DENTAL EROSION IN WORKERS EXPOSED TO
INORGANIC ACID FUMES

BY

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Changes in the colour and structure of the teeth in workers exposed to strong inorganic acid fumes have, we believe, been recognized for many years by the workers themselves. Various measures of protection have, in fact, been unofficially adopted by them, and these we shall discuss below. Because these changes do not give rise to any loss of time or earnings, and because the affected workers have been reluctant in the past to report them, the prevalence of the condition has not been fully realized and no precautions have been adopted to prevent it. The dangers of acute nitrous fume poisoning are well known and guarded against.

In the course of routine medical examination of the workers in this factory the peculiar erosion of the teeth of certain workers was observed, and this led to a full dental examination of all workers engaged in the manufacture of guncotton and nitrocellulose and exposed continuously to acid fume. The workers had been employed in this section for periods varying from one month to five years. One hundred and eighteen female workers and eight males were examined. This preponderance of female workers was due to the fact that these women had taken over work formerly carried out by men.

The Process

The processes involved in the manufacture of guncotton and nitrocellulose are well described by Read (1942) in a recent popular treatise. At one stage the cotton waste or paper rolls (scrolls) which form the raw materials of these products are dipped in earthenware baths containing a mixture of approximately 70 per cent. sulphuric acid, 22 per cent. nitric acid, and 8 per cent. water. Dipping cotton waste requires considerable skill and time (20 minutes per bath). Dipping scrolls is much simpler and less heavy work, requiring only about two or three minutes. A greater number of dippings are done per shift in this case, so that the length of exposure to fume is about equal in the two processes. The bath of acid is covered by an aluminium hood, open at one side to allow the dipping to be carried out. The hood is fitted with an exhaust pipe to carry off acid fumes (fig. 1), but this exhaust does not completely exclude fume from escaping, and if decomposition occurs while the process is being carried out it is quite inadequate to deal with the heavy clouds of nitrous fumes that are formed. The worker stands at the open side of the hood and pushes cotton waste into the bath through the opening, and then dips this waste under the surface of the acid with an aluminium or stainless steel fork. Rubber gloves and eyeshields are provided to protect the hands and eyes from splashes. No mask is provided, since the hood and exhaust are considered adequate. If a "fire" occurs, with resultant nitrous fumes, the dipper steps aside and the "fire" is put out by a male worker who wears a respirator for this purpose. Unfortunately it is not easy for the dippers in the neighbourhood to move away, because unattended and incompletely dipped cotton waste will readily decompose.

It was customary for each female dipper to work half an 8-hour shift at dipping, and half a shift at trucking, i.e. pushing trucks loaded with wet washed nitrated cotton to the boiling vats where the next stage in the manufacture is undertaken. The general ventilation of the building was much impaired under black-out conditions. The men examined were engaged in the lifting and replacing of hoods and in dealing with emergencies.

Of the female workers examined, 26 had been employed for three months or less, and all of these had accurate dental records made before commencing work. There were 29 women who had
been working at the factory for periods varying between three months and one year, and all these with one exception had also initial dental records. A further 42 had been employed for periods from one to three and a half years without, in most cases, any initial dental records having been made. In addition to these groups, 21 workers had had total extractions carried out and dentures fitted during their period of employment at this work.

Results

The degree of erosion found in many of these workers varied considerably, generally in relation to length of exposure and the texture of the affected teeth (see Table 1). Pearly white teeth were more readily affected. In all cases the teeth showing erosion were the upper and lower incisors, and in a few the canines were also involved. The erosion begins in the incisel third of the teeth and extends on the labial surface (fig. 2). There is no pitting and there is always, even in very advanced cases, a smooth, polished appearance (figs. 3 and 4). When the enamel has been destroyed the dentine is attacked and there is brown or blackish discoloration of the affected teeth, which still retain their polished appearance. The pulp chamber shrinks while this erosion is taking place, and the condition is quite painless unless the erosion is so rapid that bacterial invasion of the pulp chamber can occur, with abscess formation. This was observed in one female worker, who showed very rapid erosion of the upper central incisors within three months of starting work. None of the workers examined showed evidence of Vincent's or other infection of the gums.

Of the eight men examined, four, employed for periods varying between three months and five years, showed no evidence of erosion although showing ordinary dental decay. Two showed marked erosion (fig. 5), and two had had dentures fitted during their term in this employment. Since this investigation was carried out, one of us (J. B. L.) has noted similar erosion among male workers engaged in the manufacture of nitric and sulphuric acids.

### Table 1

**FEMALES: 118 EXAMINED; 21 WITH DENTURES**

<table>
<thead>
<tr>
<th>Time employed</th>
<th>Erosion</th>
<th>No erosion</th>
<th>Total</th>
<th>Percentage affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 3 months</td>
<td>6</td>
<td>20</td>
<td>26</td>
<td>23.1</td>
</tr>
<tr>
<td>3 months to 1 year</td>
<td>11</td>
<td>18</td>
<td>29</td>
<td>37.9</td>
</tr>
<tr>
<td>1 to 3½ years</td>
<td>26</td>
<td>16</td>
<td>42</td>
<td>61.9</td>
</tr>
</tbody>
</table>

Discussion

Erosion of the teeth due to acid has been recognized in the explosive and other industries both in this country and abroad. Legge (1934) has described dental erosion among workers exposed to hydrochloric acid fumes and to nitrate of mercury, noting in the latter type of exposure a characteristic erosion of the incisors and canines. Berenzon (1930) also noted erosion of the incisors in workers engaged in the manufacture of hydrochloric and picric acids. The condition described by him was quite painless and was present in greater or less degree in the 15 workers he examined. Erosion among acid dippers and other workers in explosive factories has also been recorded by observers in Canada and Italy (Simpson, 1919; Muzzi, 1927). They describe a typical erosion of the exposed portions of the incisors, the labial surfaces being mainly affected. In a recent survey of the effects of occupation on the mouth, Schour and Sarnat (1942) state that erosion of the lingual surface of the incisors has been observed in cases of repeated vomiting, due presumably to the high acidity of the vomitus.

The site of erosion suggests to us the direct action of acid fume on those teeth exposed by talking or mouth breathing. The canines, premolars, and molars are apparently adequately protected by the salivary wash to which they are submitted, and this finding suggests that an increased salivary flow may assist in protecting the worker.

Several unofficial methods of protection were adopted by the workers. Two girls who showed no erosion were in the habit of brushing their teeth carefully at every opportunity, before and after shifts and at meal breaks; and, what is more important, they avoided talking as far as possible. Most workers relied on scarves padded with cotton waste tied round the mouth, and Table 2 shows the findings in this respect. From this it will be seen that the wearing of a mask had considerable significance in the percentage of erosion shown by the longer-employed workers.

### Table 2

**COMPARISON OF FINDINGS IN THOSE WORKERS WHO WORE SCARVES AND THOSE WHO DID NOT**

<table>
<thead>
<tr>
<th>Time employed</th>
<th>Mask</th>
<th>No mask</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Number showing erosion</td>
</tr>
<tr>
<td>1-3 months</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>3 months-1 year</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>1-3½ years</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>42</td>
<td>15</td>
</tr>
</tbody>
</table>


In peacetime, explosive manufacture men employed as dippers were in the habit of chewing cotton waste, thus inducing an increased flow of saliva; and this practice was, we have been informed, fairly successful as a protection.

Since the manufacture of guncotton and nitrocellulose has temporarily ceased, and the female workers have been declared redundant, there has been no opportunity to try out preventive measures on a large scale. The wearing of a close-fitting mask or a respirator is quite unsuitable owing to the discomfort that would arise after a short time, but a light face-shield of a visor pattern might be helpful and more easily endured. Periodical dental examinations should be carried out and workers showing rapid erosion excluded. Alkaline tablets could also be tried, both as an aid to inducing the increased salivary flow by the mechanical process of sucking, and as neutralizing agents. Excessive talking and singing should be discouraged, the reason for this being explained to the workers. Mouth breathers should be excluded from this work. The aim of prevention should be the redesigning of the process to exclude the escape of fume. More powerful exhausts are at present impracticable.

One striking feature is that, of all the workers examined, only two voluntarily reported the condition and both these workers were recent entrants who prided themselves on the appearance of their teeth. The absence of pain and incapacity may account for this apathy. The fact that 21 women required dentures during the period they were exposed may be significant: many of these workers stated that their teeth had been affected, and their descriptions accorded with the picture given above.

Summary

1. One hundred and twenty-six workers exposed to strong inorganic acid fumes were examined.
2. Forty-five of these showed erosion affecting mainly the incisor teeth. A description of the erosion is given.
3. The condition is discussed and preventive measures suggested.

References

Simpson, R. S. (1919). Dominion Dental J., 31, 94.

For Illustrations of this Article, see page 95.
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Fig. 1.—Operatives in nitrocellulose nitrating house. Baths and hoods are shown.

Fig. 2.—The teeth of a female dipper in the guncotton section after three months' work. There is early erosion affecting the lower incisors and lower left canine. The edges and labial surfaces are typically eroded. The excellent condition of the unaffected teeth is clearly seen.

Fig. 3.—Advanced erosion of central upper and lower incisors in a female dipper after two and a half years' employment.

Fig. 4.—Female after three years' exposure. The upper dentures were fitted while engaged at this work. Note the polished appearance of the eroded incisors and the good appearance of the premolars.

Fig. 5.—Male after five years' exposure. Advanced erosion affecting labial surfaces only.
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