

**From the Chief Medical Officer
Dr Michael McBride**

HSS(MD) 17/2016



Department of
Health

An Roinn Sláinte

Mánnystrie O Poustle

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FOR ACTION

Chief Executives, Public Health Agency/Health and Social
Care Board/HSCTrusts/NIAS
GP Medical Advisers, Health and Social Care Board
All General Practitioners and GP Locums (*for onward
distribution to practice staff*)

Your Ref:
Our Ref: HSS(MD) 17/2016
Date: 27 October 2016

PLEASE SEE ATTACHED FULL CIRCULATION LIST

Dear Colleagues

CARBON MONOXIDE POISONING: ONGOING VIGILANCE TO ENSURE RECOGNITION AND PREVENTION

Action Required

Chief Executives must ensure that this information is drawn to the attention of all staff who may be involved in care or management of patients with suspected carbon monoxide poisoning.

HSCB should ensure that this information is cascaded to all General Practitioners and Community Pharmacists.

General Practitioners and hospital clinicians should use the algorithm to ensure effective management of carbon monoxide poisoning and to alert relevant authorities involved in the investigation of possible sources.

My purpose in writing to you is to remind you that carbon monoxide poisoning continues to cause preventable deaths in Northern Ireland. It is important that cases do not go unrecognised and are managed appropriately. This poisoning can mimic other illnesses.

Carbon monoxide poisoning causes a number of deaths and hospital admissions each year in Northern Ireland. As the symptoms of sub-acute poisoning are similar to those of many other conditions and, because their onset can be insidious, cases of poisoning may not be recognised by the patient or the doctor.

PREVENTION

To help reduce the risk of carbon monoxide poisoning the public should be aware of the importance of checking that their heating systems and chimney flues are safe -

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~~this is most easily done by having boilers and fuel-burning appliances serviced at~~
least annually using a suitably qualified and registered engineer. Checks should also be carried out on infrequently used heating appliances that may be used in very cold weather. Houses and workplaces should also be properly ventilated. An audible carbon monoxide alarm which complies with relevant standards is useful as a secondary precaution. It should be remembered that carbon monoxide can be produced where there is incomplete combustion of fuels such as oil, solid fuel, wood or gas.

Information for you and other health care professionals

Annex A alerts you to the signs and symptoms which might suggest carbon monoxide exposure in your patients or customers and provides advice on investigation, diagnosis and management. It complements the algorithm circulated by the Public Health Agency, which is available at www.publichealth.hscni.net/publications/diagnosing-poisoning-carbon-monoxide-co. and attached as Annex B. The appendix provides guidance on diagnosing carbon monoxide poisoning and actions to take.

Information for the public

The Department of Health (formerly the DHSSPS) has developed a public information leaflet: entitled "*Carbon monoxide: Are you at risk?*" which you can share with your patients and customers. This is available at [https://www.nidirect.gov.uk/sites/default/files/publications/%5Bcurrent-domain%3Aa-machine-name%5D/carbon monoxide are you at risk.pdf](https://www.nidirect.gov.uk/sites/default/files/publications/%5Bcurrent-domain%3Aa-machine-name%5D/carbon%20monoxide%20are%20you%20at%20risk.pdf)

Information is also available on the Health and Safety Executive for Northern Ireland (HSENI) website at <https://www.hseni.gov.uk/articles/carbon-monoxide>

Contact information

Sources of advice on the management of poisoning and relevant contact details are attached.

I hope that these measures will help ensure a greater awareness on the part of health professionals and the public of this issue and ultimately help prevent future cases of carbon monoxide poisoning.

Yours sincerely



Dr Michael McBride
Chief Medical Officer



Professor C McArdle
Chief Nursing Officer



Dr Mark Timoney
Chief Pharmaceutical
Officer

cc: Executive Medical Director/Director of Public Health, Public Health Agency
(for onward distribution to all relevant health protection staff)
Assistant Director Public Health (Health Protection), Public Health Agency
Director of Nursing, Public Health Agency
Family Practitioner Service Leads, Health & Social Care
Board *(for cascade to GP Out of Hours services)*
Medical Directors, HSC Trusts *(for onward distribution to all relevant staff)*
Directors of Nursing, HSC Trusts *(for onward distribution to all Community
Nurses, and Midwives)*
RQIA *(for onward transmission to all independent providers including
independent hospitals)*
Nigel McMahon for circulation to Chief Environmental Health Officers
The Health and Safety Executive for Northern Ireland
HSCB Head of Pharmacy and Medicines Management *(for onward
distribution to Community Pharmacists)*
Chief Executive, Clinical Education Centre;
Chief Executive, NIPEC;
Head of School of Nursing at University of Ulster; at Queens University; the
Open University;
Chief Executive NI Medical and Dental Training Agency (NIMDTA)
Professor Colin Adair NI Centre for Pharmacy Learning & Development

This letter is available on the Department of Health website at
[https://www.health-ni.gov.uk/topics/professional-medical-and-environmental-health-
advice/hssmd-letters-and-urgent-communications](https://www.health-ni.gov.uk/topics/professional-medical-and-environmental-health-advice/hssmd-letters-and-urgent-communications)

CARBON MONOXIDE POISONING

Sources of carbon monoxide

Carbon monoxide is a toxic, odourless, colourless gas. It is produced when there is incomplete combustion of carbon-containing fuel such as gas (domestic or bottled), coal, coke, oil and wood. Stoves, fires and boilers, water heaters, barbecues, paraffin heaters and room heaters are all potential sources. Caravans, boats and mobile homes are also at risk as they often use portable appliances which use these fuels. Exhaust fumes from engines or generators can also contain high levels of carbon monoxide.

The main causes of poisoning are unsafe installation or inadequate maintenance of heating systems leading to poor combustion of fuel; inadequate removal of waste products as a result of blocked and partially-blocked flues and chimneys, and insufficient ventilation. These problems can occur in all types of property and the idea that carbon monoxide poisoning is limited to poorer homes and student accommodation is false. Newly-occupied houses with gas-powered heating systems are sometimes the site of accidents.

Carbon monoxide can also seep into properties via shared flues and chimneys, so people may be poisoned by carbon monoxide leaking from adjoining property. Construction errors, such as the venting of gas fires into cavity walls, can lead to poisoning of people living above those using the fire. Integral garages can be a source of carbon monoxide if car engines are run without adequate ventilation. A barbecue lit in an area with inadequate ventilation such as a car port may also pose a risk.

How to diagnose carbon monoxide poisoning

Information on diagnosis is contained in the PHA/PHE algorithm which is attached and which can be downloaded at:

www.publichealth.hscni.net/publications/diagnosing-poisoning-carbon-monoxide-co

The diagnosis of carbon monoxide poisoning is not at all easy as the symptoms are similar to those caused by other conditions. Unless poisoning is suspected, the diagnosis will be missed. The onset of symptoms is often insidious and may not be recognised by either the patient or the doctor. The commonest symptoms and signs and an indication of their approximate frequency in carbon monoxide poisoning are shown below:

- headache: 90% of cases
- nausea and vomiting: 50% of cases
- vertigo: 50% of cases
- alteration in consciousness: 30% of cases
- subjective weakness: 20% of cases

Whilst exposure to high concentrations of carbon monoxide leads to collapse and death within minutes, chronic exposure to lower concentrations may lead to symptoms and signs suggestive of influenza or food poisoning. What appears to be the classic symptoms of food poisoning of a whole family may, in fact, be the result of carbon monoxide poisoning. Prolonged exposure to low concentrations that produce only minor symptoms may, in some cases, be associated with serious lasting neurological effects. These include difficulties in concentrating and emotional ability.

Clues to the diagnosis

The following are suggestive of domestic carbon monoxide poisoning:

- more than one person in the house is affected;
- symptoms are better when away from the house, e.g. on holiday, but recur on returning home or symptoms have commenced following a recent house move
- symptoms are related to cooking, with a stove in use; and
- symptoms are worse in winter, with heating in use.

The following signs may be recognised in the home:

- in many cases there will be black sooting or staining on or around an appliance (e.g. a stove, boiler or fire), such as on the walls;
- the accumulation of smoke or excessive condensation in rooms owing to faulty flues – (although you cannot smell carbon monoxide, you may be able to smell other combustion products);
- yellow or orange-coloured gas flames rather than a sharp blue flame on cookers, boilers or pilot lights

Clinical signs

Neurological examination is key in determining a chronic poisoning event and signs must be looked for. A neurological examination, including tests of fine movement and balance (finger-nose movement, Romberg's test, normal gait and heel-toe walking), a mini-mental state examination and testing of short-term memory and the ability to subtract 7, serially, from 100, are vital.

The cherry red skin colour is not a common sign of poisoning. This is produced when COHb concentrations exceed about 20% and is rarely seen in life.

Investigations (described in detail in the PHA/PHE algorithm above)

Carbon monoxide can be measured in expired air. Breath analysers are used in smoking cessation clinics and where these are available in surgeries they should be used. There are also analysers which are available that convert carbon monoxide concentration into carboxyhaemoglobin (COHb) concentration from the standard equilibration curve. If such devices are used, they must be used quickly as there is no point in taking a measurement if the patient has spent hours away from the

source of carbon monoxide. Measurements taken the next day at the surgery may be misleading.

Carboxy-Haemoglobin (COHb)

COHb can be measured in blood by any clinical chemistry laboratory. Venous blood should be taken into anti-coagulant and sent to the laboratory. COHb should be measured directly and several suitable co-oximeters are available. Measuring PO₂ and calculating the percentage saturation of haemoglobin with oxygen will be misleading as the PO₂ in carbon monoxide poisoning may well be normal.

Pulse oximetry is not recommended because falsely high oxygen saturations are likely to be recorded due to carboxy- haemoglobin and oxyhaemoglobin having similar light absorbences.

For interpretation of blood sample results and more detailed advice on carbon monoxide poisoning refer to TOXBASE or contact the UK National Poisons Information Service (NPIS).

Management

- Remove patient and co-habitants from the source of carbon monoxide
- Give 100% oxygen – a tightly fitting mask with an inflated face-seal is necessary for the administration of 100% oxygen.
- Contact the Public Health Agency, Health Protection Duty Room which will co-ordinate Environmental Health, Health and Safety, Social and other services to protect your patient and others (Telephone: 0300 555 0119) (**Out of hours:** Ring Northern Ireland Ambulance Control (028 9040 4045) and ask to bleep the public health doctor on call).

Hyperbaric Oxygen Therapy

The National Poisons Information Service (NPIS) does not currently recommend hyperbaric oxygen therapy. It refers to the evidence base being insufficient to justify transport of patients over long distances. If this therapy is under consideration it should be discussed with NPIS.

Expired air carbon monoxide and blood COHb are poor guides to prognosis.

Prevention is better than cure

The following simple rules will reduce the risk of carbon monoxide poisoning.

- Ensure that all fuel-burning appliances are properly installed and regularly serviced by an accredited engineer.
- Ensure that there is adequate ventilation in any room where such appliances are used,
- Ensure that chimneys or flues are clean and not obstructed,
- Do not use unflued appliances in small closed rooms,

-
- ~~Fit a carbon monoxide alarm that meets British or European Standards,~~
 - Ensure adequate ventilation in any setting where carbon monoxide might be produced and accumulate e.g. garages or car ports,
 - If moving into new premises, either your own or rented, ensure that the above checks have been carried out,
 - If you have any unexplained symptoms, be very suspicious and seek medical advice.

People to consult

For information on appliances and servicing:

Gas Safe Register (gas) www.gassaferegister.co.uk

Tel: 0800 408 5500

OFTEC (oil) www.oftec.org

Tel: 0845 65 85 080

NIACS (all fuels) Northern Ireland Association of Chimney Sweeps www.niacs.co.uk

Advice on the management of poisoning

Contact the National Poisons Information Service (NPIS) on 0344 892 0111.

Refer to TOXBASE or the National Poisons Information Service (NPIS) on **0344 892 0111** for the interpretation of blood sample results and for more detailed advice on CO poisoning.

Contact the Public Health Agency: Health Protection Duty Room **0300 555 0119** (Out of hours: Ring Northern Ireland Ambulance Control (028 9040 4045) and ask to bleep the public health doctor on call.)

The *Diagnosing carbon monoxide poisoning* algorithm is available on the website of the Public Health Agency:

www.publichealth.hscni.net/publications/diagnosing-poisoning-carbon-monoxide-co

Last points

Audible carbon monoxide alarms are available (European Standard EN 50291, showing a British Standards Kitemark or LPCB – Loss Prevention Certification Board logo) and should be recommended. These alarms are available in homeware or DIY stores, and the alarm manufacturer's instructions for installation and maintenance should be followed. It is important to remember that fitting an audible carbon monoxide alarm is not an alternative to having appliances, flues and chimneys serviced and tested.

Leaflets and further information

1. *Carbon monoxide: Are you at risk?* New leaflet for the general public, available at https://www.nidirect.gov.uk/sites/default/files/publications/%5Bcurrent-domain%3Amachine-name%5D/carbon_monoxide_are_you_at_risk.pdf
2. NI Direct 'Winter help and Advice' <https://www.nidirect.gov.uk/campaigns/winter-help-and-advice>
3. NHS Choices information on CARBON MONOXIDE poisoning: www.nhs.uk/conditions/carbon-monoxide-poisoning/pages/prevention.aspx
4. The Public Health England (previously Health Protection Agency) website – Further information on CO can be found at <https://www.gov.uk/government/publications/carbon-monoxide-poisoning>
5. *Gas Appliances – Get them checked. Keep them safe.* Leaflet produced by the Health and Safety Executive (HSE), available by calling the HSE information line on 0845 345 0055 or at www.hse.gov.uk/pubns/indg238.pdf
6. The Health and Safety Executive (HSE) has also prepared a series of short videos on gas safety, which help to highlight typical scenarios and symptoms of CO poisoning: www.hse.gov.uk/campaigns/worksmart/videos
7. The Health and Safety Executive for Northern Ireland (HSENI) in partnership with members of the Gas Safety Working Group has produced a public information sheet: *Domestic Gas Health and Safety*, http://www.hseni.gov.uk/domestic_gas_leaflet.pdf. HSENI has also produced a leaflet on *Landlords' Duties* accessible at http://www.hseni.gov.uk/gas_landlords_duties.pdf. These are also available from HSENI through its helpline on 0800 0320 121.

Appendix

Mechanisms of action of carbon monoxide

Carbon monoxide gas enters the blood via the lung. Inhaled CO combines with haemoglobin to form carboxyhaemoglobin (COHb). Once this reaction occurs, the capacity of haemoglobin to carry oxygen is much reduced. Carbon monoxide binds to haemoglobin with about 240 times the affinity of oxygen and causes a left shift in the oxyhaemoglobin dissociation curve. These effects combine to reduce oxygen delivery to the tissues.

In addition, carbon monoxide is transported dissolved in plasma and binds to intracellular myoglobin and mitochondrial cytochrome enzymes. Binding to cytochrome A3 is thought to play an important part in the toxicity of this gas.

Recent studies have shown that carbon monoxide may function as a local transmitter substance in the body playing a role in controlling permeability of the micro-vasculature and may increase adhesion of inflammatory cells and platelets to the capillary endothelium. Carbon monoxide poisoning leads to leakage of fluid across cerebral capillaries and thus to cerebral oedema. In those who have been exposed to enough carbon monoxide to produce unconsciousness, delayed neurological damage due to leuko-encephalopathy may occur. Damage tends to be focused on those parts of the brain lying at the boundaries of the fields supplied by two cerebral arterial systems, e.g. the basal ganglia. Neurological damage seems to be the result of free radical generation and lipid peroxidation. It is possible that the binding of carbon monoxide to cytochrome A3 reduces the capacity of cells to deal with free radicals.

Carbon monoxide bound to haemoglobin has a half life of about 320 minutes under normal circumstances. This can be reduced by exposing the patient to 100% oxygen: this reduces the half-life to 80 minutes; or to 100% oxygen at 2 atmospheres pressure (hyperbaric oxygen) which reduces the half-life to 23 minutes. The half life of carbon monoxide bound to mitochondrial cytochromes may well be much longer than that of carboxyhaemoglobin and hyperbaric oxygen has been suggested as being important in attacking this binding site.

Carbon monoxide binds to foetal haemoglobin and shifts the already left-shifted foetal oxyhaemoglobin dissociation curve further to the left. The half life of CO in the foetus is longer than that in the mother.

Carbon monoxide is produced continuously in the body as a by-product of haem breakdown. This leads to a normal baseline COHb concentration of about 0.5%. In pregnancy and especially in haemolytic anaemias this can rise towards 5%. Cigarette smoking leads to COHb concentrations of up to about 13% in heavy smokers.

Patient presenting with:

Headache, nausea/vomiting, drowsiness, dizziness, dyspnoea, chest pain
Could this be a case of CO poisoning? 1

Ask the patient:

- Do you feel better away from your house or place of work?
- Is anybody else in your family, house or place of work experiencing the same symptoms as you?
- Have you recently had a heating or cooking appliance installed?
- Have all gas, coke/coal, wood or oil fired appliances, eg cookers, fires, boilers at your home been serviced within the last year?
- Do you use your oven or gas stove for heating purposes as well as for cooking?
- Has there been any change in ventilation in your home recently, eg fitting double glazing?
- Have you noticed any sooty stains around appliances or an increase in condensation?
- Does your work involve possible exposure to smoke, fumes or motor vehicle exhaust?
- Is your home detached, semi-detached, terraced, or a flat, bedsit or hostel? 2

You are suspicious:

Could this be a case of CO poisoning?

You are confident:

This is NOT a case of CO poisoning

Action to take:

GP – General Practice ED – Emergency Department

1 Test for CO

GP – breath test for exhaled CO if device is available. (Note: Only indicates recent exposure; interpretation difficult in smokers. For interpretation of results see TOXBASE).

ED – heparinised venous blood sample for COHb estimation. For interpretation of results see TOXBASE and contact the National Poisons Information Service (NPIS 0344 892 0111).

2 Management – Commence oxygen therapy

GP – follow advice on TOXBASE; refer to ED if required.

ED – follow advice on TOXBASE. Contact NPIS for severe poisoning (0344 892 0111).

3 Protect your patient and others

Contact the PHA Health Protection Duty Room (0300 555 0119) for further advice to ensure a coordinated response takes place.

4 DO NOT allow patient home without a warning NOT to use the suspect appliances.

5 Follow-up

GP – note that symptoms may persist or develop later.

ED – advise patient to see GP for follow-up. Note this advice in discharge letter. 3

If patient does not improve:

- Contact NPIS for advice.
- Reconsider diagnosis. 4

Diagnosing poisoning: Notes

Carbon monoxide (CO)

Health Protection Agency guidance produced in association with the Public Health Agency

Box 1 Carbon monoxide (CO) is a mimic

Carbon monoxide poisoning is notorious for simulating other more common conditions, including flu-like illnesses, migraine, food-poisoning, tension headaches and depression.

Headache is the commonest symptom – think CO!

Box 2 CO sources are multiple

The source of CO may be in the home, in the car due to a leaking exhaust system, or in the workplace. Gas, oil, coke and wood heating appliances are the commonest sources in the home. Malfunctioning heating appliances may be indicated by there being yellow rather than blue flames (if it is not a 'decorative flame' fire) and by deposits of soot on radiants or on the wall next to the fire. There may be more than one source of CO.

Poisoning is not limited to those from lower income groups. CO can leak into a semi-detached or terraced house/flat from neighbouring premises. It is unlikely that a patient will know about servicing of appliances at his/her workplace, but it is worth asking about the sort of heating appliances in use.

It is also worth asking: Have you recently started to re-use heating appliances/boilers after the summer break/during an unexpected cold spell?

Box 3 Stopping further exposure is essential

Preventing further exposure is the most important thing you can do. Breath tests and blood samples may prove inconclusive some hours after exposure has ended: CO levels in the blood decline with a half-life of about six hours. Note that a normal concentration of carboxyhaemoglobin (COHb) does not disprove CO poisoning unless the sample has been taken soon after exposure ended. A heparinised venous blood sample should, however, always be taken and sent to the local Clinical Chemistry Lab for analysis. For interpretation of results and detailed advice on CO poisoning, see TOXBASE and call NPIS.

If you strongly suspect CO poisoning, do not wait for the result of the analysis before taking the other steps listed in Box 3. A Gas Safe Registered engineer can be located by calling **0800 408 5500** or visiting www.gassaferegister.co.uk The Health and Safety Executive Northern Ireland (HSENI) website has other helpful information on appliances. Its website is www.hseni.gov.uk Contact the Health Protection Duty Room **028 9055 3994/7** for further advice to ensure a coordinated response takes place. Follow-up is important as further consequences of chronic exposure to CO may be delayed, or mild symptoms may persist, multiply or intensify. Recommend the purchase of an audible CO alarm for installation in the home.

Box 4 Links and contact details for information on CO

- TOXBASE: www.toxbase.org
- National Poisons Information Service (NPIS) 24hr hotline: **0344 892 0111**
- Public Health England: www.gov.uk/government/publications/carbon-monoxide-poisoning
- Public Health Agency: <http://www.publichealth.hscni.net/publications/diagnosing-poisoning-carbon-monoxide-co>
- Department of Health: <https://www.health-ni.gov.uk/>
- Health and Safety Executive Northern Ireland: www.hseni.gov.uk