COMed: Working paper on CO in pregnancy

About the APPCOG and COMed

The All-Party Parliamentary Carbon Monoxide Group (APPCOG) is the leading forum for Parliamentarians from both Houses and all parties to work together in tackling carbon monoxide (CO) poisoning, improving government policy on CO safety, and raising public awareness of the threat posed by deadly CO gas.

COMed is the APPCOG’s medical and healthcare working group and was responsible for the APPCOG’s 2017 report ‘Carbon monoxide poisoning: saving lives, advancing treatment’. The group is made up of leading figures in the prevention, diagnosis and treatment of, and research into, CO poisoning.

Background

Carbon monoxide (CO) is a poisonous gas given off when a carbon-containing fuel burns incompletely. A well-known source of CO is fuel burning appliances in the home (e.g. stoves, boilers, gas fires, and heaters) that are malfunctioning, not serviced, poorly installed, or inappropriately used.¹

Each year CO poisoning causes approximately 4,000 visits to A&E in England and Wales, as well as over 30 deaths and 200 hospitalisations.² CO poisoning is estimated to cost the taxpayer £178 million every year.³ However, these figures are likely underestimates due to data gaps caused by insufficient reporting of CO incidents, and the difficulty healthcare professionals face diagnosing CO poisoning.⁴

CO poisoning causes a variety of non-specific symptoms, including: headaches; nausea; vomiting; lethargy; flu-like symptoms; dizziness; confusion; shortness of breath; abnormally rapid heart rate; fainting; seizures; and paralysis.⁵ These symptoms become more severe as exposure levels increase, with high-level exposure capable of causing coma and death within minutes.⁶ There are also a number of neurobehavioural and neuro-psychological symptoms associated with CO poisoning, including changes in memory, cognition and mood.⁷

Exposure to CO can come in many forms, from high doses in a short amount of time or long term exposure that can last many days or months, and may be intermittent. Exposure lasting less than 24 hours is known as acute; poisoning lasting more than 24 hours (usually at a lower level) is known as chronic exposure.⁸

The effects of CO poisoning increase for certain vulnerable or at-risk groups, including pregnant women and their unborn child, and young children.⁹ In-utero CO exposure is particularly harmful and has been linked with low birth weight, neurodevelopmental problems, congenital malformations and sudden infant death.¹⁰

To address this, COMed met to discuss how we can better prevent pregnant people from being exposed to CO and improve the support they receive. Written below are a series of recommendations outlining how to achieve this goal. They have been designed as a package of policies designed to work collectively.

² Ibid., p. 3.
³ Ibid., p. 5.
⁴ Ibid., p. 15.
⁵ Ibid., p. 6.
⁶ Ibid., p. 5.
⁷ Ibid., p. 30.
⁸ Ibid., p. 5.
⁹ Ibid., p. 15.
¹⁰ Ibid., p. 32.
How to address CO in pregnancy

Increase preventive measures

As described above, CO exposure often originates in the home via faulty or improperly-used fuel-burning appliances boilers. Yet the growing majority of CO screenings of pregnant people are carried out by midwives in hospitals and maternity units. This is problematic because of the half-life of carboxyhaemoglobin (COHb), which is formed when CO enters the bloodstream. COHb is widely used to diagnose CO poisoning after suspicions have been raised (e.g. by a breath analyser). However, this becomes challenging if the patient has spent time away from the source of CO as breathing unpolluted air causes COHb levels to fall, in turn making it more difficult to diagnose. As a result, we anticipate a number of non-smoking women are being exposed to CO but aren’t diagnosed because they are screened away from their homes.

Ideally, this would be addressed by providing every pregnant person with a readable CO monitor, a home check to identify CO risk factors such as an un-serviced gas appliance, and a home-based CO screening carried out by a qualified midwife. However, this would not only be relatively expensive but also poorly targeted, as research shows the risk of CO poisoning is greater in vulnerable households, such as those who live in fuel poverty. To improve the cost-effectiveness of prevention, it could be targeted to specific households using an existing policy (such as Healthy Start) that already engages vulnerable pregnant women. Of course, any efforts to improve prevention and detection must also be accompanied by rigorous treatment pathways (see below) to ensure CO incidents are properly addressed once identified.

**RECOMMENDATIONS**

1) NHS England should provide readable CO monitors to pregnant women in receipt of benefits.

2) NHS England should advise maternity units to prioritise pregnant women in receipt of benefits when allocating home-based CO screenings.

COMed also believes there is a role for non-midwifery services in preventing pregnant women and their children from being exposed to CO. Of particular interest is the Priority Services Register (PSR), a scheme that provides additional services to vulnerable energy customers including households with children under five, but not pregnant women. COMed members are also working with colleagues to support the expansion of CO screening beyond midwifery and into secondary care more broadly, to include health visitors.

**RECOMMENDATIONS**

3) The Office for Gas and Electricity Markets (Ofgem) should expand the PSR’s eligibility criteria to include households with a pregnant woman.

4) NHS England should increase support for expanding CO screening into secondary care.

Improve treatment pathways

Currently, most pregnant women book their first midwifery appointment within 8-10 weeks of gestation. These appointments include a screening for elevated CO levels using a breath analyser, which measures CO in parts per million (ppm). If an elevated reading is found then the midwife establishes whether the pregnant woman is a smoker and if so refers them onto stop smoking support where available.


Yet despite there being well-known guidance for addressing CO in pregnancy caused by smoking, there is no official protocol for investigating elevated CO amongst pregnant women not caused by smoking. This problem is compounded by midwives’ own concerns that they and their colleagues are not adequately trained to address non-smoking causes of elevated CO in pregnancy (see below).

In response, some local maternity units have developed their own protocols (or pathways) for screening pregnant women and then referring them, if elevated CO is detected, along an internally identified pathway. However, COMed members are concerned these local pathways are: overly complicated; use arbitrary ppm thresholds for elevated CO; draw from an incomplete evidence base; or don’t sufficiently investigate non-smoking sources of CO.

If used improperly, these pathways may cause pregnant women undue alarm and undermine the relationship between the midwife and her pregnant woman, the quality of which underpins all of antenatal care. Worst of all, by not understanding the complexity of diagnosing CO poisoning, these pathways may fail to identify pregnant people being exposed to CO, which in turn would prolong exposure and amplify its harm.

To address this, midwives need clarity on how to conduct CO screenings and address elevated CO levels caused by a variety of different causes, including those found in the home. It is essential that any future guidance is:

- **Consistent** – To ensure ppm thresholds for elevated CO are informed and standardised;
- **Concise** – To ensure midwives can conduct thorough screenings in often brief appointments; and
- **Clear** – To ensure elevated CO levels are investigated properly and appropriate referrals are made.

### RECOMMENDATIONS

5) **NHS England should develop a national protocol for screening CO levels in pregnant women (smokers and non-smokers), investigating elevated CO, and making appropriate referrals once elevated CO is identified.**

6) **NHS England should work with manufacturers of CO monitors used by midwives in order to promote the use of the National Institute of Care Excellence’s (NICE’s) ppm thresholds for elevated CO in pregnancy.**

COMed is also concerned that when these protocols successfully identify elevated CO, they don’t lead to appropriate referrals. Cases have been identified where pregnant women with elevated CO are referred to Emergency Departments where specific training needs regarding CO and the physiological influences of pregnancy are not targeted. A preferable referral would be to an Obstetrician (a pregnancy specialist) where training on the complexities of CO in pregnancy can be more appropriately directed.

This challenge is exacerbated by the lack of national guidance on the provision of Hyperbaric Oxygen Therapy (HBOT) to pregnant women, which several members of COMed have seen used to treat elevated CO in pregnancy. Additionally, NHS England is phasing out the provision of HBOT as there are unanswered questions regarding its efficacy. However, there are similar questions regarding the use of normobaric oxygen therapy in pregnant women and foetuses.

### RECOMMENDATIONS

7) **NICE should develop specific guidance on preventing, diagnosing and treating CO exposure, which should include CO screenings conducted by midwives.**

8) **NHS England and NICE should work together to develop guidance on providing normobaric oxygen therapy to pregnant women in light of HBOT no longer being supported by NHS England as a treatment for CO exposure.**
Fill research gaps

By screening the majority of pregnant women for elevated CO, midwives are generating significant amounts of valuable data that could improve our understanding of CO in pregnancy. However, this wealth of data is largely inaccessible because it is fragmented across many local units, each of which use several incompatible computer systems preventing collation of these records into a single nationwide collection. Efforts are being made to compile regional data, such as an ongoing project in Greater Manchester, and we hope their results will begin to address the lack of data on CO incidence rates amongst pregnant women.

Alongside the data’s inaccessibility, there are also concerns about the utility of its content. When CO screenings are recorded they often only contain the CO level, the person’s use of tobacco, and increasingly use of e-cigarettes. Crucially, it does not include data on non-smoking sources of CO (such as faulty appliances) and this ambiguity is made worse by the issues surrounding COHb’s half-life, as described above.

To improve our understanding of the CO risk factors faced by pregnant women and to refine efforts to prevent exposure to CO, it is essential we address these significant gaps in data collection. One solution could be using the Gas Emergency Service to collect data on CO cases via its incident-reporting telephone service. However, this may not catch pregnant people in vulnerable circumstances who are exposed to CO but are unable to report the incident (e.g. a lack of CO alarm, fear of recriminatory eviction, etc.). We should therefore interview this subgroup to ensure future preventative measures include all pregnant people.

**RECOMMENDATIONS**

9) Operators of the Gas Emergency Service should begin collecting data on the composition of households (including pregnant women) that report incidents. We recommend these operators engage with the Information Commissioner’s Office to seek further guidance on achieving this.

10) Qualitative research into perceived CO risks amongst pregnant women should be conducted, particularly amongst pregnant women in vulnerable circumstances. Such research should have a quantitative element included to confirm exposure.

Alongside our understanding of CO exposure’s causes, we also lack a full understanding of how CO effects the body during pregnancy, especially its long-term developmental impact on children following in-utero exposure. With limited knowledge of the biological mechanisms that cause CO’s symptoms, our capacity to develop new and improved treatments is restricted. A notable example of this is the provision of oxygen treatment (HBOT or normobaric oxygen) to pregnant women exposed to CO. The physiological changes brought about by pregnancy create additional uncertainties around the effects and use of HBOT and NBOT (both short and long-term) on both pregnant women and foetuses. This includes, for example, understanding how long to supply treatment and whether there is a risk of injury to the woman by oversupplying the brain with oxygen, or risk to the foetus by undersupplying oxygen treatment. Research to improve an understanding of treatment alongside the new era of research that is developing on understanding the mechanisms of CO is important.

**RECOMMENDATIONS**

11) Current basic scientific research to investigate CO’s neurological effects should be expanded to examine the impact of CO exposure in-utero on emotion and cognitive function.

12) Longitudinal research on the long-term effects of oxygen treatment on pregnant women and their babies is needed.

Expand CO training

As highlighted above, midwives have expressed concerns to COMed that they and their healthcare colleagues are not sufficiently trained to investigate non-smoking causes of elevated CO in pregnancy and then make appropriate referrals.
CO exposure causes a variety of non-specific symptoms, some of which can be mistaken for signs of early pregnancy (e.g. nausea) or the effects of living in poverty (e.g. lethargy and depression). To address this ambiguity, midwives must be provided with more information and training on investigating potential symptoms of CO poisoning, especially those of lower-level chronic exposure which are particularly subtle.

Training is also needed to improve midwives’ knowledge of home-based sources of CO, as this will increase their confidence when their suspicion is raised by elevated CO levels in pregnant women who don’t smoke. Further to this, midwives should be given more guidance (alongside the pathways described above) about appropriately referring pregnant women with elevated CO. For this to be successful, these referral destinations must also receive additional training specific to CO poisoning, that includes consideration of the mental wellbeing of the woman throughout the rest of the pregnancy and her ability to act on advice provided.

Lastly, an expanded training programme should develop in phases as the evidence base develops. The first phase should utilise existing knowledge to build a foundation of understanding of CO’s symptoms and how to screen for exposure amongst midwives. This should draw from knowledge developed by Public Health England and its partners as part of their work to reduce smoking during pregnancy. The second phase should come later following research efforts (discussed above) that will inform training and guidance amongst other healthcare professionals.

**RECOMMENDATIONS**

13) Training provided to midwives on CO screening should encompass sources of CO beyond smoking to facilitate more confident assessment of elevated CO levels in pregnant women and enable the initiation of appropriate action.

14) Expand training on CO in pregnancy to include Obstetricians, other members of the maternity team and Emergency Department professionals.

**Contact Details**

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