Gas Safety Trust

Grants Summary 2011 – 2018

Making a Difference

CORGI

CORGI Services Ltd donates its profits to support the Gas Safety Trust

About us

We provide grant funding, advice and support to any organisation to carry out research and evidence gathering relating to gas safety.

Since 2013 we have awarded £2million to a variety of programmes and projects relating to gas/fossil fuel safety and CO.

Areas of Interest

Our current projects look at (but are not limited to) the following areas:

- The possible link between CO and neurological conditions
- CO exposure risks to pregnant women and the foetus
- CO in the leisure environment
- CO emissions from solid fuels

Number of Grants

Since 2013 we have awarded 25 grants to 16 institutions/ organisations.

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Foreword

Since 2013, the Gas Safety Trust (GST) has proactively funded academic research and empirical data-collection with a view to improving our knowledge and understanding of carbon monoxide (CO) poisoning in pursuit of our key aim of preventing death and injury from this avoidable occurrence.

The Trust has worked closely with industry and policy experts to identify priority areas where research is needed. To that end, we have supported a number of PhD students, established experts and engineers, and researchers in their work, by committing to circa £2 million in grant funding.

With regards to low-level CO poisoning, our approach has been two-pronged: not only to try to establish the scale of the problem, but also, accepting that there is an underreported public health issue, to establish what can be done to mitigate and prevent it.

Regarding the former, we have worked with a number of front line-agencies to collect data and information, regarding the latter, we have sought to develop new biomarkers and diagnostic processes that will assist healthcare professionals and other first-responders to spot CO poisonings more easily when they come across them.

Our aim is to be responsive to emerging issues

The data we publish as the Downstream Incident Data Report (DIDR), shows the downward trend in CO poisonings relating to piped natural gas, as a direct response to the initiatives undertaken by policymakers and industry over the last 40 years This work has also identified older people as a demographic that is particularly at risk of CO poisoning, a finding that has led to the Trust funding research into the possible links between CO and dementia. Older people as well as the young, and pregnant women are all at-risk groups, and we are currently funding or hope to fund, research that will address these issues.

Our aim is to be responsive to emerging issues, and we are looking at research proposals that will investigate CO in leisure environments such as boats and tents, as well as considering the risks associated with solid fuels, which have seen an increase in reported incidents in recent years.

More broadly, the Trust will continue to work with initiatives to coordinate research internationally, such as the International CO Research Network (ICORN), and will host events that help to share knowledge and generate fresh thinking.

Finally, I would like to thank the GST Trustees who give their time and expertise freely to support the Gas Safety Trust, and to the GST team at ENA, who have managed our work over the last six years.

Chris Bielby
Chairman
Gas Safety Trust

Key Statistics

Over the past 6 years the Trust has awarded over

£2 million worth of grants

The Trust has awarded grants to

26

institutions or organisations

During 2015/16 there were

5 fatalities

due to CO poisoning from piped natural gas,

4 of these fatalities were over the age of 60

ALL

fatalities occurred during the

WINTER PERIOD

4 FATALITIES and **15 INCIDENTS** were linked to **PIPED NATURAL GAS**

Almost a QUARTER of people have stored a BBQ inside their tent/ caravan after cooking

Shockingly,

14%

of people admit to bringing a barbecue INSIDE their tent/caravan due to bad weather, with a further

1 in 10

people stating that they haven't done so, but would

14%

of people said they would use a cooking appliance to warm up their tent

Institutions Awarded Grants

The Gas Safety Trust has become the UK's leading gas safety research charity with the key objectives of further improving gas/fossil fuel safety for the public and industry throughout the UK and reducing the incidents of death and serious injury from carbon monoxide (CO) exposure. The Trust does this through awarding grant funding, advice and support to organisations for the research and data collection relating to CO poisoning.

Downstream Gas

Liverpool John Moores University
UCL
Castleland
Newcastle University
Public Health England
IGEM
Cranfield
Imperial College London
Lifeskills for Learning
Frimley Park Hospital
East of England Ambulance Service
National Energy Action
Lancaster University
National Poisons Information Service
University of Lausanne

1 Summary of Grants Awarded

2013

IGEM

Measurement of Carbon Monoxide Emissions from Domestic Gas Appliances at Low Ventilation Rates

This project investigated the potential concentration of CO created by gas appliance emissions in poorly ventilated domestic buildings.

Undertaken by the HSE's Health and Safety Laboratory, the investigation tested four different domestic gas appliances: a four ring hob single oven gas cooker, a wall-mounted flueless gas fire, a portable cabinet heater, and a standard gas fire requiring a flue.

It concluded that there was no increased risk of CO poisoning due to low levels of ventilation, provided that the appliances were properly installed to the manufacturer's recommended instructions and were correctly maintained.

However, the report does highlight a number of potential problem areas that could be investigated further, such as the effects from poorly maintained appliances, or the risks when using alternative heating fuels such as wood or other solid fuels.

While the investigation focussed on CO concentration there were recordings of elevated CO2 emissions from gas appliances which could be the subject of further research.

Findings

1. Concentrations of CO did not exceed the 15 minute Short Term Exposure Limit (STEL) value of 200 ppm at any time during the test.

2. A gas cooker with all four gas hob rings at maximum could be capable of emitting enough CO to exceed the 8-hour Workplace Exposure Limit (WEL) of 30 ppm, although this would be extremely unlikely in practice as this raised the ambient temperature in the test room above approximately 40 °C, which would not be comfortable for an occupant.

3. Operating the gas oven alone at its maximum setting resulted in a maximum CO concentration of 9.2 ppm and typically had an equilibrium value of 6 to 7 ppm.

4. With the flue-less gas fire operating at maximum, the concentration of CO never exceeded 7.2 ppm and could therefore be operated without risk of harmful exposure to CO.

5. When using a portable cabinet heater at a ventilation rate of ≈0.00 h-1, a CO concentration of 33.4 ppm was detected, which was the highest recorded concentration during any test.

6. A portable cabinet heater could emit enough CO to cause exposures of approximately 30 ppm if operated in a room with a ventilation rate of less than 0.25 h-1.

7. It should be noted that the cabinet heater was tested in conditions outside of the manufacturer's recommendations, i.e. lower than the recommended room ventilation rate.

8. A properly installed flue can provide a natural ventilation rate to a room exceeding 1.00 h-1.

9. A gas fire in good working order when connected to a properly installed flue can be operated indefinitely without emitting any harmful concentrations of either CO or CO2. Tests carried out using the gas fire with a flue produced peak CO concentrations of less than 5 ppm.

10. Although none of the appliances tested produced harmful levels of CO, ventilation rates of <0.5 h-1 to 1.0 h-1 were less efficient at removing CO.

11. Oxygen levels in the room remained above 20% v/v when the oven alone and fire with flue were in use. All other appliances resulted in oxygen levels ranging 17.8 - 19.9% v/v. The minimum oxygen level measured was 17.8% v/v during use of the hob rings with no mechanical ventilation.

12. For all appliances except the gas fire with a flue, the STEL for CO2 was exceeded at least once during testing. The highest concentration of CO2 was 1.93% v/v, measured during use of the hob rings with no mechanical ventilation. Similarly, for all appliances except the gas fire with flue the concentration for the 8-hour WEL was exceeded but for considerably shorter periods than 8 h.

13. A functioning Atmospheric Sensing Device fitted to the cabinet heater should have activated once the CO2 concentration exceeded 0.8 v/v. Although the air in the test room was considered to be relatively well mixed there was no measurement position at the exact location of the heater so it is not known what the CO2 concentration was here.

*Click **here** to read the final report.*

2014

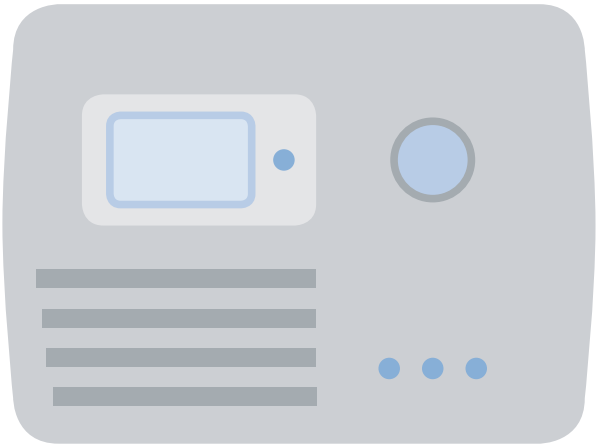
Liverpool John Moores University

Carbon Monoxide National Monitoring Study

The Liverpool John Moores University CO Monitoring study collected CO-related data in partnership with the Fire & Rescue Service and its home fire safety checks, as well as in situ CO data loggers.

As part of their normal home fire safety check, selection process dwellings were identified and, in agreement with the occupants, a CO recording device (and audible CO alarm) was placed in the property for a minimum of 2 weeks. After this period the data logger was removed (the CO alarm remained) and the output examined to see if there was any CO present at low levels within the property and to identify the potential source of the CO.

The first phase of this study started in 2011. From 2014 it was funded by GST. Due to changes to Fire Service funding this project ran for longer than intended, and is due to produce its final report in early 2019.



2014

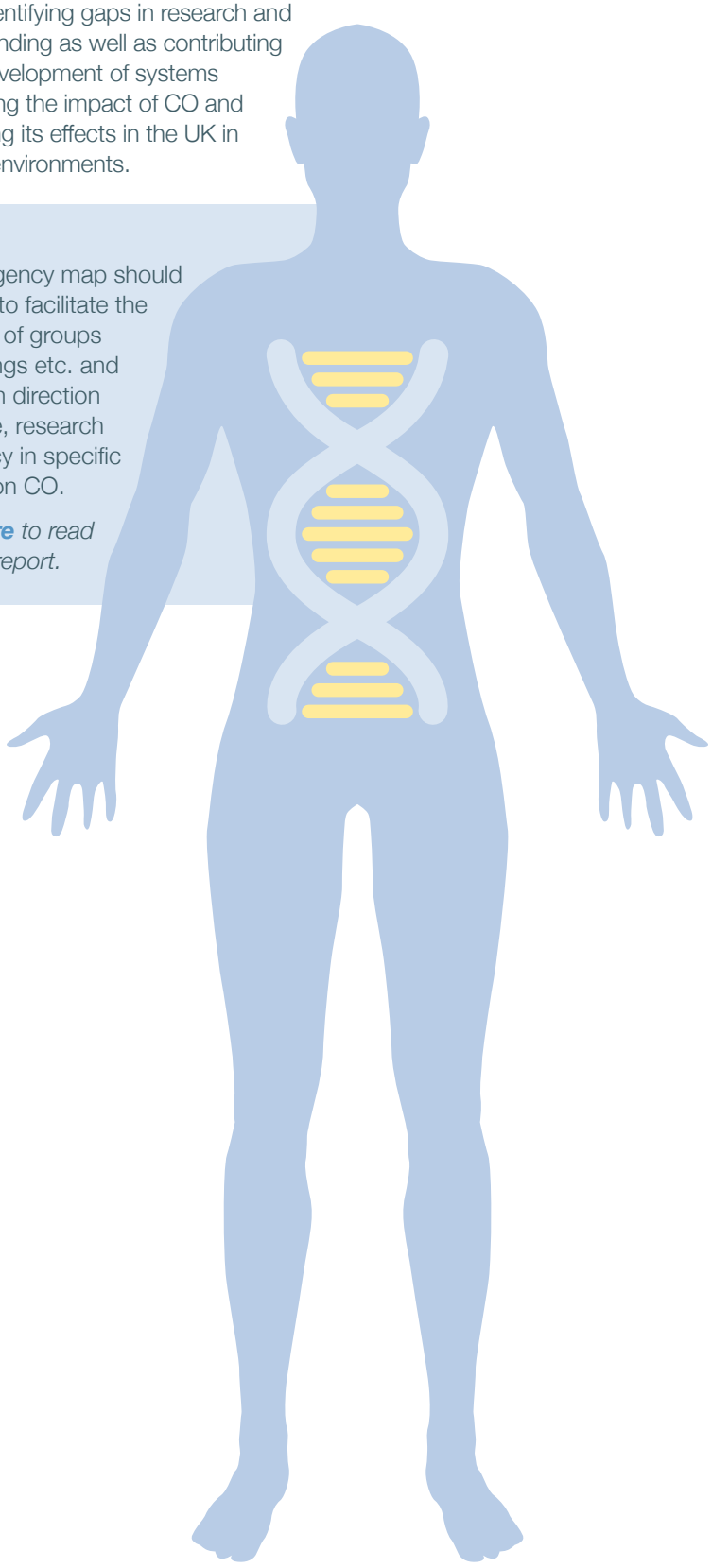
Cranfield University

Study to Determine the Impact of CO+ on Populations in Various Environments

The CO+ Impact is a thorough review of existing research and regulation relating to CO in the UK and elsewhere. It considers not only the medical side of research but also in correlation with the chemical/physical effects.

This research explored how people are affected by CO in a variety of environments and to what degree. The environments looked at included those associated with leisure activities such as boats, caravans and tents, as well as in the home, specific working environments and public spaces.

The outcome of this research is a report identifying gaps in research and understanding as well as contributing to the development of systems for defining the impact of CO and monitoring its effects in the UK in defined environments.



Recommendations

1. A system dynamics study should be conducted to determine the current invested agencies in carbon monoxide poisoning prevention, and coordinate them and their impacts.

2. The study should engage with the current groups on CO to determine how they interact and impact each other and themes surrounding CO in order to create an agency map.

3. The agency map should be used to facilitate the inclusion of groups at meetings etc. and drive with direction and ease, research and policy in specific themes on CO.

*Click **here** to read the final report.*

2015

National Energy Action

Understanding Carbon Monoxide Related Safety Risk in Vulnerable Households

Action for Warm Homes

From October 2015 - April 2016 and October 2016 - April 2017 National Energy Action collected data from 349 households, specifically those on low incomes and with a range of vulnerabilities.

There are recognised shortcomings in existing data on CO exposure levels, and recorded deaths and injuries attributable to CO have occurred across different tenancy types and socioeconomic groups. However, it may be safely assumed that there is a reasonable overlap between those households qualifying for Priority Services Register assistance and CO exposure risk.

Actions to help prevent CO poisoning in the home require the regular maintenance and servicing of appliances (and the installation of audible CO alarms) as well as their correct use. These activities are not cost-free, and are unlikely to be prioritised by households with limited budget. Priority Services Register households are frequently those that are privately rented, and there is some evidence to suggest that these tenures are higher risk than others.

Despite clear legal responsibilities to their tenants, data from the Gas Safe Register indicates that many landlords fail to provide tenants with an assurance of the safety of their gas appliances. In a poll of privately rented homes, only half received an up-to-date gas safety record when moving in and 75% were left without a valid record for their entire tenancy. Also, results from a Department of Health study in 2011 suggested that one-fifth of lower-income households could regularly be exposed to CO levels above WHO guidance.

At the same time, households qualifying for Priority Services Register-based assistance are also likely to qualify for a range of other forms of assistance that could improve their health and welfare, but for whatever reasons are not yet exploiting these services. Organisations visiting Priority Services Register households are in a good position to identify such households and refer them on for further assistance.

This research sought to understand CO knowledge, behaviour and practices amongst low income households.

Recommendations

1. Join up fuel poverty and gas safety initiatives.

Government energy efficiency programmes such as ECO replace old and inefficient boilers and install first-time boilers and central heating in low income households in order to alleviate fuel poverty. This is welcomed however CO risk will not necessarily be addressed in these households if occupants continue to use and rely on older room heaters such as gas fires.

This research has shown it is not always correct to assume that households with modern boilers will favour them over other heating systems. Instead, amongst occupants vulnerable to fuel poverty, combustion room heaters may be preferred for cost reasons or both primary and secondary appliances will be run concurrently in attempts to achieve adequate warmth. Consideration should therefore be given to supporting households replace or maintain appliances such as gas fires.

Equally, it is critical that households are educated on their central heating systems and occupants on low incomes are supported to optimise use of these systems without compromising on energy affordability.

A key role is required for frontline service providers such as local authorities and community organisations, who are already reaching and protecting households in need. These agencies should be supported to deliver integrated fuel poverty and CO safety

initiatives, including providing measures such as CO alarms to fuel poor households. Here, there is a clear role for gas distribution network companies to support these agencies. The gas networks have existing obligations on fuel poverty and CO awareness under the regulator Ofgem's RIIO-GD1 price control model. Ofgem should further incentivise the gas networks to join up action on fuel poverty and CO awareness in the next price control period (after 2021).

2. Support non-gas households to replace old and risky boilers.

Historically, non-gas homes have disproportionately missed out on heating measures under ECO and this study shows rural households with boilers not fuelled by mains gas are disproportionally older, riskier and inefficient models. Rural off-gas homes are at increased risk of living in severe fuel poverty, nor are they served by free safety checks of gas appliances offered to low income owner-occupants under the Priority Services Register (PSR). For both energy affordability and safety reasons these households must be targeted in future government energy efficiency programmes. Specifically, NEA recommends a minimum target for installation of first time central heating systems under the next iteration of ECO (from October 2018) and that this target is aligned to Ofgem's scheme to provide free connections to the mains gas network for fuel poor non-gas homes.

3. Promote the PSR as a pathway to free gas safety checks.

Gas suppliers are required to offer free gas safety checks to low income and vulnerable households but the volume of these checks has historically been very low. This is unfortunate because this service can help to address CO risk in low income owner-occupant households who may be neglecting to service appliances for cost reasons but may also be more susceptible to adverse effects from CO exposure for reasons of age or ill health.

The gas industry (suppliers and network distributors) must improve efforts to sign-up low income and vulnerable customers to the PSR and passport eligible households into annual free servicing plans.

4. Improve public awareness about the CO risks of combustion appliances beyond gas boilers.

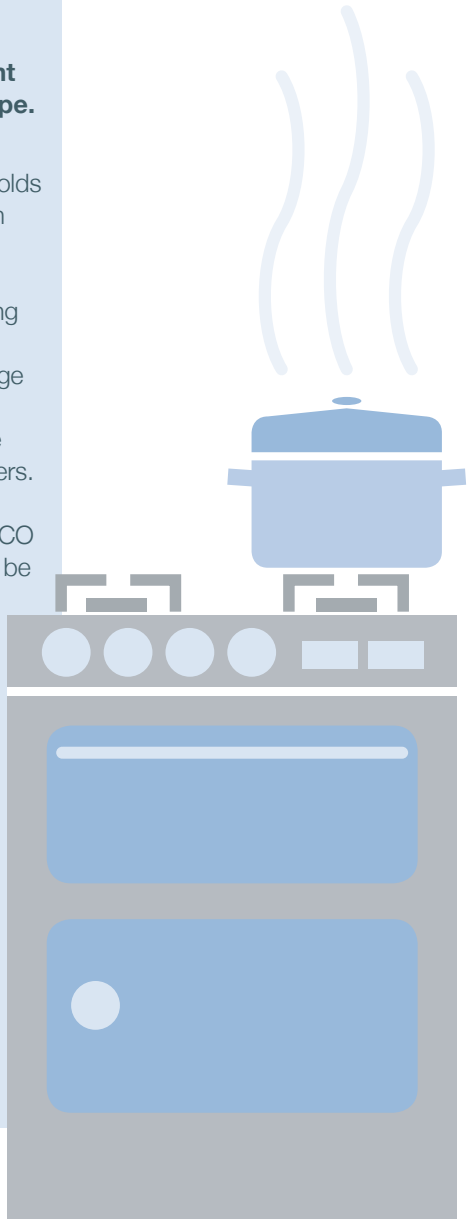
Households servicing gas boilers are not always extending this behaviour to include other gas appliances in the home. Gas cookers in particular are perceived to pose a low CO risk relative to boilers and households are largely unaware that such appliances require maintenance. Gas safety messages should be made clearer to communicate about the risks posed by different gas appliances and advised on their proper installation, use and maintenance. Gas fires and gas cookers should be prioritised in such messages and catch-all and ambiguous terms such as 'appliance' should be avoided.

5. Target and tailor CO safety messages to account for different household, appliance and fuel type.

Safety may not always be the most effective message to prompt households to check their appliances. Instead, an understanding of the appliance and household type should inform CO campaigns. For example, emphasising reliability and comfort may help drive boiler servicing, particularly in older age households susceptible to the cold. While a focus on safety may be more suitable for appliances such as cookers. Amongst low income families and working-age households, integrated CO and fuel poverty interventions should be considered (elevated CO levels and lower mean temperatures were observed in these homes).

Clear messaging about landlord and tenant responsibilities is also critical, particularly in social rented housing where appliances are more likely to be owned by tenants and not covered by landlord gas safety checks. Households off mains gas should be targeted with bespoke campaigns addressing servicing of oil, solid fuel and LPG appliances.

*Click **here** to read the final report.*



2015

Cranfield University

The Use of Biomass Fuels in the UK, and the Potential Human Health and Environmental Impacts

In April 2014 Cranfield University undertook a 10-week research project in Milton Keynes, carried out by postgraduate students taking MSc courses concerned with environmental and health management and protection.

Biomass use equates to fuel switching away from the current major fuels (e.g. gas and electricity) either for use in existing or future buildings. Biomass burning creates a range of gasses and particulate pollutants, and has characteristics that differ from those produced by combustion of other fuels. This could have both local and national implications for air quality and health. Burning solid fuels such as wood in homes may present a changing risk of indoor pollution and fires. This risk may actually be enhanced by air tight energy efficient homes which are now being constructed, and also by major programmes to improve the energy efficiency of existing homes.

The project included consideration of those pollutants generated and the risks to the health of people exposed in non-occupational (homes, outdoor air) and occupational environments (biomass fuelled power plants).

It consisted of laboratory and field studies including surveys of people's awareness of risks. It looked at the toxicity of combustion products in comparison to other fuels as well as considering wider issues about sustainable supply of biomass fuel and impacts on biodiversity, with a view to identifying any possible adverse and beneficial outcomes of increased use of biomass fuels.

Recommendations

1. For future scenarios using locally supplied energy crops, it is recommended to study the human health impacts of small-scale biomass burning devices for these different types of feedstock.

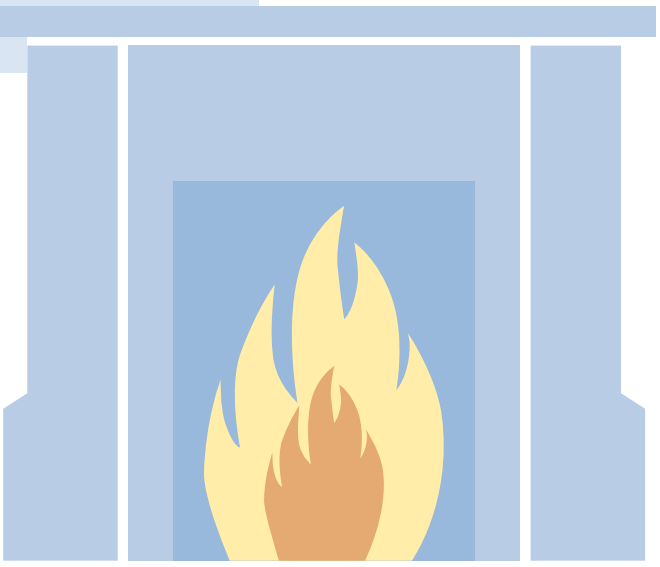
2. In order to analyse how a massive change to biomass burning devices would affect Milton Keynes air quality, further research should be done. More houses and during more time should be analysed to have more conclusive results.

3. There should be an incentive to improve appliances by replacing old burners by new ones. Also smart use of maintenance and ventilation are advised to reduce health risks.

4. Awareness should be raised on the risks associated with current fireplaces or old appliances, especially regarding the possible health impact that a long term exposure to the emitted pollutants as CO or PM could have.

5. A functional ash handling and disposal system should be put in place for homes in the Milton Keynes area, to address the potential risks posed by heavy metals from biomass burning.

*Click **here** to read the final report.*



2015

East of England Ambulance Service

Carbon Monoxide Pre-hospital Screening Study

The Department of Health estimates that around 4,000 people attending Accident and Emergency departments each year in the UK are diagnosed with CO poisoning. However, accurate numbers are difficult to determine because the signs and symptoms of CO poisoning are very similar to other common illnesses and as such are easily misdiagnosed.

This study provided evidence as to whether CO screening by Paramedics attending patients in their home could be effectively carried out, and so become part of the routine observations that are undertaken.

In addition to this, by using ambient air CO analysers, the study identified the number of patients exposed to CO in the 999 emergency ambulance environment and explored the experience of CO exposed patients and their clinical presentation.

This study produced valuable data on the incidence of CO exposure in the targeted area in the East of England Ambulance Service. The data sample included around 20,000 measurements taken over the 12-month study.

Conclusions

1. An incidence density of 4 patients per 10,000 incidents attended, had been exposed to CO at levels which would not have been suspected at the point of the 999 ambulance call.

2. Ambulance clinicians would appreciate greater awareness of CO, and supported the case for prehospital CO monitoring.

*Click **here** to read the final report.*

2015

Public Health England

Pilot Study to Develop Protocol to Monitor COHb at Post Mortem

Public Health England's (PHE) CO pilot study has been initiated in order to develop a protocol for coroners to test for, and report on, CO poisoning at post mortem in England and Wales.

The 2011 All Party Parliamentary Carbon Monoxide Group (APPCOG) report identified a key role for coroners to support increased detection of CO poisoning in England and Wales. The report recommended that "the Government should ensure that all coroners' post-mortems routinely test for carboxyhaemoglobin (COHb) levels".

The pilot takes the first important steps towards obtaining a more complete estimate of the number of CO deaths by testing at post-mortem and is being carried out before a national data collection exercise can be undertaken so that the procedure can be defined, developed and implemented.

This study was delayed due to administrative and recruitment issues. This apparent setback has allowed the study to take advantage of regulatory and legislative developments (including the introduction of Medical Examiners in April 2019), as well as the most recently published laboratory techniques for testing blood. The study will now publish its final report in Summer 2019.

2015

National Poisons Information Service

Research into Medical Professional's Awareness of Carbon Monoxide Poisoning

Undertaken by the National Poisons Information Service (NPIS), this survey sought to gauge healthcare professionals' awareness of CO poisoning, following a pilot project.

The 2011 All Party Parliamentary Carbon Monoxide Group (APPCOG) report highlighted the challenges faced by healthcare professionals in diagnosis and treatment. According to the Department of Health, every year in the UK, over 200 people go to hospital with suspected CO poisoning, leading to around 40 deaths; however, relatively little is known about its epidemiology.

The NPIS Annual Report 2014/15 included data from 479 telephone enquiries (calls) that related to CO exposures involving a total of 682 patients. This study utilised the NPIS's TOXBASE® online resource and its 24-hour telephone advice service to gather information from users, with a follow-up questionnaire sent to gain further data, all of which was used to understand how a diagnosis was made and if cases were confirmed. At the same time, healthcare professionals accessing the TOXBASE CO entry were presented with a simple pop-up box asking whether they were seeing a patient with suspected CO poisoning and for a contact address.

A questionnaire was then sent to these healthcare professionals for additional information. The results of this exercise were then analysed with the aim of improving how CO poisoning is diagnosed.

*Click **here** to read the one-year report.*

Conclusions

1. Continue with the dynamic pop up "x-form" for data collection.

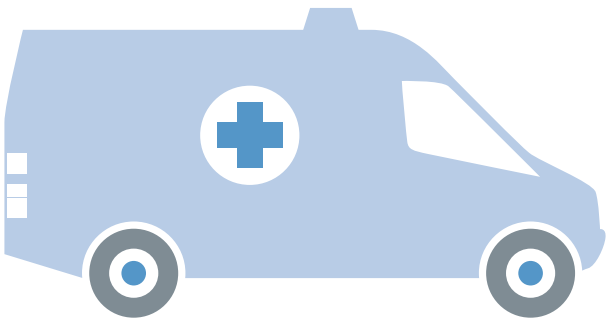
2. Adapt "x-form" wording for NHS111/24/Direct users to encourage responses.

3. Consider methods to feed back project findings to users.

4. Encourage data collection from Specialist in Poisons Information during telephone enquiries Winter 2016/17.

5. Analyse data to show affects of low level chronic exposures compared with low level acute exposures. Produce symptom profile by organ class for both types of exposure. Plot all acute and chronic exposures by PSS, symptom profile and time since exposure. Plot only acute and chronic exposures with low %COHb by PSS, symptom profileand time since exposure.

*Click **here** to read the final report.*



2016

Cranfield University

CO+ Safety Project

Cranfield's CO+ Safety project examines the release of CO during pyrolysis of charcoal and other solid fuels by burning them in a controlled environment controlling variables to establish the safest possible way to burn and extinguish solid fuels used in home and leisure environments. These include boats, tents, caravans, domestic dwellings and specific working conditions.

It seeks to understand the fundamental principles of CO release from different fossil fuels and develop a number of solutions that could be implemented and which will improve the safety of fossil fuel burning.

This study is a three-year PhD, co-funded with the Boat Safety Scheme. The candidate is currently writing up his thesis and this will be published in Autumn 2019.

2016

Newcastle University

The Utility of Mitochondrial Complex IV Analysis as a Biomarker of Carbon Monoxide Exposure

This study by Newcastle University examined cytochrome c oxidase (COX) activity as a means of detecting CO exposure.

Directly demonstrating CO toxicity in human exposures to CO is difficult as symptoms of CO poisoning are non-specific and CO can be rapidly eliminated from the body.

Once the level of suspicion in the medical practitioner is raised, methods to confirm CO exposure require specialist equipment: blood, gas or breath analysers, which tend to be utilised some time after the patient has been removed from the source of exposure, thus making detection difficult and poisoning harder to confirm due to the half-life of CO in the body.

It is considered likely that CO poisoning is underdiagnosed and if diagnosed, not necessarily detected or confirmed, making accurate morbidity and mortality statistics caused by exposure to CO, difficult to attain.

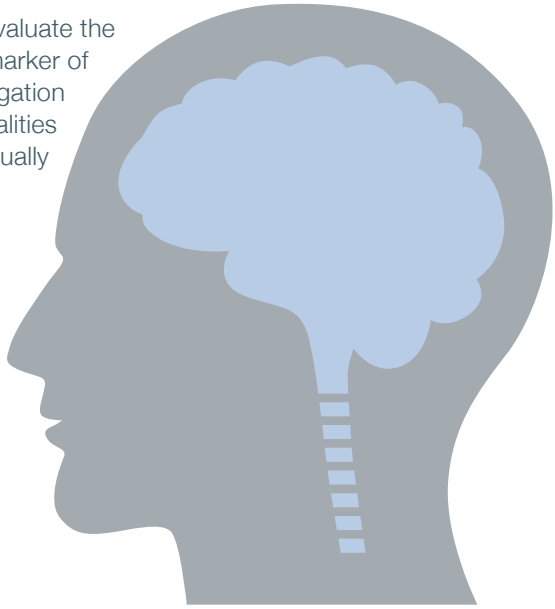
There is a need therefore, to identify markers of exposure to CO which indicate both the presence and levels of toxicity, for use by medical practitioners and coroners, and for such markers to be robust and long lasting.

The terminal enzyme of the mitochondrial respiratory chain, cytochrome c oxidase (COX) is a major cellular target for CO inhibition. Evidence suggests that CO may cause long lasting inhibition of COX, even when CO exposure has stopped, indicating that COX activity may be an indicator of CO exposure.

The purpose of this study is therefore to:

1. Determine if mitochondrial COX activity levels were stable post mortem, to permit COX to be used as a screening tool in Coroner's investigations of suspected CO poisoning.
2. Determine levels of mitochondrial COX in post mortem human brain tissues exposed in vivo to CO, and to determine if COX levels differed from those found in normal tissues.

This study allowed us to evaluate the potential of COX as a biomarker of CO exposure in the investigation of CO poisoning where fatalities occur, with a view to eventually using COX activity in other tissues as a marker of CO exposure at post mortem and also in accident and emergency departments.



Conclusions

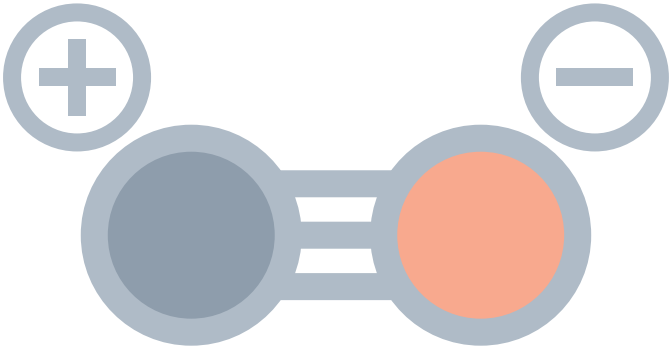
1. Our investigations have shown that COX activity is relatively stable to a wide range of agonal and post mortem factors which may impact Coronial investigations and therefore COX could be used as a marker if a need can be identified.

2. Using the unique access to tissues from individuals acutely exposed to high levels of CO, we have demonstrated that COX activity is unaffected by CO exposure, indicating that tissue hypoxia is the likely cause of death under these circumstances. Extending these investigations has shown that the major protein subunits of COX, COX1 and COX2, are also unaffected by high level acute CO exposure. Whilst these studies indicate that acutely CO mediates its effect through hypoxia, chronic lower level exposures which are known to cause neurological and cognitive effects may act via different mechanisms over and above those of hypoxia. Although investigation of such low level chronic exposures should be a priority, it is unlikely that novel biochemical investigations such as those undertaken as part of this study could be repeated due to the absence of available tissue.

3. Extending the work using the available CO exposed tissues to investigate the physiological CO signalling system we have shown that acute high level CO exposure causes a reduction in the CO target enzyme soluble guanylate cyclase (sGCSβ) and an increase of the downstream effector p38 mitogen activated protein kinase (p38MAPK). These novel findings suggest that the system which normally responds to low levels of endogenously produced CO, may at high exogenous CO levels be altered in an attempt to reduce the toxic effects of CO. These findings indicate that by investigating changes in the physiological CO system, it may be possible to monitor CO exposure. Understanding the chronic effects of CO exposure would be of use since many symptoms of CO exposure such as fatigue, headache, loss of concentration may stem from prolonged CO exposures and from longer term changes to cells and tissues.

4. The finding of an altered physiological CO response system lends itself to further investigations into the effects of CO. Using in vitro approaches with human cells (peripheral blood cells, lymphocyte cell lines), it should be possible to determine the acute and subacute effects of CO exposure by profiling gene expression to identify the relevant proteins and systems which are altered in response to CO exposure. These could then be carried forward to in vivo animal studies where confirmation of changes could be obtained in a controlled environment. Such markers of CO exposure would enable clinical studies to be put in place to determine the expression of these proteins in blood to demonstrate CO exposure in the absence of raised carboxyhaemoglobin, particularly where the non-specific symptoms of exposure are present (e.g. headache, nausea, dizziness fatigue), and where there is a suspicion of CO exposure. Such a test may also be useful as an adjunct for monitoring individuals who are known to have been exposed to CO to determine how rapidly tissues return to normal following removal from exposure, thus also providing some insight into why delayed effects from CO exposure are experienced by patients after apparent recovery.

*Click **here** for the final report.*



2016

University College London

Determinants of CO Exposure in the English Housing Stock: Modelling Current and Possible Future Risks

Using available national-level survey data (English Housing Survey) as a basis, this project examined the presence of potential CO emission sources and surveyor-perceived CO exposure risks; and sought to use the physical characteristics of the dwellings to derive multizone indoor air quality and ventilation models of the housing variants in the EHS in order to quantify the CO exposure risks across the whole current English housing stock.

In addition, it investigated the impacts on low-level CO concentrations in homes of a range of energy efficiency and ventilation measures, in line with modern building standards applied to the existing English housing stock, in order to achieve climate change mitigation goals.

Using the indoor CO concentration estimates, this research quantified the degree to which housing may modify the risk of CO poisoning in dwellings at the population level across dwelling ages and types, geographical regions, socioeconomic groups, tenures, and other factors. This investigation sought to help identify housing variants and populations most at-risk of CO morbidity/mortality, thus helping to prioritise gas safety interventions and advice.

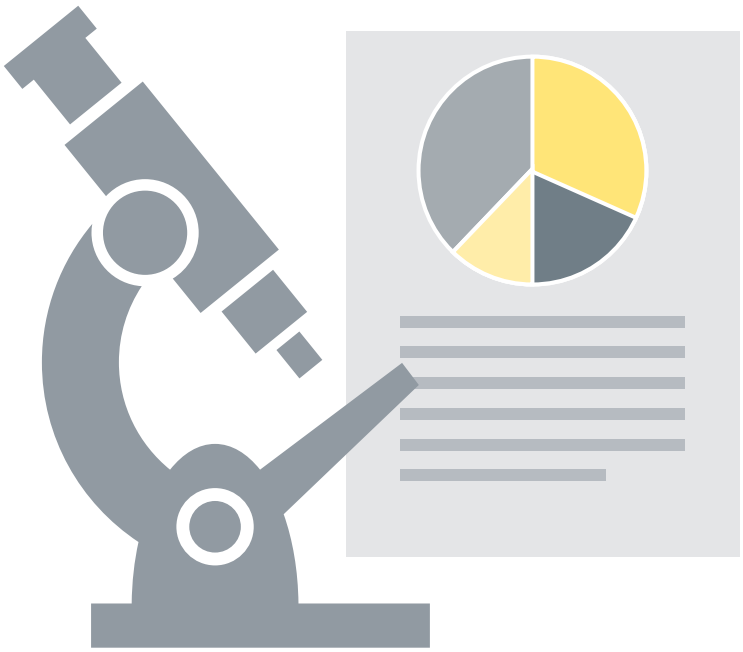
Conclusions

1.This report has examined the variations in risk of low-level but potentially harmful CO exposure across the English and Welsh housing stock using available housing stock databases, and by developing and implementing a metamodel to estimate indoor concentrations across the stock. Results indicate a wide range of relative risks across the housing stock, with certain dwelling types such as converted flats, at greater risk than others.

2. Retrofitting is expected to significantly increase the number of dwellings that exceed the EU limits of CO exposure during a year by around 15% where PPV is not explicitly included as part of the refurbishment scheme.

3. Further research is required to obtain empirical data on indoor CO emissions and indoor concentration ranges from different indoor appliances.

*Click **here** for the final report.*



2016

St Georges University Hospitals, Surrey University/Frimley Park Hospital

Emergency Department Screening Study

The research carried out by Surrey University and Frimley Park Hospital seeks to understand the number of patients presenting to emergency departments (EDs) with raised carboxyhaemoglobin (COHb) levels that could be caused by CO exposure in the home or at work.

This research aims to reduce misdiagnosis so that patients are treated appropriately and not sent back to the site of exposure before it is safe to do so.

As part of the research, all patients presenting at the hospital ED with specific symptoms such as chest pain, headache or seizures, will complete a health questionnaire. For those patients with raised COHb levels whose answers reflect possible CO poisoning, a registered gas engineer will be sent to investigate the scene of the suspected exposure.

This research follows on from a 2011 study by Dr Clarke measuring raised COHb levels in certain patients that presented to four emergency departments in England.

It is hoped the research and its findings will go some way to establishing a more accurate estimate of the prevalence of CO poisoning in the UK, resulting in correct diagnosis and treatment for sufferers.

This study was delayed due to changes to participating Hospitals which set back the medical ethics process. The study commenced recruiting patients in December 2018 and will produce its final report in Spring 2020.

2016

University Centre of Legal Medicine, Lausanne/Brunel University/ Public Health England

Effect of Blood Storage Methods on COHb and use of CO as a Biomarker for Diagnosis.

This research examines the effect of various blood storage methods on the effect on carboxyhaemoglobin (COHb) levels. It is understood that some methods may show lower levels of COHb being found and lead to under-diagnosis.

The project aims to test a new method for identifying the true role played by CO in CO poisoning. The current way of detecting the presence of CO in the blood is to measure the levels of COHb. This research will look at levels of CO and COHb and assess whether storage has an effect on the measurements leading to the underestimation of the true role of CO, and whether CO rather than COHb in the blood is a more reliable way to detect CO poisoning.

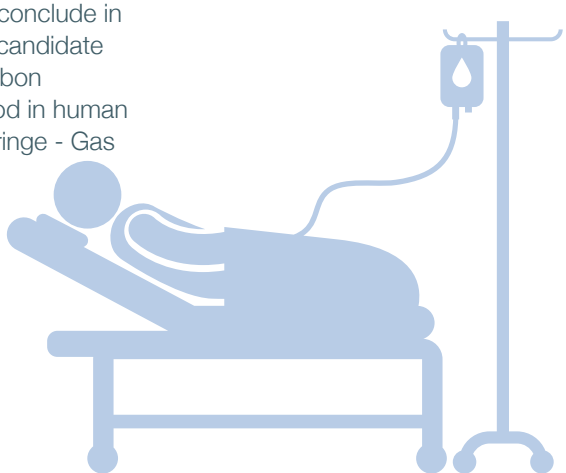
The 2011 All Party Parliamentary Carbon Monoxide Group (APPCOG) report identified a key role for coroners to support increased detection of CO poisoning in England and Wales. The report recommended that "the Government should ensure that all coroners' post-mortems routinely test for carboxyhaemoglobin levels".

The report also acknowledged the difficulty for coroners in recognising CO as a possible cause of death and suggested a potential under-diagnosis of CO poisoning by clinicians. Coroners are in a unique position to identify the circumstances leading to a CO fatality, including the source of CO, where it is located, and the behaviour of those involved.

This study complements the aforementioned Public Health England Coroners' pilot study.

This study is a three-year PhD, which started in 2017, and will conclude in early 2020. In 2018 the candidate had an article called 'Carbon monoxide analysis method in human blood by Airtight Gas Syringe - Gas Chromatography - Mass Spectrometry (AGS-GC-MS): relevance for post-mortem poisoning diagnosis' published in Journal of Chromatography B.

You can read this ***here***



2017

Imperial College

Investigating Novel Therapies for Acute Carbon Monoxide Exposure, Injury Mechanisms and Biomarkers for Low Level and Repeated Exposure to Carbon Monoxide in an In Vivo Rodent Model

This piece of research looks at low-level exposure, how to improve understanding of what constitutes a low level, how we can improve diagnosis and how we can better treat it.

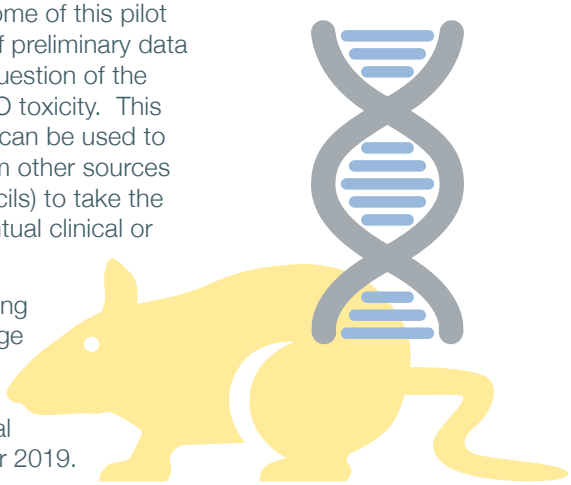
Low-level CO exposure may be much more widespread than estimated for the following reasons:

1. It is unknown whether there is any safe low-level limit for CO exposure;
2. It is unknown whether repeated exposure to CO is additive or cumulative;
3. There are no reliable diagnostic tests or 'biomarkers' for low-level sub-acute CO exposure;
4. The clinical symptoms of non-lethal CO toxicity are non-specific and easily confused with other medical conditions.

This project addresses these four key gaps in the scientific knowledge with the objective of addressing the issue of low-level CO toxicity and the socio-economic cost to the UK.

The successful outcome of this pilot study is a package of preliminary data that addresses the question of the extent of low-level CO toxicity. This provides results that can be used to apply for funding from other sources (e.g. Research Councils) to take the work forward to eventual clinical or diagnostic use.

This study is concluding its data collection stage and the data will be analysed with a view to publication of a final report during Summer 2019.



2017

Lancaster University

Impacts of Chronic Low Level CO Poisoning in Older Adults

Carried out by Lancaster University and supported by the West Midlands and Merseyside Fire Services, this research gathers data on low levels of CO present in the homes of older adults and then screens their cognitive function and mental health. The research is assisting in the understanding of whether low level and long term CO exposure can be a risk factor in neurological disorders such as dementia.

The Alzheimer's Society say that over 850,000 people have a diagnosis of dementia in the UK, with numbers set to rise to over 1 million by 2025. They say that this will increase to 2 million by the year 2051. In the UK, 1 in 6 people over the age of 80 and over 40,000 people under 65 years of age have been diagnosed with dementia.

Symptoms of dementia include memory impairment and cognitive impairment for example affected language skills, motor skills and recognition. These symptoms are similar to those displayed by people who have been poisoned by CO.

In 2016, the GST, in collaboration with the National Institute for Health Research (NIHR) Clinical Research Network West Midlands, held a roundtable discussion in Birmingham to look in particular at CO in relation to the impact on peoples' cognitive function as well as potential links to dementia.

This piece of research from Lancaster University stemmed from discussions that took place at this roundtable and from data showing that over the 2014/15 winter period there were four fatalities in people over the age of 80 , from three separate incidents involving piped natural gas.

This study is a three-year PhD, which commenced in January 2018. The candidate has just started collecting data in partnership with West Midlands Fire and Rescue, and this study is expected to conclude in early 2021.

2017

Newcastle University

Identification of Protein Markers in Peripheral Blood Lymphocytes Following CO Exposure

This study looks at possible new ways to detect CO poisoning which could be used when CO exposure is suspected at lower levels.

This research focusses on developing techniques that demonstrate the specific effects of CO on cells and tissues by identifying how changes in the cells (biomarkers) can occur. These biomarkers are required to show both the level of CO exposure and the toxic effects of CO, and need to be robust and long lasting for practical use by medical professionals.

Department of Health (DH) statistics state that every year in England and Wales, approximately 30 people die from CO poisoning, that 200 people are admitted to hospital, and around 4,000 people attend A&E, are treated and sent home. However, it is generally accepted that these figures underestimate the scale of the problem, due to the difficulties in diagnosis.

The fact that symptoms of CO poisoning are similar to the symptoms of the common cold and flu provide challenges for medical professionals to diagnose and as such, it is often overlooked. Furthermore, current methods to confirm CO poisoning in the body require specialist equipment that is frequently used long after the patient has stopped being exposed to CO, making it much more difficult to determine if a person has been exposed since CO can be rapidly eliminated from the body.

This study was a short bench-based study. The research has been completed and a final report is being written up for publication in early 2019.

2017

Liverpool John Moores' University

Surviving Carbon Monoxide (CO) Poisoning: An Interpretative Phenomenological Analysis

This study fills a gap in the academic literature that informs healthcare practice. At the moment we know a great deal about symptomology from medical papers written from the point of view of the author of the paper, rather than the person enduring those symptoms. Effective treatment, support and management has to be developed through incorporating the point of view of the sufferer, in order to take a holistic approach to complex conditions such as this, but as yet the literature does not give us any idea about what it is like to live with the immediate and longer term aftermath of being poisoned from the survivor perspective.

The use of Interpretative Phenomenological Analysis (IPA) as a qualitative methodology allows new knowledge about this experience to emerge. Survivors/victims who have previously not had their views considered have a voice. For example, this approach allows people to discuss the symptoms that were experienced and that were not generally 'obvious', as opposed to the more typical symptoms that the public are encouraged to look for and report (such as headaches and flu-like symptoms). It also allows them to express their feelings at the issues caused by the lack of understanding of the condition, which leads to misdiagnoses (such as ME, CFS, mental health disorders), underreporting, and the issues around where help can be sought.

Once collected and analysed, the data will inevitably lead to further research as additional areas of interest that come to light through this research are examined and investigated. Smaller numbers of participants therefore allow for greater depth and exploration of the issues that matter to the people concerned. In this instance, people who have been poisoned by CO will ultimately have a way of not only raising awareness about the whole situation, but will be able to communicate with the agencies who are supporting and dealing with others who may have to live through the same experience in the future.

GST provided funding for the PhD candidate to take a sabbatical from her job to complete her studies on a full time basis. She has finished collecting data and is in the process of analysing that data and writing up her work. It is expected she will complete her PhD in Autumn 2019.

2 GST Strategy

The following chapter sets out the Gas Safety Trust's strategy for the next three years, from April 2019 until March 2022. It provides an overview of the organisational background; reviews the current situation; and proposes the mission and goals for the organisation.

Background

The GST is a registered charity, established in 2005 to further improve gas safety for the public and industry throughout the UK. The objective of the charity is to reduce the incidents of death and serious injury from CO poisoning.

We have a stable financial position with regards to reserves that enables the Trust to continue momentum in commissioning academic research which will allow it to lobby policymakers and improve gas safety in the UK.

The Trust intends to explore options for co-funding larger projects. This will facilitate an increase in the number of projects that are granted funding.

Trustees

The GST Trustees have overall responsibility for the strategic direction and governance of the Trust. The Trustees meet at least four times a year.

Mission Statement

To become the trusted source for evidence-based information relating to CO enabling us to promote action to end CO poisonings in the UK.

Our evidence will be used to:

- Inform further research.
- Influence policymakers in the UK.
- Improve awareness and the understanding of CO poisoning amongst the general public and healthcare professionals.
- Understand the effects of low-level CO poisoning and the number of near misses.

The Trust will aim to achieve its mission by:

- Identifying and funding research to fill gaps in knowledge relating to CO.
- Making the resulting evidence freely available to all.
- Engaging with the relevant bodies in the UK (and internationally where relevant) to improve the safety and understanding of CO.
- Providing evidence and information to inform awareness campaigns.
- Lobbying all relevant stakeholders including Government and regulatory bodies to improve safety relating to CO in the UK.

Purpose

The purpose of the GST is to improve knowledge relating to CO and to improve safety in the UK, with the ultimate goal of ending death and serious injury from CO poisoning.

This will be achieved by:

- Working with relevant bodies (in the UK, and internationally where relevant) to identify the key issues relating to CO.
- Funding and facilitating world-class research to improve the understanding of the key issues.
- Ensuring that findings are used to improve the lives of people living in the UK.
- Working in partnership with others to achieve the greatest impact in preventing death and injury from CO poisoning.

Goals

The original purpose of the charity emphasised prevention of deaths from gas (CO) in the home. In recent years the number of such deaths has declined drastically.

However, we recognise that exposure to CO at lower levels in homes and other environments may be a widespread problem, carrying a threat to health and wellbeing. This issue is not well recognised and has only recently begun to be considered.

Furthermore, the Trust will continue to contribute to underpinning knowledge of CO by funding research that looks at CO from a biochemical perspective.

Between 2019 and 2021, GST will work towards the following goals, by finding and funding research and using the results to inform and influence others to implement change.

The Trust will add to the evidence on these issues by funding several strands of research including but not limited to:

- Understanding the effects of low-level CO poisoning and the number of near misses.
- Working with healthcare professionals to understand and improve how they diagnose, treat and provide aftercare for CO poisoning.
- Understanding the behaviour and characteristics of CO from a chemical, biological and physical perspective.
- Exploring the impact of modern building standards on indoor air quality.
- Examining other key contexts (for example: leisure environments, fuels other than natural gas, and potential links to other conditions and illnesses).

Values

GST is an independent organisation, free from the influence of external stakeholders. It is inclusive and transparent in all its actions and operates within a system of sound governance.

GST aims to be an authoritative voice and source of information and evidence relating to CO safety from all sources. GST will work in partnership with external stakeholders in order to achieve its goals.

The evidence produced will be consumer friendly, easy to understand and available to all through the GST's online CO Portal.

Appendix: 1

Trustees and Team

Chair

Chris Bielby

Deputy Chair

Paul Everall

Independent Trustee and Treasurer

Julian Allsopp

Independent Trustees

Helen Atkinson

Dr Susan Bews

Phil Brown

Jon Butterworth

Pat Fulker

Karen Gillespie

Mark Hazelton

Professor Andy Shaw

Roger Webb

GST Team

Adrian McConnell

Graham Hall

Appendix: 2

How to Apply for Funding

Applications submitted to GST are considered on an annual basis.

Please note that completion of a Grant Application Form is required you should review the Grant Application Procedure and Guidelines as well as our Terms & Conditions document, to evaluate whether your application is appropriate.

You can find these documents on our **Apply Now** page.

If you have any questions please contact **Adrian McConnell**.

Gas Safety Trust

T: 0207 706 5111

E: info@gassafetytrust.org

@GasSafetyTrust

Gas Safety Trust

www.gassafetytrust.org

www.coportal.org

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CORGI Services Ltd donates its profits to support the Gas Safety Trust