Long term effects on the olfactory system of exposure to hydrogen sulphide

Alan R Hirsch, Gilberto Zavala

Abstract

Objective—To study chronic effects of hydrogen sulphide (H₂S) on cranial nerve I (nervi olfactorii), which have been only minimally described.

Methods—Chemosensations (smell and taste) were evaluated in eight men who complained of continuing dysfunction 2–3 years after the start of occupational exposure to H₂S. Various bilateral (both nostrils) and unilateral (one nostril at a time) odour threshold tests with standard odours as well as the Chicago smell test, a three odour detection and identification test and the University of Pennsylvania smell identification test, a series of 40 scratch and sniff odour identification tests were administered.

Results—Six of the eight patients showed deficits of various degrees. Two had normal scores on objective tests, but thought that they continued to have problems. H₂S apparently can cause continuing, sometimes unrecognised olfactory deficits.

Conclusion—Further exploration into the extent of such problems among workers exposed to H₂S is warranted.

Keywords: hydrogen sulphide; smell; taste disorders

Patients 1–4

On 8 January 1993, 900 pounds of H₂S were released into the environment over a 2.5 hour period at a construction site at a gas refinery in St Croix, Virgin Islands. Two years later we examined four of the workers, who had experienced various local irritating effects including lacrimation, eye irritation, nausea, vomiting, headache, sore throat, and skin irritation. They had also experienced chemosensory phenomena consistent with H₂S exposure, the smell of rotten eggs, and a strong metallic taste. None of the patients had lost consciousness during the accident. At the time of the accident, atmospheric H₂S concentrations were not obtained, but in previous months the patients had been exposed to similar low level releases, when the recorded concentrations of H₂S were as high as 243 ppm in the work area. The past exposures of these four patients is considered chronic.
### Table 1  Clinical data 3 years after exposure to H$_2$S

<table>
<thead>
<tr>
<th>Patient No</th>
<th>Age (y)</th>
<th>Loss of consciousness with exposure</th>
<th>Onset of taste problem</th>
<th>Rate of deficit</th>
<th>Duration of deficit</th>
<th>Phantosmia?</th>
<th>Encephalopathy?</th>
<th>At refinery construction site (chronic)</th>
<th>At petroleum plant gas leak (acute)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>No</td>
<td>Chronic</td>
<td>Increased then no change</td>
<td>Immediate</td>
<td>No</td>
<td>Subclinical</td>
<td>Hyposmia</td>
<td>Hyposmia</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>No</td>
<td>Chronic</td>
<td>Increased then no change</td>
<td>Immediate</td>
<td>Yes</td>
<td>Clinical</td>
<td>Hyposmia</td>
<td>Anosmia</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>No</td>
<td>Chronic</td>
<td>Increased then no change</td>
<td>Immediate</td>
<td>Yes</td>
<td>Clinical</td>
<td>Moderate hyposmia</td>
<td>Severe</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Yes</td>
<td>Chronic</td>
<td>Increased then no change</td>
<td>Immediate</td>
<td>No</td>
<td>Clinical</td>
<td>Moderate hyposmia</td>
<td>Severe</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Yes</td>
<td>Chronic</td>
<td>Increased then no change</td>
<td>Immediate</td>
<td>No</td>
<td>Clinical</td>
<td>Moderate hyposmia</td>
<td>Severe</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Yes</td>
<td>Chronic</td>
<td>No change</td>
<td>Immediate</td>
<td>No</td>
<td>Clinical</td>
<td>Moderate hyposmia</td>
<td>Anosmia</td>
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<tr>
<td></td>
<td>7</td>
<td>Yes</td>
<td>Chronic</td>
<td>No change</td>
<td>Immediate</td>
<td>No</td>
<td>Clinical</td>
<td>Moderate hyposmia</td>
<td>Anosmia</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Yes</td>
<td>Acute</td>
<td>No change</td>
<td>Immediate</td>
<td>No</td>
<td>Clinical</td>
<td>Moderate hyposmia</td>
<td>Anosmia</td>
</tr>
</tbody>
</table>

### Clinical evaluation

All patients were asked their subjective experience of anosmia, hyposmia (decreased odour sensitivity), hyperosmia (increased odour sensitivity), phantosmia (phantom smells), dysosmia (deranged sense of smell), hypogeusia (decreased taste sensitivity), phantogeusia (the taste equivalent of phantosmia), and dysgeusia (the taste equivalent of dysosmia). All were asked to follow the instructions in the appendix in preparation for objective tests. They then underwent bilateral (with both nostrils simultaneously) odour detection tests according to the methods of Amoore and Ollman.7 Most also underwent other olfactory tests: the University of Pennsylvania smell identification test (UPSIT), a series of 40 scratch and sniff forced choice odour identification questions scored according to age and sex as described in the published guidelines for the UPSIT; and the unilateral (one nostril at a time) threshold tests of Amoore and Ollman7 for pm carbinol, para ethyl phenol (pe-phenol), naphthalene, pyridine, 1,8 cineole (cineole), isobutyl isobutyrate (isob-isob), isovaleric acid (iv-acid), 2,3 butanedione (diacetyl), pentadecalactone (pd-lactone), I-carvone, phenylethyl alcohol (pe-alcohol), and tetrahydrothiophene (thiophane). They also underwent the Chicago smell test, consisting of three forced choice questions pertaining to odour and three open ended questions pertaining to odour identification.9,10

### Results

At the time of our evaluations, all patients had subjective complaints of chemosensory dysfunctions, which consisted of hyposmia (eight
patients), dysosmia (one patient), hyperosmia (one patient), phantosmia (one patient), hypogeusia (eight patients), and phantogeusia (one patient). Problems began immediately for three of the four patients who had acute exposure at the site of the gas leak, but for only one of the four patients exposed at the construction site. The onset of their problems ranged from immediately to 2 years after exposure (table 1).

Objective test results are summarised in table 1. Patients Nos 3 and 5 had normal scores on objective tests, but still considered subjectively that their chemical senses were deficient. All three from the acutely exposed group who took the UPSIT odour identification test had poor scores, whereas three of the four in the chronic group had normal scores and the fourth was only mildly hyposmic.

Discussion
An impaired ability to identify odours along with a normal ability to detect them as shown by our patient No 7 has been described to occur with head trauma and may indicate the existence of a lesion of the central nervous system rather than a peripheral lesion in the olfactory nerves. All of our patients with acute exposure were deficient in their ability to identify odour. Such olfactory deficit could be due to the loss of consciousness and head trauma associated with falling.

Patient No 1, however, was mildly hyposmic on the UPSIT without having lost consciousness and without head trauma. This deficit in the case of our subjects, could be due to the neurotoxic effect of the H2S on the olfactory receptor site or through the retrograde degeneration of the olfactory nerves as they project through the olfactory bulb and tract to the olfactory cortex.

As some of our construction worker patients had histories of considerable toxic exposures including use of alcohol which we have shown can induce olfactory deficit, it seems possible that our findings of olfactory deficits are unrelated to exposure to H2S and instead are associated with confounding factors—such as collateral toxic exposures.

Conclusions
As long as three years after their exposure to H2S, a high percentage if not all of our patients continue to have olfactory deficits. The long duration of this deficit indicates that it may be permanent.

Patients Nos 3 and 5 who complained of deficits yet were normosmic on tests may have originally been more sensitive than the average, and thus experience real losses. Patients who have been exposed to H2S should be routinely screened for olfactory deficits and if any are found, vigilant monitoring for H2S must be undertaken at the work site. Also, these patients must be advised to take precautions at home, including the use of smoke detectors, gas detectors, and food tasters.

Poorly documented effects on the chemical senses have also been seen after exposures to various other neurotoxins including nitrogen tetroxide and benzene.

In our industrial society, chemosensory dysfunction may well be a hidden epidemic among workers exposed to various toxic chemicals. The extent of such problems among workers exposed to H2S and other industrial effluviums is a subject deserving of further careful exploration.

Appendix: Questionnaire
As we are testing abnormalities of smell and taste, the following precautions must be taken:
- You may eat no pastry items for 24 hours before your visit. You may drink no alcohol for at least 4 days before your visit.
- You may drink no alcohol for at least 4 days before your visit.
- You may eat no pastry items for 24 hours before your visit.
- From the midnight before your visit, you may have none of the following; food, gum, cigarettes, or any drink other than water.

IT IS IMPORTANT THAT YOU FOLLOW THESE INSTRUCTIONS TO INSURE THE VALIDITY OF THESE TESTS
- From the midnight before your test day, you should use no scented soap, cosmetics, deodorants, shaving cream, aftershave, perfumes, or lipsticks. The only underarm deodorant you may use is Gillette roll on.
- From the midnight before your visit, you may use only shampoo with no or minimal smell—that is, ivory shampoo.
- You may brush your teeth, but we ask you not to use toothpaste.
- All your usual medications should be taken and if you have diabetes you should eat.
- Foods and beverages containing caffeine that you should try to avoid:
  - Chocolate
  - Coffee
  - Cola
  - Tea
  - Cocoa
  - NoDoz

Other over the counter products that are “stimulants” should be sure to read your labels.

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