Carbon monoxide from neighbouring restaurants: the need for an integrated multi-agency response

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ABSTRACT

Background Carbon monoxide (CO) is a colourless, odourless toxic gas produced during incomplete combustion of carbon-based fuels. Most CO incidents reported to the UK Health Protection Agency (HPA) are due to faulty gas appliances, and legislation exists to ensure gas appliances are properly installed.

Methods We present three CO poisoning incidents of unusual origin reported to the HPA. In each, residents living above restaurants were poisoned after workers left charcoal smouldering overnight in specialist or traditional ovens whilst ventilation systems were turned off. This led to production of CO, which travelled through floorboards and built up to dangerous concentrations in the flats.

Results Working with local authorities, these incidents were investigated and resolved, and work was conducted to prevent further occurrences.

Conclusions The novel nature of these CO incidents led to delays in recognition and subsequent remedial action. Although previously undescribed, it is likely that due to the number of residences built above restaurants and the rising popularity of traditional cooking methods, similar incidents may be occurring and could increase in frequency. Multi-agency response and reporting mechanisms could be strengthened. Awareness raising in professional groups and the public on the importance of correct ventilation of such appliances is vital.

Keywords air quality, public health

Introduction

Carbon monoxide (CO) is a colourless, odourless gas that can be toxic when inhaled. At low levels, chronic CO poisoning can produce symptoms of lethargy, flu-like illness and impaired memory; at high levels, acute CO poisoning can produce headaches, nausea, vomiting and may lead to loss of consciousness and death.1

CO is produced when carbon-based fuels burn with insufficient oxygen. It is recommended that all domestic gas, solid fuel and oil-fired appliances be serviced annually by qualified engineers to ensure they are burning correctly and have adequate ventilation to prevent production of CO.2

However, CO can travel through any cavities or gaps in the walls and floors separating properties, therefore residents of neighbouring properties may be at risk of CO poisoning from appliances in neighbouring premises for which they have no maintenance or servicing responsibilities.

We present three incidents reported to the Health Protection Agency (HPA), which have not previously been described, that occurred within a few months of each other.

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in 2008–09, where unusual activity in restaurants led to CO affecting local residents.

**Incidents**

**Incident one**

Shortly after its installation, the CO alarm in a flat began sounding in the early hours of the morning. Registered gas engineers could find no fault with the gas appliances in the flat or with the alarm itself. Over the next few months, the alarm continued to sound and the presence of CO was confirmed in the flat by engineers. The resident and a guest reported headaches and lethargy and consulted their general practitioner. Eventually, the source was traced to the Indian restaurant below the flat, where the charcoal-burning tandoor oven was apparently left smouldering overnight while the ventilation system was turned off.

Five months after the initial alarm activation, the gas engineers recommended that the flat’s resident inform and seek assistance from the local authority (LA) pollution team. The LA confirmed the presence of CO in the restaurant and issued an Abatement Notice prohibiting the use of the oven without extractor fans. Unfortunately, the CO alarm continued to activate, culminating in an incident where the residents found it difficult to rise from bed in response to the alarm and had to call the emergency services, who confirmed that the charcoal had been left burning.

Immediate action to seize the oven by the LA could not be taken until witness statements had been provided by the emergency services describing the violation of the Abatement Notice. Whilst awaiting these, the pollution team asked the HPA for public health advice. Advice was given regarding environmental levels of CO, symptoms of CO intoxication and a recommendation was made to check neighbouring properties, especially for vulnerable residents. HPA advice was distributed to local residents. Occupants of the flat were advised to visit their doctor and if they felt unwell and alerted paramedics attending a different call.

Over a 3-month period, residents in a flat were repeatedly alerted to elevated CO levels in their property by their CO alarm. The LA confirmed levels of 45 ppm CO in the flat but no source could be found within the property. A long-standing odour nuisance complaint suggested that the restaurant below should be considered as a source, but the gas oven was in working order.

The investigating LA officer provided residents with written copies of HPA advice, advised ventilation of the property if the alarm sounded and to consult a doctor if they experienced any symptoms. Having confirmed that the CO alarm was working correctly and that the situation was still unresolved, the LA officer was concerned about long-term exposure to CO and contacted the HPA for advice.

The HPA reviewed the sampling results from the flat and concluded that although not hazardous to health in the short term, concentrations of 45 ppm over 8-h periods or longer are above the UK air quality standard of 10 ppm for 8 h and remedial action should be taken.

Monitoring equipment was installed by the LA in both the restaurant and flat. Figure 1 shows the close correlation between CO concentrations in the two premises, with the increase in the restaurant closely followed by an increase in the flat. On a later visit to the restaurant, the officer noticed the presence of a charcoal-fired tandoor oven. Aware of incident one, the HPA suggested the two LAs liaise.

The LA officer was able to demonstrate that the tandoor oven was indeed the source. As in incident one, the extraction system had been turned off overnight and the charcoal left smouldering, with CO levels in the restaurant peaking in the early hours of the morning (Fig. 1). The oven was replaced with a gas oven and subsequent monitoring confirmed that significant levels of CO were no longer being produced.

**Incident two**

Over a 3-month period, residents in a flat were repeatedly alerted to elevated CO levels in their property by their CO alarm. The LA confirmed levels of 45 ppm CO in the flat but no source could be found within the property. A long-standing odour nuisance complaint suggested that the restaurant below should be considered as a source, but the gas oven was in working order.

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**Incident three**

Two housemates living in a flat above an Asian restaurant felt unwell and alerted paramedics attending a different call nearby. Suspecting CO poisoning, the ambulance and fire services evacuated a further seven people from two other flats above the restaurant. All were taken to hospital and the HPA informed.
COHb levels ranged from 7.4 to 21.6%, the normal range for non-smokers is usually between 1 and 2%; residents in flats closer to the restaurant had higher levels than those on higher floors. Residents from all three flats reported having felt ill for 3–6 weeks, one had visited their GP with a flu-like illness, suggesting that the flat occupants may have been exposed to CO for several weeks. None of the flats had CO alarms.

The LA established that the heating and cooking devices in the flats were electric and the CO source was identified as the charcoal-burning grills in the restaurant, which had been left on overnight while the extractors were turned off. Measurements taken by the LA next to the active grill were 150 and 500 ppm CO, and a Prohibition Notice was served on the oven. A safer gas-fuelled grill was installed and CO alarms were fitted to all three flats. The LA visited all of the restaurant chain’s premises and other restaurants with charcoal-burning appliances in their borough.

**Discussion**

**Main finding of this study**

This case series describes three incidents of CO poisoning in residential properties. Although some residents had taken precautions—regularly servicing gas boilers, installing CO alarms and consulting healthcare professionals—in each case they were exposed to CO from activities in neighbouring properties. The restaurants used charcoal-burning tandoor ovens or grills, which were in working order, however by leaving these burning overnight without adequate ventilation, CO was produced, travelling through wall and floor spaces to reach significant levels in neighbouring domestic properties. These unusual scenarios led to delays in recognition of the problem, reporting and intervention by appropriate authorities.

**What is already known on this topic**

CO poisoning incidents in England and Wales that are reported to the HPA mostly occur in residential properties, due to faulty installation of gas-fired central heating appliances or the inappropriate use of outdoor heating or cooking appliances indoors. There is existing legislation covering the installation, maintenance and use of gas appliances in both residential and workplaces, there is currently no similar legislation covering non-gas appliances. Residential landlords and restaurants owners are not required to install CO alarms, although it is strongly recommended by the Health and Safety Executive (HSE) that an audible alarm meeting British or European standards (BS Kitemark or EN 50291) is installed in homes and workplaces.

The HPA and LAs work collaboratively in response to CO incidents, with the HPA providing toxicological and
public health advice, and the LA using their legislative power to act to prevent further harm. However, property owners are expected to take responsibility for ensuring correct maintenance and use of appliances, and complying with recommendations and notices.

A literature review of scientific journals and grey literature using the search terms ‘carbon monoxide’ and ‘restaurant’ or ‘takeaway’ identified risk to workers from CO and cooking appliances, with charcoal identified as a particular risk. Papers associated with public exposure to CO from restaurants are few; in 1996, mass CO poisoning of diners from traditional charcoal cookers occurred in Réunion, and Health Protection Scotland recently published results of an investigation into the link between odour complaints from takeaway restaurants and CO gas.

What this study adds

The need for integrated multi-agency response

In incident one, there was a delay of 8 months from the initial identification of high levels of environmental CO until the necessary action was taken. This was partly due to the delay in other agencies/professionals informing the HPA and LA.

The LA and HPA can only take action if they are aware or informed of an incident. Registered gas safety engineers are expected to inform relevant authorities if they identify a problem during an inspection, but this system could be strengthened. Moreover, gas engineers may not necessarily confirm the presence of CO or investigate non-gas sources, meaning that some CO incidents are missed entirely. An opportunity for identification of CO poisoning was also missed in incident three by the general practitioner; the non-specific symptoms of CO poisoning are often misdiagnosed and an algorithm to aid diagnosis among medical practitioners is available.

Figure 2 shows some of the agencies involved in CO incident response. The response can be complex and there is potential for notifying or preventative actions to be overlooked; a key role of the HPA is to coordinate response and ensure a comprehensive, timely resolution. The CO Action Card lists the recommended steps for HPA staff and gives an overview of the roles and responsibilities of different organizations. It is notable that in incident two, the HPA

![Diagram](https://example.com/diagram.png)

**Fig. 2** The main communication routes for reporting CO poisoning incidents in England. Reporting is not always mandatory and additional routes and organizations may exist. NHS, National Health Service, GP, general practitioner.
acted as a central information point, allowing experience to be shared between different LAs.

**Carbon monoxide can travel between properties**

CO poisoning may not be suspected initially if investigation is limited to appliances in the household of the affected case(s). Regular servicing of boilers and household appliances, though important, will not offer protection from CO that has originated in neighbouring properties; indeed, in two of the three incidents, residents were only alerted to the danger by their CO alarms. This emphasizes the importance for emergency responders at a CO incident to ensure that occupants of neighbouring premises are safe.

**Clarification of legal and enforcement action**

In incident one, the delay was aggravated by difficulties associated with monitoring compliance with the LA Improvement Notice conditions. Such breaches occurred in the early hours of the morning, making evidence-gathering challenging. Production of significant levels of CO can be difficult to prove as production may be intermittent or, as time elapses, properties will have been ventilated and COHb metabolized.

Understanding the different legislative options available and evidence required for each is the responsibility of the regulating bodies, but this knowledge is also important for public health practitioners who can assist the LA and HSE. In these incidents, legislative options included the Environmental Protection Act 1990 (Part III) and the Health and Safety at Work Act 1974.

In the light of these cases, the HPA, in discussion with regulatory bodies, is investigating how to clarify the legal requirements on the use of traditional non-gas ovens. Indeed, the Chartered Institute of Environmental Health has recently recommended that new legislation is introduced so that installation of CO alarms is mandatory in all residential premises adjacent to commercial food outlets. In addition, the UK 2011 All Party Parliamentary Gas Safety Group parliamentary enquiry has received this evidence and highlighted the requirement for the HSE and local authorities to raise awareness of CO in the catering industry due to these incidents.

**Prevention, awareness raising and training would be useful**

As CO poisoning is preventable, it is a priority to raise awareness of the above issues in all the organizations involved, including gas engineers, restaurant owners and members of the public.

In all three incidents, the ovens were in working order but were being used inappropriately, with ventilation systems turned off overnight. There is therefore a need for the regulatory bodies to ensure that users of charcoal ovens are aware of the need for adequate ventilation at all times. This could be done by LA food hygiene officers who regularly inspect restaurants, for example.

Targeted cross-agency training for professionals may improve the efficiency of the response through highlighting and identifying the roles and expertise of each agency. The HPA runs CO Workshops annually across England, which are well-attended by EHOs, public health practitioners, emergency responders (fire, ambulance) and policy-makers such as the HSE and Department of Health. The incidents described here provide useful learning scenarios.

**Limitations of this study**

This case series describes three incidents reported to the HPA. Due to the delays in notification to the HPA and to the number of agencies involved, some facts and timelines presented may be distorted, although every effort has been made to ensure these are accurate. This again emphasizes the importance of early notification and close partnership working between all the organizations.

**Conclusions**

Residential flats are frequently built above restaurants in urban areas. It is therefore possible, and indeed likely, that similar CO poisoning events are occurring that enforcing bodies and the HPA are unaware of. Traditional-style ovens are becoming fashionable in UK restaurants as people seek an authentic gastronomic experience. In addition to tandoor ovens, other ethnic ovens have been implicated in CO safety issues as many do not meet CE (European Directive) standards.

The current emphasis on making buildings more energy efficient makes it easier for indoor gases to build up and travel through any gaps or cavities within walls and floorboards. Legal requirements for the installation of CO alarms in restaurants and mandatory ventilation of charcoal-burning ovens could be considered to prevent further similar incidents occurring.

Although two of the incidents presented regarded low-level, chronic CO poisoning, the third case of acute intoxication reported from an emergency department demonstrates how dangerous unrecognized and uncontrolled production of CO can be. Raising awareness of these issues in all of the organizations involved and members of the public is a priority.
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