dentist with the aspirator left running on full power for 20 minutes continuously. The aspirator was simply switched on and no attempt was made to record levels during amalgam removal.

After complete cooling of the vacuum motor the same test was repeated but this time mercury vapour levels were measured periodically at the aspirator exhaust vent for 30 minutes. In order to carry this out samples of aspirated exhaust air were collected periodically with a sampling bag for analysis. Air temperature was also recorded at the exhaust vent.

The test was repeated after thoroughly cleaning amalgam contamination from all internal pipe work as well as the separator canister. Further test runs were carried out after cleaning the bacterial exhaust air filter and also with the vacuum motor replaced with a new one free from contamination.

Results

At the breathing zone of the dentist mercury vapour levels increased steadily with aspirator operating time. The test was terminated after 20 minutes as room concentrations had already reached 250 µg/m³ or ten times the occupational exposure limit. Figure 2 shows the rise in mercury vapour concentration in the breathing zone as the aspirator is left running on full power, the small fluctuations were probably caused by air currents within the laboratory.

Figure 3 shows mercury vapour concentrations at the exhaust

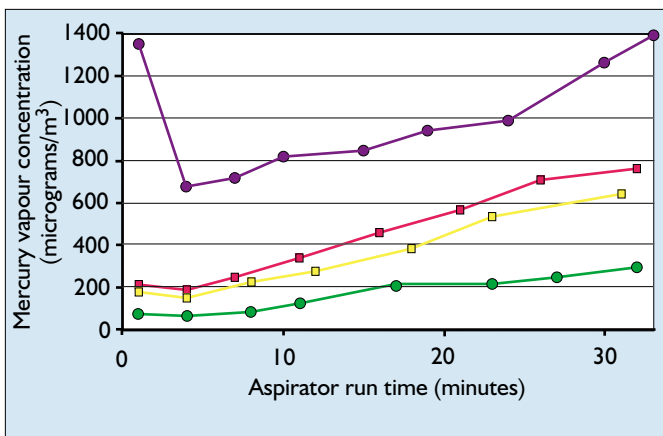


Fig. 3 Mercury vapour concentration of emissions at the aspirator exhaust vent. Blue, contaminated aspirator; red, internal tubing and canister cleaned; yellow, internal tubing, canister and air exhaust filter cleaned; green, internal tubing, canister and air filter cleaned and old vacuum motor replaced.

vent. In the aspirator's contaminated condition an initial spike in mercury vapour emissions to 1400 µg/m³ is seen before falling back to 700 µg/m³ and then rising steadily back up to 1400 µg/m³ again after 30 minutes of continuous operation.

Figure 4 shows the increase in air exhaust temperature as the electric vacuum motor heats up with run time.

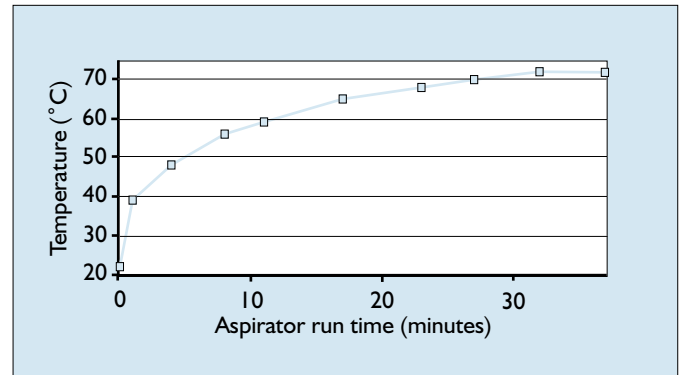


Fig. 4 Increase in aspirator exhaust air temperature as vacuum motor heats up with run time.

Visual examination of the internal pipe work following the initial tests revealed gross amalgam contamination in the internal pipe work. Heaviest contamination being visible as a build up of an amalgam concretion in the corrugated plastic pipe leading from the clinical suction tube manifold to the top of the separator canister (Figure 5.) Similar gross amalgam concretions were also visible in the suction manifold. By comparison the external clinical suction tubing and internal canister were relatively clean.



Fig. 5 Photograph of amalgam contamination within corrugated internal tubing of aspirator.

Cleaning of the internal and external pipe work and canister produced almost a 40% reduction in mercury vapour emissions at the exhaust port. The same pattern of an initial spike in mercury levels as the machine was switched on followed by the linear rise with temperature increase was still observed.

Further reductions of 10% in vapour emissions were observed when the old blackened amalgam dust contaminated foam bacterial air filter was cleaned.

Subsequently replacing the old vacuum motor with a new uncontaminated one further reduced mercury emission by approximately 25%.

Discussion

The present occupational exposure limit for mercury vapour is 25 µg/m³ based on a time weighted average over an eight-hour working day.^{6,7}

It should be noted that the laboratory where the tests were carried out was relatively large compared with many dental surgeries. The aspirator had a maximum air flow rate of about 300 l/minute through its 3 suction tubes which is the same rate at which mercury contaminated air at up to 50 times the occupational exposure limit entered the test room through its base. At 300 l/minute it would take only 90 minutes of use to exchange the entire volume of air in the author's own surgery through this aspirator. Dilution is an important mechanism for mitigating the effects of contamination and the importance of having adequate ventilation in the working environment cannot be over emphasised.

Approximately 40% of the mercury vapour emissions from this aspirator resulted mainly from amalgam contamination of the internal pipe work. The flexible corrugated plastic tubing appeared to offer a good surface for gross amalgam deposition to occur.

The foam bacterial air exhaust filter also contributed to mercury vapour emissions by acting as a trap for particulate amalgam through which hot air from the vacuum motor passed before venting into the room.

The vacuum motor itself also acted as a significant source of mercury vapour because of amalgam dust particulates trapped within the motor housing and armature. The vapour pressure of mercury rises exponentially with temperature and consequently as the vacuum motor heated up with run time mercury vapour release increased.

The initial spike in mercury vapour emission as the aspirator was turned on can be explained by a build up of vapour within the casing released by amalgam dust contamination after the aspirator had been turned off.

Even after the old motor was replaced with a new 'clean' one it was not possible to completely eliminate all mercury vapour emissions. The vacuum motor was surrounded by sound insulating material, which had become contaminated with particulate amalgam dust, as was the whole of the internal casing. Heat from the operation of the vacuum motor warmed the surrounding amalgam contaminated insulation and metal casing propagating the release of mercury vapour.

Although cleaning the internal pipe work of the aspirator led to a 40% reduction in mercury vapour emission, caution should be exercised whilst carrying out this procedure as readings taken inside

the aspirator cabinet above the canister and vacuum motor whilst hot were sometimes off the scale of the analysing instrument. It is recommended that this procedure should be carried out only with adequate ventilation and use of a mercury vapour absorbent mask and then only when the vacuum motor has cooled. As mercury crosses the placenta, pregnant workers should avoid cleaning contaminated parts of aspirators such as the separator canister.

Venting of aspirated waste air to the outside is clearly desirable in view of the findings of this report. The particular device under test was not designed to have its exhaust vented to the outside although its modern equivalent has the option to do this. Guidelines do exist which recommend that dental vacuum exhaust should be vented outside at roof level away from air intakes and opening windows.⁸ The guidelines are not mandatory and appear to be made in the main with regard to bacterial contamination rather than to the possibility of mercury vapour exposure.

It is not known whether mercury vapour emissions from this particular aspirator are representative of any others in existence in the UK or how many dental aspirators in use may vent their air directly into the surgery environment.

The safety of dental aspirators with respect to mercury emissions warrants further research.

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