

UKIEG Conference 2018

*Ventilation, Indoor Air Quality  
and Human Health*

Abstract Book

# Indoor and outdoor air quality in closed psychiatric wards

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## ABSTRACT

Eco-psychosocial elements of care are key when pharmacological components cannot provide a cure. For psychiatry, facilities comprise important components of treatment regimes. Special institutions have been created to accept responsibility for the dangerousness related to mental illness, a responsibility our communities cannot handle. So, mental healthcare provision organisations provide specially designed institutions within the treatment plan. For more severe pathologies, including those that require sections, patients stay in closed wards. This translates to restrictions in movement and anti-ligature features installed to prevent harm and self-harm. Yet, at the same time these are healthcare premises that medical standards, including hygiene and prophylaxis, need to be met. We present data and findings from two studies that involve closed wards with a time-lapse of 15 years. For the first study, there was a control group of open wards. 12 facilities were examined. Each ward was evaluated using the SCP model, a tool for the evaluation of mental health premises, to identify the relation between policy, care regime and patient-focused built environment. This involved data collection from plans, visits and detailed staff and patient interviews. Ethical approvals were sought and granted in all cases. During the 15 year period mental health provision in the NHS was influenced by changes regarding facility provision models, smoking policy and anti-ligature technologies related to the built environment. The research identified four themes related to the air quality of the wards:

- Patients' perception of air quality
- Opportunities for access to open air as determined by design
- Restrictions to ventilation in relation to anti-ligature
- Smoking policy implications

It also highlighted controversies between anti-ligature and air quality and issues related to non-smoking policies. This addresses the complexity of psychiatric space and the need for integrated approaches when it comes to policy and built environment interface.

## **Indoor Air Quality and Health- Spotlight on CO: A Call For Action By Healthcare Professionals**

Isabella Myers: Chairman, All Party Parliamentary CO Group's Stakeholder Forum Medical Sub-Group (COMED)

### **ABSTRACT**

The most recent of the CMO's Annual Reports focussed on the effects of air pollutants on health, where exposure to indoor air pollutants (including lower levels of exposure) and effects on health was noted. Carbon monoxide (CO) is found in both the indoor and outdoor environment. It is a colourless, odourless and tasteless gas produced by the incomplete combustion of carbon-based fuels such as gas, oil, coal, biomass and wood. However, the prevention of exposure to CO from indoor sources is more complicated than originally thought and whilst exposure to higher levels of CO can cause significant effects on health and even death, scientific understanding indicates that lower levels of exposure can also cause ill health. This presentation seeks to use CO as an exemplar to highlight the problems faced by healthcare professionals in their role to prevent, diagnose and treat patients exposed to indoor air pollutants.

In 2017, COMED produced a report that presents a series of essays by its healthcare professional members. The report provides an insight into the difficulties healthcare professionals face in their role to prevent, diagnose and treat patients exposed to CO. In raising these issues, gaps in the scientific understanding of CO and its effects on health are highlighted and recommendations are made to stakeholders to assist healthcare professionals. An update on the scientific and medical research being undertaken in light of these recommendations will be provided.

However, the difficulties associated with preventing exposure, and in improving the diagnosis, treatment and follow-up of CO poisoning, emphasises the need for joined-up action amongst stakeholders on indoor air pollutants more broadly. By identifying the measures and protocols required to reduce poisoning by CO, the need for similar considerations regarding the reduction of other indoor air pollutants to improve health and wellbeing are highlighted.

# Towards Optimising Building Control Strategies for Energy, Health and Well-Being

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## ABSTRACT

Previous investigations of the so called ‘performance gap’ in buildings have tended to focus exclusively on differences between designed and in-operation energy use. This limited approach can hide a variety of other ‘unintended consequences’ across a range of outcomes. The Total Performance of Low Carbon Buildings (TOP) project investigates the building stock as a dynamically complex system. Covering a number of cross-sectorial large-scale low-carbon buildings in the UK and China, the study combines energy-use data, empirical active and passive monitoring strategies for a wide range of airborne pollutants, relative humidity, temperature and CO<sub>2</sub> concentrations with validated building modelling, occupant questionnaires, observational studies and analysis by system dynamics. This research has begun to up-pick the multiple and varied causes of the performance gap in both locations and across various sectors including schools, hospitals, offices and residential apartments.

Initial findings from the UK show a need for better understanding and commissioning of ‘newer’ low-carbon technologies and variations existing between the use of mechanical and natural ventilation strategies. Uncertainties around the accuracy of devices used for pollutant monitoring have been highlighted and addressed. Evidence also shows that use of natural ventilation strategies in areas of high external pollution e.g. PM<sub>2.5</sub>/NO<sub>2</sub> can lead to trade-offs between airborne pollutant exposure and energy use, requiring decisions regarding priorities around occupant health. In addition, that filtration in mechanical systems tends to reduce some pollutants from outdoor sources, but have little or no impact on others. Adopting a systems approach combining indoor environmental quality (IEQ) targets with goals around energy demand reduction and occupant factors, can potentially lead to a reduction in the energy performance gap with additional health co-benefits for occupants particularly in the area of exposure to airborne pollutants from a variety of indoor and outdoor sources.

# **The Impact of a Quick Start Guide on Occupant Habits and Indoor Environment in Homes**

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## **ABSTRACT**

With UK Government's recent commitments to build 1 million new homes by 2050, the importance of ensuring good indoor quality in new energy efficient airtight homes is paramount. Building Performance Evaluation projects undertaken by MEARU over the last 10 years have consistently cited occupant habits as a contributory factor to the 'performance gap' in terms of energy efficiency but also in relation to poor indoor environmental conditions in homes. With occupants spending increasingly longer time indoors then this has a significant problem with health and wellbeing. Reducing ventilation rates to improve energy efficiency and lower carbon emissions, without providing a planned and effective ventilation strategy is likely to result in a more toxic and hazardous indoor environment, with concurrent and significant negative long-term and undesirable impacts on public health.

Occupant guidance and a satisfactory handover procedure is often the missing link between the designer and the end-user of the new homes to ensure the occupant knows how to work it as efficiently as possible. The Scottish Building Standards (Section 6- Energy) have recently introduced the requirement of a Quick Start Guide (QSG) in all new housing and whilst this is predominantly to address issues of energy consumption it also recognizes that guidance on home ventilation is equally critical.

This paper reviews work previously undertaken MEARU which identifies a recommended template for a Quick Start Guide and evaluates 3 new build social housing developments in Glasgow which have used this guidance as part of Glasgow City Council's target for all new homes to meet the Scottish Building Standards Sustainability labelling initiative (2011) at the Silver Standard accreditation. This paper not only reviews the effectiveness of this occupant guide but also the the associated handover process as an important step towards improving indoor air quality in new homes.

## **Spray foam insulation, VOCs and indoor air quality (IAQ) - discovering the known unknowns**

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### **ABSTRACT**

The potential for energy reduction with PU insulation is significant, but there is limited knowledge on the impact on indoor air quality. To fill this gap, we conducted experiments utilising gas chromatography-mass spectrometry to analyse VOCs emitted from three spray foam insulation products. Passive sampling with SPME was used to undertake a broad analysis of the VOCs. 1,2-dichloropropane (1,2-DCP) was found emitting from all three cured products. 1,2-DCP was also found emitting from other spray foam insulation products in different studies, but its origin was unknown. A TD-GC-MS active sampling was undertaken on the raw material of one of the foams and the cured product. Our results indicated that 1,2-DCP (Class 1 carcinogen) and 1,4-dioxane (Class 2B carcinogen) were both present in the raw material and emitted from the cured product. Albeit the scale of the study is limited and the results preliminary, the results do point to contamination of the raw products as a likely source of these VOCs. This research could highlight that harmful VOCs were present in the raw ingredients for insulation products and that they should be averted at the source. These actions would reduce the effort to control and mitigate the emissions to safe levels through natural and/or mechanical ventilation once they have potentially entered the indoor air.

# Coincidental measurement of indoor environment and workplace productivity in a modern UK office building

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## ABSTRACT

Most studies on indoor environment and productivity have been conducted in controlled, static conditions often not representative of the real world. This paper uses a case study-based real-world approach to undertake coincidental measurement of indoor environment and workplace productivity in a mechanically-ventilated office environment in Southern England.

A range of environmental parameters (indoor air temperature, relative humidity (RH) and CO<sub>2</sub> levels) are monitored continuously, alongside outdoor temperature and RH for seven months (March-September 2017). During this period, *longitudinal* surveys (online survey) recorded occupant perceptions of their working environment, thermal comfort and self-reported productivity, while performance tasks were designed to objectively measure productivity. In addition, *transverse* survey (using BUS methodology) was conducted in April 2017 to provide a snapshot record of occupant perception of their working environment.

Physical monitoring showed that during occupied hours (8am-6pm, Monday-Friday), indoor temperatures were relatively warm, staying within 22-24°C for the majority of the time and maximum temperature going up to 26.4°C in March. The BUS survey results (n: 69) revealed that when occupants perceived their environment to be uncomfortable, their perceived productivity decreased (eg. stuffy smelly air results in decrease in productivity). Interestingly occupants estimated that their productivity decreased by 7% due to the indoor environmental conditions. Online surveys also showed that perceived productivity was found to decrease in the afternoon as compared to the morning when indoor temperature and CO<sub>2</sub> levels went up. This was supported by outcomes of the performance tasks which showed that as indoor temperature increased, the proportion of correct answers in the numeric test decreased.

It is evident from the study that correlations were found between indoor environment and staff productivity (self-reported and measured). By managing the indoor environment effectively, there is potential to improve work place productivity.

# **Integrated air quality monitoring technology for high-volume, low-cost measurements of indoor air quality**

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## **ABSTRACT**

National Air Quality Testing Services (NAQTS) has developed an integrated air quality monitor (NAQTS V1000) incorporating the latest developments in low-cost sensor technologies, alongside a regulatory grade Condensation Particle Counter (CPC), thermal desorption tubes (TD), and other environmental measurements. Users can interact with the device using a HTML GUI and a database management system that can be directly uploaded to the cloud. The NAQTS V1000 unit is a portable air quality monitoring station designed to be easy-to-use for high-volume, low-cost measurements, facilitating a holistic understanding of indoor and outdoor air pollution.

The NAQTS V1000 measures Particle Number (CPC), CO<sub>2</sub> (NDIR), CO, NO<sub>2</sub>, and VOCs (Metal Oxide and Electrochemical), and is also fitted with Temperature, Pressure and Relative Humidity measurements. External GPS and Noise measurements are available through USB ports on the back of the equipment.

NAQTS' use of dual technologies for key gaseous measurements enables cross sensitivity correction algorithms to be employed, and an orthogonal calibration procedure to be employed. NAQTS' regulatory compliant CPC allows users to measure ultrafine particles (<100nm, with a lower detection limit of 10nm), whilst keeping fluid consumption low due to an integrated solvent recovery system. The novel integration of TD tubes for GC-MS into a real-time air pollution monitoring device allows low-cost sensors to be used as triggers for VOC speciation, adding another layer to potential analyses.

This presentation will introduce the community to this new technology, as well as results from the work packages that have used this equipment, including work on the dichotomy between energy efficiency and good IAQ, Environmental Justice and IAQ, citizen science, vehicle interior air quality, indoor-outdoor, and others.

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Posters

# **Raising awareness of how poor Indoor Air Quality can affect human health**

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## **ABSTRACT**

### Introduction

Modern life in developed countries results in people spending approximately 90% of life indoors: at home, school, office, restaurants.<sup>2</sup> This is a national concern.

For Allergy UK the main concerns are the impact of poor ventilation, high humidity, on house dust mites and moulds, increased airborne contaminants caused by products used around the home e.g. for DIY, building, furnishing and cleaning, also allergens from animals and plants in the home.<sup>1</sup>

Indoor Air Quality is crucial for human health and particularly important for vulnerable groups i.e. babies, children, the elderly, as well as people living with respiratory and allergic diseases.

### Methodology

A literature and web search was conducted to gather evidence and to explore solutions that other countries may have implemented to address these concerns.

### Results

- 2,000,000 healthy life years are lost every year due to exposure indoors in EU<sup>4</sup>
- Indoor air levels of many pollutants may be 2-10 times higher than outdoor levels
- Implementation of guidelines is expected to reduce burden of disease by 55% with basically no effect for energy use if advanced ventilation systems are used.
- 900 compounds HARMFUL TO HEALTH have been detected in indoor air quality  
Such as: Anthropogenic pollutants - building materials, and outdoor pollutants (VOC, NO<sub>2</sub>, CO<sub>2</sub>, PM<sub>5</sub>, PM<sub>10</sub>) Allergens - moulds, pollen, and biological contaminants<sup>3</sup>
- Poor air quality in Europe has been considered responsible for 2 million healthy years lost every year. The situation is particularly problematic for people with allergy, asthma and COPD, who are the first to react to bad indoor air quality.

### Discussion points

- Air represents a bigger exposure burden and health threat indoors than outdoors
- Indoor air quality is important for health in European countries
- Allergy UK are active as part of a group of stakeholders in an All Party Parliamentary Group to ensure Indoor Air Quality is addressed on the political agenda.

References:

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3. Morghenti, D. (2017). EFA Presentation - Why buildings are key to achieve a better health in the EU? Healthy Building Day conference, European Parliament.
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## **Overview of the impact of a limited asymmetrical array on the natural ventilation of a 6 m<sup>3</sup> cube. Findings from the Refresh cube campaign (RCC) at Silsoe, UK.**

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### **ABSTRACT**

With 50-70 % of the world's population now living in urban areas, understanding the coupling between internal and external flow is of paramount importance to ensure the health and wellbeing of a building's occupants. The urban environment is a complex, multidisciplinary area of study and not all the findings in research are translated to building design.

A staggered array of 6 m<sup>3</sup> straw cubes was created in a rural area (Silsoe, UK) as part of the REFRESH cube campaign (RCC) to represent a simplified urban area, with one cube having controllable openings (sealed, single sided and cross ventilated) and instrumented internally. This provides full-scale ventilation data for an idealised array (7 months) and the isolated cube (2 months) across a range of meteorological conditions, alongside CFD and wind tunnel modelling results. A wide range of variables were measured continuously, including: local, reference and internal flow, stability, background meteorological conditions, internal temperature, and ventilation rates (tracer gas and pressure difference).

The presence of the array causes a 50% to 90% reduction in normalised ventilation rate measured by pressure difference when the reference wind direction is normal to the cube. The decrease in natural ventilation varied with wind direction with large amounts of scatter for both the array and isolated cases. The relation between local and reference wind is non-linear with three distinct behaviours, which over 1, 5, 10, 30 and 60-minute averages, which are not captured by simple windspeed corrections. The tracer gas and pressure difference ventilated measurement methods are nonlinearly correlated for both isolated and array set-ups and are affected reference wind direction.

## **Using IAQ and other environmental criteria to influence tenants choice of offices within the same building**

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### **ABSTRACT**

This paper examines the indoor air quality (IAQ) and other environment criteria of two rentable offices within the same building, and the impact upon a tenants decision as to which of the naturally ventilated rooms to occupy.

The building is located in central London with one façade exposed to a busy London road with a high volume of traffic and a number of bus stops immediately adjacent to the building. A second side of the building faces a quiet car park set 90 degrees from the busy London road.

Both offices are located on the second floor, are the same shape and floor size, and have a door opening on to a small balcony that overlooks either the busy road or the car park. In determining which of the two offices to select the tenant has had performed an indoor environment quality (IEQ) assessment of both offices. This involved examining acoustic performance and lighting levels over a typical working day as well as IAQ (temperature, relative humidity, carbon dioxide and carbon monoxide).

Based on the results of the IEQ assessment of both offices a decision was made as to which to rent. This paper sets out the reason for why one office was chosen over the other and emphasises the importance that IEQ made in the process. The results show how IEQ could be used to maintain value of office spaces when considering health and comfort conditions.

## **The Gas Safety Trust**

Chris Bielby, The Gas Safety Trust

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### **ABSTRACT**

The Gas Safety Trust, established in 2005 as a registered charitable body, 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 the funding of research and data collection relating to carbon monoxide poisoning.

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

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

You can find out about how to apply for funding on the GST website:

<http://www.gassafetytrust.org/apply-for-funding/apply-now>