MERCURY HAZARDS ASSOCIATED WITH HIGH SPEED MECHANICAL AMALGAMATORS

G. S. NIXON, PH.D., M.SC., F.D.S.
T. C. ROWBOTHAM, B.D.S., F.D.S.

The leakage of mercury from capsules during high-speed amalgamation is investigated. The results show that mercury losses do occur during the mixing process in the dental surgery.

Cook and Yates (1969) describe mercury poisoning which resulted in a dental surgery assistant having mercury in the blood. It has been suggested by Jorgensen (1970) that these cases could be dissipated from the capsule through the air. These droplets would then be scattered over a large area which would greatly increase the surface area of mercury from which vapourisation could take place.

Although automatic mixing eliminates skin contact there is an additional hazard of possible leakage from the capsule while mixing. Automatic mixing using low viscosity dental units is achieved by squeezing mercury through a cloth and eliminating the chance of mercury exposure (fig. 1). Prepared mercury may be used with the fingers (fig. 1). Prepared amalgam is almost continuously present and is with the passage of time.

Fig. 1.—Excess mercury squeezed from amalgam.
s are available for the use of amalgam. There are encapsulated type with alloy and mercury. Such a type is to be used once but not many a number of times by reducing the amount of mercury. The main types of capsules intended for repeat use and capsules of alloy and amalgamation is common. A pestle is a capsule, not some form of sealing the possibility that this seal was effective and could mercury.

was undertaken to examine a hazard occurring.

from Capsules

to mercury in an unused proportioned encapsulated determined by drilling a hole at the end of the capsule and mercury was added to mercury of approximately weight of mercury in the hole was completely glycerol cement and after mixing from the envelope, for 10 seconds in a five unused capsules were found any mercury loss was Amalcap capsules which

Loss with Alloy/Mercury

It was appreciated that, while mercury loss could occur when mercury was used alone, the preparation of amalgam in clinical practice could produce different results. Therefore 10 new encapsulated amalgam capsules (Amalcap) were weighed before and after mixing for 10 seconds in a Silamat machine and any loss recorded (Table V).

Losses due to the alteration of alloy/mercury ratios were determined using both Amalcap capsules and W.S. capsules. As the present trend is towards the use of lower mercury ratios which eliminates the need to remove excess mercury from the amalgam a 5 parts alloy: 4 parts mercury weight ratio was employed. Some practitioners however, prefer a softer mix and the experiment was repeated using 5 parts alloy: 6 parts mercury to determine if a greater loss occurred with the higher mercury ratio. In both experiments a pre-amalgamated alloy was used. The results of these are given in Table VI and Table VII. The effects of an alloy with a longer amalgamating time was determined using a ratio of 7 parts alloy: 8 parts mercury and mixing in a W.S. capsule and amalgamator (Table VIII).

Measurement of Mercury Vapour

The concentration of mercury vapour in the air and floor around the Silamat mixer was determined using a Hanovia mercury vapour detector No E 3472. The mixer was covered in a polythene cover of 0.2 m² capacity and the mercury vapour concentration measured under this cover. The results are given in Table IX.
cury loss from unused pre-proportioned capsules ranged from 0-3169 to 0-0054 g (Table I). When the capsules had been on a previous occasion these losses were 0-0012 to 0-0004 g (Table II). With the amalgam in the S.S. White capsule the mercury loss was 0-0001 to 0-0005 g (Table III) 0-0108 to 0-0629 g with the W.S. capsule (Table IV). When the standard alloy/Amalcap capsule was used the losses were 0-0002 to 0-0001 g with the maximum loss in Amalcap IV. When the amalgam ratio was altered the losses with Amalcap capsules were 0-0007 to 0-0004 g with a 5:4 ratio and 0-0007 to 0-0009 g with a 8:7 ratio (Table V). With alteration of the mercury ratio in the W.S. capsules the losses were from nil to 0-0007 g (Table VI). Slower amalgamating alloy was used as a control and the losses were from 0-0003 to 0-0005 g (Table VII).

Mercury vapour concentrations are shown in Table IX. In the open clinic a reading of 200 μg/Hg/m<sup>3</sup> was obtained with increases occurring around the mixer. When the readings were taken, i.e. >200 μg/Hg/m<sup>3</sup>, it was found that a 5:4 alloy was used.

<table>
<thead>
<tr>
<th>Sample</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss grammes</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
</tr>
</tbody>
</table>

Table VIII—Losses with slower amalgamating alloy in W.S. capsules using 7 parts alloy:

<table>
<thead>
<tr>
<th>Sample</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss grammes</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
</tr>
</tbody>
</table>

Table IX—Mercury Vapour Measurements

<table>
<thead>
<tr>
<th>Measuring device</th>
<th>10 μg/Hg/m&lt;sup&gt;3&lt;/sup&gt;</th>
<th>20-30 μg/Hg/m&lt;sup&gt;3&lt;/sup&gt;</th>
<th>40-60 μg/Hg/m&lt;sup&gt;3&lt;/sup&gt;</th>
<th>80-100 μg/Hg/m&lt;sup&gt;3&lt;/sup&gt;</th>
<th>140 μg/Hg/m&lt;sup&gt;3&lt;/sup&gt;</th>
<th>&gt;200 μg/Hg/m&lt;sup&gt;3&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>r mixer</td>
<td>20-30 μg/Hg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>nase of mixer</td>
<td>40-60 μg/Hg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ide polythene cover</td>
<td>80-100 μg/Hg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ide polythene cover with amalgam</td>
<td>140 μg/Hg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ide polythene cover with mercury</td>
<td>&gt;200 μg/Hg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

of these experiments show clearly that mercury spillage during mechanical amalgamation is real. The seal of the capsule, particularly of capsules not intended for re-use, is not as complete as it appears. This is shown in cross-section, when passage of mercury between the capsule wall and cap can be demonstrated (fig. 2).

Fig. 2.—Cross-section demonstrating mercury (M) between cap (C) and body (B) of used Amalcap capsule ×10.

Using a stroboscope, triggered to give a single flash and the Silamat mixing machine which vibrates at 4,500 vibrations per minute, the ejection of mercury from a capsule can be shown clearly (fig. 3).

When mercury is mixed with alloy, as in clinical practice, the loss is fortunately not so great, due to the rapid amalgamation which takes place particularly when pre-amalgamated alloy is used. Even when the mercury/alloy ratio was increased there was no significant increase in loss. There was a greater loss, however, when
amalgam was used due perhaps in part to the availability of Amalcap type capsules for use once only. Even with the introduction of pre-amalgamated mix the loss of amalgam was still high. A 20 mixes a year, if an alloy with a longer shelf life were used the loss could be over 4 kg for the year.

A. J. E. Smith and G. J. Dekker (1970) drew attention to the poisoning in dental surgeries of spilled mercury. They noted that smaller droplets are more difficult to clean up and that methods of cleaning up the problem: floor mops should not be used elsewhere, must be dispersed. They point out the danger of air conditioning and state that carpets and rugs should be avoided in surgeries as they quickly become contaminated.

It must be stressed that ventilation of dental surgeries is all important as evidenced by the trials with the mercury vapour meter. Where there is a free current of air the level of concentration of mercury is not particularly high even when spilled mercury is found. When the surgery is enclosed, the level of mercury may be increased and become a hazard to health. At present the maximum allowable concentration of mercury is 100 μg/m³ for a 40-hour week exposure, but some authorities consider this figure too high and a figure of 50 μg/m³ has been suggested. Particular attention should be paid to floors and surroundings which should be free from cracks or crevices. An examination of all amalgamators in the clinic showed, in each case, mercury lodged in inaccessible areas.

All waste amalgam should be kept under water or in sealed containers which prevents mercury vapour from being given off. Mercury should not be handled and leak proof capsules must be used for mechanical amalgamation. Consideration should be given in the design of amalgamators to sealing the outer cover and producing smooth rounded surfaces which can be readily cleaned.

ACKNOWLEDGMENTS

We wish to thank Mr R. T. Bagley, Safety Officer in the University of Manchester, for his assistance in measuring the mercury vapour concentrations.

REFERENCES