Table 6—Facts known about non-respondents, untraceable doctors, and respondents with occupation not given. Results expressed as proportions of total cohorts

Row No		Total (No in cohort=3819)		Men (total cohort=2363)		Women (total cohort=1456)	
		No	%	No	%	No	%
1	Not registered (September 1994)	85	2.2	45	1.9	40	2.7
2	Registered abroad (September 1994)	86	2.3	59	2.5	27	1.9
3	Registered, practising in United Kingdom	674	17.6	470	19.9	204	14.0
4	Registered, likely to be practising	107	2.8	73	3.1	34	2.3
5	Registered, occupation unknown	182	4.8	121	5.1	61	4.2
6	Total non-respondents	1134	29.7	768	32.5	366	25.1

Row 3 is based on Department of Health data for September 1993.
Row 4 is inferred from entries in 1994 medical directory.

guess" estimate of doctors lost from medicine in the United Kingdom in 1994 of about 629 (736 minus 107), or 16% of the cohort.

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Lesson of the Week

Something in the air: survival after dramatic, unsuspected case of accidental carbon monoxide poisoning

Richard Pullinger

Doctors should not assume hypoxic death in cases of overwhelming poisoning with natural gas

In cases of intentional carbon monoxide poisoning the diagnosis is usually straightforward and is suggested by the circumstances in which the patient is found. In contrast, accidental carbon monoxide poisoning remains underdiagnosed because the source of carbon monoxide is often not obvious and may be remote and because the symptoms of poisoning—headache, lethargy, nausea, and vomiting—are non-specific.

In the United States a review of death certificates over 10 years identified 56 133 deaths in which carbon monoxide poisoning was implicated.¹ Of these, 46% were suicide, 28% were associated with burns, and 21% were unintentional for other reasons. Fifty seven per cent of these last unintentional deaths were related to exhaust fumes from a motor vehicle, which in most cases was stationary. A three year study of carbon monoxide poisoning in France identified 735 cases, of which 196 had domestic causes.² The domestic sources of carbon monoxide were water heaters (57%), boilers (21%), coal stoves (9%), braziers (4%), cookers (2%), and heating devices (1.5%). In addition, reports of carbon monoxide poisoning due to poorly maintained or poorly ventilated domestic appliances have come from Switzerland,³ Denmark,^{4,5} and Belgium.⁶ In one report of domestic carbon monoxide poisoning from the United States patients were poisoned far from the source of the gas: carbon monoxide had been drawn into a motel's air conditioning system from the heating vents of a nearby swimming pool.⁷

The indoor use of cooking devices designed for outdoor use is also an important cause of carbon monoxide poisoning. Foutch and Henrichs reported the death due to carbon monoxide poisoning of two mountaineers at 4300 m while they were cooking inside

their tent.⁸ Several reports detail carbon monoxide intoxication resulting from the indoor use of charcoal barbecues for cooking⁹⁻¹¹ and for heating.^{12,13}

Carbon monoxide poisoning is well recognised in deep sea divers and is caused by faulty air compressors or contamination of air with fumes from nearby combustion engines or burners.¹⁴ The symptoms of such poisoning are non-specific, sometimes mimicking decompression sickness, but, fortunately, hyperbaric oxygen is effective treatment for both conditions. In less specialist surroundings Heckerling found that seven out of 37 patients presenting to an accident and emergency department with headache had carboxyhaemoglobin concentrations greater than 10%.¹⁵ Subsequent investigation by the gas company found that six of the seven patients had been exposed to toxic concentrations of carbon monoxide at home, but in none of them had carbon monoxide poisoning been suspected by the admitting doctor. Dolan found that of a sample of patients presenting to an accident and emergency department with flu-like symptoms, 23.6% had carboxyhaemoglobin concentrations of 10% or more.¹⁶ In none of them was carbon monoxide poisoning diagnosed.

I report a case showing the importance of considering carbon monoxide poisoning even when there is no direct evidence of gas combustion.

Case report

An unconscious woman in her 70s was brought by ambulance to an accident and emergency department. Her neighbour had contacted police when she noticed that post had not been collected from the front

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door for five days. On entering the house police officers noticed a strong smell of gas and found that the grill of the gas cooker had been turned on but was unlit. There was no food near the cooker. The patient was found unconscious upstairs on the bathroom floor and her husband was found dead in bed. Their two pets were also dead. All the external doors and windows of the house were closed.

On arrival in the department the patient had dry skin and was irritable with a score of 10 on the Glasgow coma scale and a rectal temperature of 29°C. Her pulse rate was 70 beats per minute and regular; her blood pressure was 170/70 mm Hg and peripheral perfusion was poor. Her respiratory rate was 16 breaths per minute, and auscultation of the chest gave normal results. No focal neurological signs were elicited. Serum concentration of sodium was 154 mmol/l, of potassium 3.6 mmol/l, urea 20.8 mmol/l, creatinine 198 mmol/l, and glucose 8.5 mmol/l. Her haemoglobin concentration was 131 g/l, white cell count $16.1 \times 10^9/l$, platelet count $311 \times 10^9/l$, and differential neutrophil count 0.84. These results were thought to reflect prerenal failure secondary to severe dehydration. The presumptive diagnosis was hypothermia after asphyxia due to displacement of air by natural gas.

She was actively rewarmed by bladder irrigation and given oxygen at an estimated fractional inspiration of 0.8, broad spectrum antibiotics, and subcutaneous heparin prophylaxis. Her recovery on the ward was complicated by a left femoral artery embolism, but she made a full recovery after embolectomy and oral anti-coagulant treatment.

The coroner's postmortem examination of her husband showed advanced atherosclerotic coronary artery disease and pulmonary changes consistent with bronchopneumonia. His carboxyhaemoglobin concentration was estimated to be 56%. Subsequently the carboxyhaemoglobin concentration in the blood sample taken from the patient on admission was found to be 40%.

An examination by British Gas of the cooker in the patient's kitchen showed deposits of lint around the air inlet ports of the grill burner. When lit the flame was yellow, indicating incomplete combustion, and the carbon monoxide concentration in the vicinity of the burner was in excess of 2000 parts per million. The carbon monoxide concentration on the first floor after the grill had been alight for one hour was 500 parts per million and increased to above 800 parts per million after two hours.

Discussion

Exposure to concentrations of 500 parts per million of carbon monoxide for five hours or more can result in blood concentrations of carboxyhaemoglobin of up to 40%; at this concentration impaired judgment or collapse is likely to render a person unable to recognise or escape from the cause. As this patient had a carboxyhaemoglobin concentration of 40% the gas burner had gone out only shortly before she was found. What is surprising is that she survived for four days after collapsing before she was discovered.

The absence of food on or near the unlit grill led rescue services and medical staff to assume that the gas to the grill had been turned on accidentally. In fact, the patient had on this and other occasions lit the grill for

warmth while making tea for her husband. As a result of overuse and inadequate servicing of the grill, carbon monoxide accumulated and concentrations upstairs rapidly became toxic. Landlords in the United Kingdom are required by law to ensure that domestic gas appliances are inspected annually by an approved heating engineer. The patient and her husband, however, owned their home, and there are currently no statutory regulations governing maintenance of domestic gas appliances in owner occupied properties.

In cases of unintentional domestic carbon monoxide poisoning doctors are responsible for ensuring that a source of incomplete combustion is identified and corrected before the patient returns.

Carboxyhaemoglobin concentrations are readily measured, and poisoning is often reversible. Carbon monoxide poisoning remains underdiagnosed because symptoms and signs of toxicity may be confused with other medical conditions and because the source of carbon monoxide may not be immediately apparent. Doctors in accident and emergency departments should consider carbon monoxide poisoning in all patients with unexplained headache, lethargy, nausea, vomiting, or reduction in consciousness, especially those found in an enclosed vehicle or building. In particular, doctors should not assume that collapse or impaired consciousness are due to prolonged hypoxia when patients are discovered in buildings smelling of natural gas or in which burners are on but unlit.

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