2nd UK & Ireland Exposure Science meeting

March 4, 2014

Manchester Central Conference Centre

2nd UK & Ireland Exposure Science meeting

Programme

9:00 AM	**Registration Open**	
9:30	**Start and Introduction**	
9:35	**Keynote speaker 1**	
	Professor Roy M. Harrison	*The challenges of estimation of human pollutant dose from routine ambient measurements*
10:20	**Oral presentations 1**	
	Eirian Thomas	*The WHO Chemical Risk Assessment – Global Collaboration in Human Health Risk Assessment*
	Christine Robinson	*Identifying Exposure Assessment Decision Rules: Efficacy of expert ratings in exposure assessment*
10:50	**Poster presentations 1**	
11:00-11:45 Coffee break & poster viewing		
11:45	**Oral presentations 2**	
	Vikas Singh	Modelling exposure to $PM_{2.5}$ in London using a dispersion model
	Karen Galea	Are children in buggies exposed to higher fine particulate matter levels than adults?
	Jacqui Hamilton	Investigating Exposure to Nitrosamines in Thirdhand Tobacco Smoke and Potential Cancer Risk in Non-Smokers
	Jonathan Gillespie	Development of an efficient field measurement approach to evaluate the effects of traffic control interventions on exposure to traffic-related air pollution
12:45	**Poster presentations 2**	
13:00-14:00 Lunch		
14:00	**Keynote speaker 2**	
	Professor Mark J Nieuwenhuijsen	*The Exposome: hype or reality?*
14:45	**Oral presentation 3**	
	Lindsay Bramwell	*PBDEs in breastmilk and serum of UK couples: an exploration of exposure sources*
	Cassandra Rauert	*How do Brominated Flame Retardants migrate from treated products into indoor dust?*
15:15-15:45 Coffee break & poster viewing		

15:45	**Oral presentations 4**	
	Helen Crabbe	*Estimated population exposure to chemicals in private drinking water supplies of Cornwall*
	Louise Hussey	*Psychosocial factors associated with work-related mental ill-health affecting different socio-economic workforce groups*
	Susan Hodgson	*Determinants of childhood lead exposure in the post leaded-petrol era; the Tooth Fairy cohort from Newcastle upon Tyne*
	Tony Riddell	*Assessment of Internal Exposure to Radionuclides from Bioassay Measurements*
16:45: 17:00 Concluding session		

Scientific committee

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Dr. John Gulliver
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Imperial College London

Professor Stuart Harrad
School of Environmental Chemistry
University of Birmingham

Professor Chris Collins
Geography and Environmental Science
University of Reading

Poster Presentations 1		
1.1	Leigh Crilley	*Chemical characterization of ambient particles at urban schools to determine the sources of children's exposure*
1.2	Dominique Young	*Investigating Chemical Composition, Sources, and Temporal Trends of Aerosols Using a Year-long AMS Dataset from London, UK.*
1.3	Eunhwa Jang	*Seasonal and spatial heterogeneity of exposure to particulate PAHs for individual sources*
1.4	Salem Albalawi	*Personal versus fixed-site monitoring for assessing $PM_{2.5}$ exposure in an industrial city, Saudi Arabia*
1.5	Suzanne Bartington	*Domestic exposure to Carbon Monoxide and PM2.5 in biomass fuel households in Janakpur, Nepal*
1.6	Daniela Fecht	*Assessment of spatiotemporal exposure estimates in small area exposure studies*
1.7	Yutong Cai	*Methods to harmonise air pollution and noise assessment in EU Biobanks*
1.8	Stefan Reis	*Integrating ambient air pollution modelling with exposure assessment*
1.9	Susanne Steinle	*Personal exposure to airborne particles in varying micro-environments*
1.10	Dantong Liu	*Size distribution, mixing state and source apportionments of black carbon aerosols in London during winter time*
1.11	John Gulliver	*Modelling air pollution exposures: enhancements to intra-urban land use regression models*
1.12	Ian Crawford	*Real-time detection of primary biological aerosol: An Ultraviolet Light Induced Fluorescence detection method.*
1.13	Louise Uffindell	*The potential for organic contaminants to migrate to off-site human receptors during remediation*
1.14	Danielle C Ashworth	*Comparative assessment of particulate air pollution exposure from municipal solid waste incinerator emissions*
1.15	David Morley	*Feasibility of a road traffic noise exposure model based on low-resolution inputs for national level modelling*

Poster Presentations 2		
2.1	Alice Davis	*Worker behaviour and chemical exposure*
2.2	Jackie Morton	*Background levels of metals in urine samples to assist with exposure assessments.*
2.3	Jackie Morton	*Establishing background levels for five arsenic species in urine samples in a UK population*
2.4	Bashar Altakroni	*Double strand breaks and N7-methylguanine levels in human sperm DNA*
2.5	David de Pena	*Spatial variation of metal concentrations found in honeys around Greater Manchester*
2.6	Stuart Harrad	*The INFLAME and A-TEAM Marie Curie Initial Training Networks: Objectives and Initial Outcomes*
2.7	Aikaterini Kademoglou	*Properties and effects of indoor dust on flame retardant bioaccessibilty*
2.8	Eva Batistatou	*Efficiency of two-phase designs to correct for exposure measurement error*
2.9	Cassandra Rauert	*Microscopic investigations of indoor dust contamination with Brominated Flame Retardants*
2.10	Gopal Pawar	*Application of 3D-human skin equivalents for in-vitro assessment of dermal absorption of organic flame retardant chemicals*
2.11	Louise Uffindell	*Fires containing ammonium nitrate fertiliser*
2.12	Glen Titmarsh	*Myeloproliferative Neoplasms: an in-depth case-control (MOSAICC) Study*
2.13	Damien McElvenny	*Cancer mortality in the British Rubber industry – a 45 year follow-up*
2.14	Frank de Vocht	*Exploring "external exposure" and internal biological pathways of depression using causal inference modelling*
2.15	Louise Uffindell	*Potential health effects of vanadium in contaminated land*

Abstracts - Oral

Oral 1
The WHO Chemical Risk Assessment – Global Collaboration in Human Health Risk Assessment

Duarte-Davidson, R; Thomas, E; Idahosa –Taylor E; ; Weis CP; Hughes K; Vickers C

With a view to strengthening collaboration globally in the assessment of risks to human health associated with chemical substances and in line with obligations under the Strategic Approach to International Chemicals Management, the World Health Organization launched the WHO Chemical Risk Assessment Network in July 2013 following extensive consultation. The Network is comprised of representatives from a broad range of organizations with relevant expertise, from all regions and economic strata worldwide. The Network is project oriented, with a focus on risk assessment issues identified as priorities by institutions such as capacity building and training, risk assessment methodology, sharing knowledge and identification of research priorities in support of risk assessment. The Network is expected to provide streamlined access to risk assessment resources and peer expertise in exposure assessment, hazard analysis and human health risk evaluation. Participants will have capability to share case studies, queries and recommendations relevant to chemical risk assessment. The nature and objectives of the Network will be outlined, along with example projects and activities. Information will also be provided on participation and enrolment in the Network.

Oral 1
Identifying Exposure Assessment Decision Rules: Efficacy of expert ratings in exposure assessment

Christine Robinson, Annemarie Money, Frank de Vocht

In exposure assessment, accurate measurements are sometimes impossible or impractical to obtain, for instance, when assessing exposure retrospectively. Experts are called upon to utilise their subjective judgement to provide ratings.
The use of experts in exposure assessment is often criticised for being a 'black box' and lacking transparency or, simply for being unreliable and lacking in validity. The study aims to begin unpacking the black box using qualitative research techniques to get to the heart of experts' decision-making processes. We focus here on the opportunity provided by the methodology to assess the consistency in experts' rating of exposure probability and intensity.
Forty-eight job descriptions were created. Thirty for the cotton and textile industry and 18 from other industries with known exposure risks for respiratory diseases. The descriptions varied in the amount of detail provided on the process tasks undertaken and factors such as the year and location. They were placed online and experts were recruited to assess the job descriptions on an ordinal scale: for exposure probability, where 1 is very unlikely and 5 is very likely, and intensity, where 1 is very low and 5 is very high.
Data collection is currently ongoing and response rates are encouraging. Ratings will be analysed for agreement. Analysis will also be undertaken to investigate whether the level of agreement is dependent upon any of the variants, for example, the level of detail supplied.
The analysis will complement existing work investigating expert judgement and allow for a more comprehensive understanding of the optimum level and type of information required by exposure assessors in order to maximise consistency and accuracy.

Oral 2
Modelling exposure to $PM_{2.5}$ in London using a dispersion model

Vikas Singh and Ranjeet S Sokhi

Traffic related particulate matter pollution can have significant health impacts due to direct association between exposure to traffic and adverse health outcomes. The traffic contribution at different urban microenvironment needs to be characterised as the individuals spending significant amount of time near the roads may be more exposed to traffic related pollution. In this paper, OSCAR air quality assessment system has been used to predict traffic related $PM_{2.5}$ concentration at higher resolution to study the spatial extent of the exposure to pollution originating from road transport sources across London for year 2008. The model has been validated against the London air quality network measurements. The population weighted mean exposure has been calculated for the people according to the amount of time they spent undertaking specific activities and location. While the exposure to the PM2.5 near busy roads is found to be higher than that from the background as expected, analysis is shown of how exposure is related to the time spent near roads as well as where people live. According to model predictions, the traffic increment to total $PM_{2.5}$ can be up to around 50% near busy roads; the total concentrations can therefore be almost three times the regional background. The total urban increment close to busy roads is found to be around 7-8 $\mu g/m^3$ in which the estimated traffic contribution is over 2 $\mu g/m^3$. However the contribution is spatial heterogeneous across London. The highly heterogeneous contribution emphasises the need for modelling studies to be carried out at high spatial resolution which can be particularly important for health impact assessment. As people spend time in cities for various activities, this heterogeneity will affect their exposure to $PM_{2.5}$. Such information will help decision makers when formulating their pollution control strategies. This work was supported by FP7 project TRANSPHORM.

Oral 2
Are children in buggies exposed to higher fine particulate matter levels than adults?

KS Galea, L MacCalman, M Amend-Straif, M Gorman-Ng, JW Cherrie

Young children and infants in buggies travel closer to the ground and the height of average vehicle exhaust and may be subjected to higher pollutant concentrations than adults. A mobile sampling system attached to an unoccupied child's buggy was used to sample real-time $PM_{2.5}$ concentrations at two heights - the nominal breathing zones of a seated child and that of the adult pushing the buggy. During each monitoring period, the monitoring devices were co-located at the child breathing zone height to allow any fluctuations in the devices' performance to be identified. The co-located comparisons indicated significant differences in the measurements and allowed for necessary corrections to be applied before data analysis. The average ratio results over the monitoring periods suggest that children are not exposed to higher concentrations of $PM_{2.5}$ than adults. However, when comparing the real-time data $PM_{2.5}$ concentrations, there were multiple time points where the child monitor experienced higher peak concentrations than the adult. The average concentration over the monitoring periods (area under the curve (AUC)) was generally higher for the child, the exceptions being a period during day 2 and all the day 5 measurement periods. The average ratio of adult AUC to child AUC was 0.73 (95% CI = 0.51 to 1.03), which became highly significant upon removal of the day 5 data. The findings of this small scale study suggest that significant variations in peak $PM_{2.5}$ concentrations may occur with height of sampling. It is considered that further studies aimed at investigating differential exposure to vehicular air pollutants with height should include direct measurement of black carbon, in addition to monitoring over different seasons and time periods to account for variability in pollutant levels.

Oral 2
Investigating Exposure to Nitrosamines in Thirdhand Tobacco Smoke and Potential Cancer Risk in Non-Smokers

Jacqueline F. Hamilton, Noelia Ramírez, Mustafa Z. Özel, Alastair C. Lewis, Rosa M. Marcé, Francesc Borrull

In addition to passive inhalation, non-smokers, and especially children, are exposed to residual tobacco smoke gases and particles that are deposited to surfaces and dust, known as thirdhand smoke (THS). However, until now the potential cancer risks of this pathway of exposure have been highly uncertain and not considered in public health policy.
For the first time, we have estimated the potential cancer risk by age group through non-dietary ingestion and dermal exposure to carcinogen N-nitrosamines and tobacco-specific nitrosamines (TSNAs) measured in dust samples from forty six homes. Using a highly sensitive and selective analytical approach we have determined the presence of nicotine, 8 N-nitrosamines and 5 tobacco-specific nitrosamines in 46 settled dust samples from homes occupied by both smokers and non-smokers. Using observations of house dust composition, we have estimated the cancer risk by applying the most recent official toxicological information. Calculated cancer risks through exposure to the observed levels of TSNAs at an early life stage (1 to 6 years old) exceeded the upper-bound risk recommended by the USEPA in 77 % of smokers and 64 % of non-smokers homes. The maximum risk from exposure to all nitrosamines measured in a smoker occupied home was one excess cancer cases per one thousand population exposed. Interestingly, the results suggest an ambient pollution source of many of the nitrosamines, with high levels seen in non-smoking homes located in urban apartment block.
The results presented here highlight the potentially severe long-term consequences of THS exposure, particularly to children, and give strong evidence of its potential health risk and, therefore, they should be considered when developing future environmental and health policies..

Oral 2
Development of an efficient field measurement approach to evaluate the effects of traffic control interventions on exposure to traffic-related air pollution.

Jonathan Gillespie, Nicola Masey, Hao Wu, Chun Lin, Neil Ferguson, Mat Heal, Iain Beverland

We are currently developing an efficient approach for measurement of traffic-related air pollutants to evaluate (before, during and after) proposed traffic control interventions using variable message signs in Glasgow (intervention to be implemented by other researchers in the EU Carbotraf project: http://carbotraf.com/).
This approach involves simultaneous deployment of passive diffusion tubes (PDTs) to measure NO2 (over 1 week periods) complemented by very short-term (approx. 5 minute duration) measurements of black carbon, particle number count, and PM2.5 at each PDT measurement location.
Weekly measurements of NO2 demonstrated moderate to high correlation with short term measurements of black carbon (max R2 = 0.70) and moderate but highly variable correlation with particle number (max R2 = 0.49). PDT's were capable of consistently resolving small scale spatial variations in weekly NO2 concentration on a scale of 10's of metres. PM2.5 was not strongly correlated with NO2 and did not demonstrate the marked small scale spatial contrasts noted for the other pollutant metrics.
We will describe the field measurement methods and analyses of our observations; and discuss how this approach could be used for simultaneous evaluation of traffic control interventions, and for development and evaluation of statistical and deterministic exposure models for application in environmental epidemiology research.

Oral 3
PBDEs IN BREASTMILK AND SERUM OF UK COUPLES: AN EXPOLRATION OF EXPOSURE SOURCES

Bramwell L, Fernandes A, Rose M, Harrad S, Pless-Mulloli T

Introduction: Polybrominated Diphenylethers (PBDEs) are a class of Brominated Flame Retardants (BFRs) previously added to everyday items such as soft furnishings and electronics. Their use EU wide has been restricted since 2004. They are lipophilic, accumulating in fatty tissue. Many BFRs are environmentally ubiquitous and bio-accumulating. Inhalation and ingestion of indoor dusts and foods like oily fish and meat are potential exposure sources of PBDEs. Potential adverse human health effects of PBDE exposure and body burden are reproductive toxicity, neurotoxicity and immune effects. This study is the first in the UK to examine matched serum samples from cohabiting couples, serum and breast milk samples, and duplicate diet and dust samples from their homes, workplaces and vehicles.
Materials and methods: Ten co-habiting volunteer couples each completed food frequency and lifestyle questionnaires to gauge long term exposures, food and activity diaries for one week and room and vehicle surveys (e.g. furnishings/ computers/carpeting/ age/ usage). This information was used to evaluate individuals' external exposures to PBDEs. At the end of the week, study participants provided 24 hour duplicate diet samples, samples of dust from homes and workplaces, blood samples, and breast milk samples where possible.
Results and Discussion: The detail of participants' exposure histories provided by questionnaires and room surveys along with the laboratory measurements has allowed unique interpretations of individuals PBDE body burdens. Both dust and diet were found to be important exposure sources, depending on the individual's circumstances. Couples demonstrated similar serum congener concentrations unless one of them often stayed away from home for work (different diet and dusts), they had different diets e.g. vegetarian versus high red meat consumer, or one had occupational exposure to foams and furnishings or electronics.

Oral 3
How do Brominated Flame Retardants migrate from treated products into indoor dust?

C. Rauert, S. Harrad

Brominated flame retardants (BFRs) are organohalogen compounds added to a variety of fabric, foam and plastic products around indoor environments. Elevated concentrations of these compounds in indoor air and particularly indoor dust have been reported in numerous studies. This is of concern as a variety of studies have shown that for young children contact with indoor dust is the principal pathway of human exposure to these contaminants. The human health concerns have led to bans and restrictions on the manufacture and new use of several BFRs. Limited information is available however on how these compounds migrate from the treated product where they are used into dust. The most popular migration pathway hypotheses include 1) volatilisation with subsequent partitioning to dust for the more volatile compounds and 2) abrasion of particles/fibres from the treated product through everyday 'wear and tear', directly transferring into the dust.
Test chambers are one method for investigating these migration pathways and in the current study an in-house designed and built test chamber was utilized. Both the volatilisation and abrasion migration pathways were explored with curtain samples treated with the technical formulation of hexabromocyclododecanes (HBCDs). Both migration pathways were generated in the chamber with the abrasion experiments resulting in HBCD dust concentrations orders of magnitude higher than the volatilisation experiments.
The results are consistent with the hypothesis that abrasion of treated products is a likely cause of the extremely high dust levels of BFRs reported in many indoor studies. Given the importance of dust as a human exposure pathway for BFRs; understanding the pathways via which they migrate from products to dust is of importance to understand potential exposure and to lead to more sustainable approaches to flame-retarding consumer goods and materials.

Oral 4	Estimated population exposure to chemicals in private drinking water supplies of Cornwall.

H Crabbe, R Close, T Fletcher, A Rimell, M Watts, L Ander, D Middleton, P Smedley G Leonardi

Background: Safety of private drinking water supplies (PWS) is of concern globally. In the UK approximately 1 million people have a PWS. In the South West of England, historical activities such as mining have caused elevated levels of arsenic, copper, aluminium, iron, lead, nickel and cadmium in PWS, with potential risks from ingestion. **Aim:** To estimate the population exposure to chemicals from PWS in Cornwall.

Methods: To survey a sample of residents with PWS and develop an exposure model comprising: (1)Analyses of chemical concentrations in their current drinking water sources; (2).Collation of population related data to estimate the number of people potentially exposed to levels of chemicals above the prescribed concentration or value (PCV) in the Private Drinking Water Supply Regulations (2009).; (3)3. Analysis of biological samples (hair, nails and urine) of this sample population, to explore exposure and uptake of chemicals. **Results:** Between 2011-13 we sampled 511 households with PWS in Cornwall and analysed for 65 inorganic analytes, which found a number of households with chemical concentrations above the PCVs (35%). For the range of chemicals tested, 11 were found at levels exceeding the regulations. Questionnaire information on PWS and sources of exposure to chemicals are used to develop a population exposure model.

Population exposure assessment: We sampled around 20% of the approx. 2850 PWS in Cornwall, serving a population of over 6,500 adults. For arsenic, 6% of household tap water samples had a concentration greater than the PCV of 10 µg/L. Applying this percentage to the Cornish population with PWS, 162 households or 372 adults in Cornwall may be exposed to arsenic > 10 µg/L. For manganese, 12% exceeded the PCV equivalent to 782 adults in Cornwall. Further work will estimate population exposure from the biomonitoring sample. This work will help planning and implementation of prevention strategies

Oral 4

Psychosocial factors associated with work-related mental ill-health affecting different socio-economic workforce groups

Louise Hussey, Annemarie Money, Raymond Agius

Introduction: Social inequalities in health have long been described with an inverse relationship between social class and morbidity[1]. Studies amongst British civil servants showed an increase in rates of mental ill-health with decreasing employment grade[2]. However, analysis of work-related mental ill-health data and socio-economic group reported by GPs show highest rates amongst lower managerial and supervisory occupations. The Health & Occupation Research network in General Practice (THOR-GP) collects data on work-related ill-health reported by GPs. This study aimed to analyse the psychosocial factors associated with the work-related mental ill-health reported from different socio-economic groups. **Methods:** GPs report cases of work-related mental ill-health on-line. Details submitted include demography, employment data and precipitating factors associated with the ill-heath episode. Cases were coded using the National Statistics Socio economic Classification (NS-SEC) and a system for classifying precipitating factors. The 15 most frequently reported factors were analysed to evaluate how they differed by NS-SEC group. **Results:** Between 2006 and 2012 there were 1919 cases reported. Overall workload (20%) and bullying (10%) were the most frequently reported precipitants. Workload was more frequently reported with an increase in social-economic group. Problems associated with staff shortages were most frequently reported amongst the NS-SEC group for lower managers and supervisory occupations. Bullying was most frequently reported in cases classified in the lowest NS-SEC group and the group for small employers and own account workers were most frequently reported with issues related to work schedule/hours/shift work. **Conclusions:** Precipitating factors attributed to work-related mental ill-health vary with socio-economic group. Mental ill-health rates may be highest amongst the lower managerial and supervisory groups as they have problems associated with a heavy workload and dealing with organisational issues such as staff shortages. This information reported from GPs may help develop workplace interventions targeted to prevent psychosocial factors affecting different sections of the workforce.

Oral 4
Determinants of childhood lead exposure in the post leaded-petrol era; the Tooth Fairy cohort from Newcastle upon Tyne

S Hodgson, C Manmee, W Dirks, T Shepherd and T Pless-Mulloli

Lead is an environmental contaminant causing irreversible health effects in children. It is widely accepted that a safe level of lead exposure does not exist. We used dentine lead levels (DLLs) as a measure of early life lead exposure and explored determinants of lead exposure in children living in Newcastle upon Tyne, a historically industrialised UK city, in a cohort born since legislation was introduced to remove lead from petrol, paint and water pipes.
The 'Tooth Fairy study' cohort comprised 69 children aged 5-8 years. We collected upper deciduous incisors from children and questionnaire data from their parents in 2005. We measured lead levels in pre and post-natal enamel and dentine using Laser Ablation Inductively Coupled Plasma Mass Spectrometry, and assessed associations between DLLs and residential, dietary, lifestyle and socio-economic characteristics.
DLLs were low (mean 0.26ug/g, range 0.06-0.77), however we observed considerable variability in DLLs within and between children suggestive of differing exposure levels and/or exposure sources across this population. Variables earlier documented to be associated with childhood lead levels, including measures of socio-economic status, parental occupation, age of home, existence of lead paint/lead water pipes, or home renovations, were not found to be significant determinants of DLLs in this study.
Lead levels in this cohort were low suggesting legislation to reduce exposure has been successful, but variability remained. We suggest that relevant exposure pathways should continue to be investigated to enable targeted interventions and prevention of lead-induced health impacts in vulnerable populations.

Oral 4
Assessment of Internal Exposure to Radionuclides from Bioassay Measurements

Tony Riddell

Evidence that intakes of radionuclides could have a detrimental effect on human health first appeared in the 1920s when it was recognised that women employed in painting items with luminous radium based paints ("Luminisers") were experiencing bone necrosis and developing osteosarcomas. Accepted knowledge at that time, from conventional toxicology, was that there should be an intake 'threshold' for such adverse effects and this could be used to control exposure risks. In 1941 the USA's National Bureau of Standards established the first limit on internal exposure, a radium body content of 0.1 μCi (3.7 kBq), this being one tenth of the estimated level at which any health effects had previously been reported in luminisers.
Radium, like many of the radionuclides of greatest concern from the perspective of internal exposures (e.g. plutonium, uranium), is an alpha particle emitter and such emissions are impossible to detect directly from a source within the body due to their low power of penetration. Consequently, methods to assess internal exposure have been developed that use measurements of activity in biological samples and mathematical descriptions of how this quantity relates to overall internal exposure. These mathematical descriptions of radionuclide biokinetics have evolved from simple excretion functions to complex, biologically plausible, multi-compartment recycling models of absorption, distribution, metabolism and excretion, which can be used to assess doses to individual organs and tissues.
With it now being understood that radiation induced cancers are a stochastic effect and that even small exposures may increase cancer risks, the methodology developed to assess radionuclide exposures is also being used to provide doses for use in epidemiological analyses to investigate risks at low doses. This review will discuss the development of methodology for the assessment of internal exposure to radionuclides from bioassay measurements for both occupational protection and epidemiological research purposes.

Abstracts - Posters

1.1
Chemical characterization of ambient particles at urban schools to determine the sources of children's exposure

Leigh R. Crilley, Godwin A. Ayoko, Mandana Mazaheri and Lidia Morawska

An urban microenvironment where children spend a large portion of their day is school, and thus this is an important site for monitoring exposure to airborne particles. To determine the sources and driving factors of children's exposure at school a comprehensive study was undertaken analysing the concentrations of organic carbon (OC) and elemental carbon (EC) at 25 schools in Brisbane, Australia. The EC tracer method was applied to quantify the concentrations of primary and secondary OC. Average OC/EC ratios ranged from 1.88 to 19.36 at the schools, indicating that both primary and secondary sources were present. The contributions of the sources above background levels were distinguished using multivariate techniques and clusters of schools were identified with differing exposure to primary and secondary sources. Levels of vehicle emissions at the schools were primarily dependent on total traffic counts on surrounding roads and secondly on the wind direction relative to the surrounding roads. At one group of schools, vehicle emissions were the principal source, characterised by elevated concentrations of primary OC and EC. High concentrations of secondary OC were observed at another group of schools, which were correlated with solar radiation levels indicting influence from photochemical secondary organic aerosols (SOA) formation. While local meteorology affected the measured concentrations, overall the range of concentrations measured at these schools can be considered as representative of children's exposure to vehicle emissions and SOA.

1.2
Investigating Chemical Composition, Sources, and Temporal Trends of Aerosols Using a Year-long AMS Dataset from London, UK.

Dominique E. Young, James D. Allan, David C. Green, Paul I. Williams and Hugh Coe.

Atmospheric aerosols have a complex nature resulting from the range of sources, which leads to one aerosol exhibiting different properties to the next, such as size and chemical composition. Consequently, the exact impacts of aerosols including their effect on health, and the mechanisms by which they occur are not well understood. Examination of various aerosol properties, as well as their sources, and how they change spatially and temporally, is essential for refining the quantification of aerosol effects in health policies. Furthermore, reducing air pollution is imperative when three-quarters of Europe's population currently live in urban areas.

The Aerodyne aerosol mass spectrometer (AMS) can quantitatively measure size-resolved chemical composition of non-refractory submicron particulates with high-time resolution. The AMS has demonstrated its versatility in a range of environments across the world and is capable of measuring ammonium nitrate, ammonium sulphate, ammonium chloride and organic particles. Positive matrix factorisation (PMF) is a useful tool for apportionment of organic aerosols where different sources can be probed. Here we present a year-long UK urban background data set from the compact Time-of-Flight AMS (C-ToF-AMS) including results of PMF analysis. This data set offers a unique opportunity to investigate urban aerosols and their sources, allowing daily, seasonal, and annual trends to be evaluated. Following these measurements, a long-term monitoring instrument, the Aerodyne aerosol chemical speciation monitor (ACSM) which also measures chemical composition, has been deployed at the same location. The long-time base provided by the AMS and ACSM allows temporal changes in particulate composition and aerosol sources to be monitored.

1.3
Seasonal and spatial heterogeneity of exposure to particulate PAHs for individual sources

Eunhwa Jang, Mohamed S. Alam and Roy M. Harrison

Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous compounds, produced through incomplete combustion processes. PAHs are a semivolatile class which exists as both gaseous and particulate phases undergoing continuous G/P partitioning. Because of the known mutagenic and carcinogenic properties of PAHs, benzo(a)pyrene (BaP) is widely regulated as an indicator of the PAH mixture. However, the use of BaP alone implies that it always well represents the hazard associated with the PAH mixture.
Positive Matrix Factorization was applied to three UK datasets of PM_{10}-bound PAHs (Northern Ireland, industrial urban and urban) and source apportionment conducted.
Significant contributions to particulate PAH were seen from traffic emissions and coal burning sources. Heterogeneous source-specific contributions of BaP at each site were seen, which may be driven by different local emission characteristics. Different seasonal contribution patterns between a domestic coal burning source and a metallurgical industry source allowed separation of two PAHs source profiles.

1.4
Personal versus fixed-site monitoring for assessing $PM_{2.5}$ exposure in an industrial city, Saudi Arabia

Mr Salem AlBalawi, Dr. Susan Hodgson, Dr. Anil Namdeo & Prof. Tanja Pless-Mulloli

Background: Air pollution is a known risk factor for adverse health effects. Many epidemiological studies use outdoor air pollution levels based on fixed-site monitoring data as a surrogate for human exposure, however individuals spend, on average, 85% of their time indoors, where exposure sources differ from outdoors. Personal monitoring allows more appropriate exposure estimation, but, to date, little has been done to compare exposure based on fixed-site versus personal monitoring, and no such comparisons have been carried out in the Middle East.
Aims: To investigate the validity of fixed-site versus personal monitoring of $PM_{2.5}$ in an industrial city in Saudi Arabia.
Methods: We collected 24-hour personal monitoring of $PM_{2.5}$ exposure from 28 students aged 16-18 years, using a SidePak AM510 set to record $PM_{2.5}$ levels every minute. Students completed a time-activity diary to identify time spent in key microenvironments, especially outdoors and indoors. Students also carried a GPS device to log their geographic position. Hourly ambient $PM_{2.5}$ levels for the same 24 hour periods were extracted for the nearest fixed-site monitoring station.
Results: Hourly mean $PM_{2.5}$ exposures were significantly higher when assessed via personal monitoring (Mean=39.3 $\mu g/m^3$, Median=30.5, $p<0.00$, SD=52.2, Range=816.3) than fixed-site monitoring (Mean=19.7 $\mu g/m^3$, Median=12.2, $p<0.00$, SD=24.8, Range=257.6). There was a non-significant correlation between log transformed personal and fixed-site monitor $PM_{2.5}$ levels when subjects were predominantly outdoors (Correlation=0.31, $p=0.07$, n=39hrs), and a weak, but significant correlation when subjects were indoors (Correlation=0.14, $p<0.00$, n=605hrs). The spatial validity of the fixed monitor data (versus personal monitor data) is been explored in GIS.
Conclusion: The validity of fixed site air monitoring data as a proxy for personal exposure to PM needs to be characterised so that the exposure error associated with this proxy measure is better understood.

1.5
Domestic exposure to Carbon Monoxide and PM2.5 in biomass fuel households in Janakpur, Nepal

Bartington SE, Bakolis I, Gulliver J, Devakumar D, Kurmi O, Osrin D, Ayres JG, Saville N, Costello A, Manandhar DS and Hansell AL

Background: Household air pollution from solid fuel use is responsible for 3.5 million annual deaths and 4.3% of the Global Burden of Disease. The objectives of this exposure study were to report domestic CO and PM2.5 levels and explore the efficacy of CO as a proxy measure for PM2.5 in southern Nepal, where biomass is the primary domestic cooking fuel source.
Methods: Kitchen CO and PM2.5 levels were measured at 1-minute intervals for a 48-hour period in 12 biomass fuel households (wood n=4, dung n=4, mixed n=4). CO levels were recorded using an electrochemical sensor (Lascar EL-USB-CO) with concurrent PM2.5 monitoring by co-located photometric device (TSI DustTrak II/SidePak AM510) and additional gravimetric particulate collection by sampling pump (Casella APEX) in a subset of households.
Results: In all households cooking was performed twice daily with a median total duration 4 hours (range 3-6 hours). Overall 48-hour average CO concentrations in wood and dung households were 5.5 ppm (SD 5.3) and 5.4 ppm (SD 4.4) respectively; significantly higher ($p<0.001$) than in mixed fuel households (4.6 ppm, SD 3.4). In 11 households 1-hour average CO levels exceeded WHO 1-hour guideline limits (10 ppm) for between 1 and 9 hours of the 48-hour sampling period, particularly during cooking sessions. The measured range of 48-hour PM2.5 concentration by photometric sampling (n=8) was 32 to 9930 μm-3 (mean 531 μm-3) with 1-hour average concentration 49 to 2478 μm-3 (mean 542 μm-3). Diurnal variability of CO and PM2.5 was similar reflecting morning and evening cooking periods, with moderate correlation between hourly levels (Spearman's Rho=0.65, $p<0.001$).
Conclusions: Kitchen CO and PM2.5 concentrations in this region frequently exceed WHO Indoor Air Quality standards. These findings suggest CO may be used as a proxy for PM2.5 levels in this setting and further research will examine this relationship by emission source.

1.6. Assessment of spatiotemporal exposure estimates in small area exposure studies

Daniela Fecht, Federico Fabbri, Linda Beale

Background and Aims: Exposure to air pollutants is often estimated based on location. Either ambient pollutant concentrations measured at the nearest monitoring station or modelled concentrations are assigned to a specific location such as residential address. Mobility and time spent in locations away from home, however, greatly influence people's exposure. Ignoring this spatiotemporal element can result in inaccurate exposure estimates, but the magnitude and spatial distribution of the expected exposure error is largely unknown.
Methods: An urban simulation environment was used to compare a location-based exposure proxy to personal exposure. Exposure misclassification due to the use of ambient PM_{10} concentration measurements nearest to the home instead of personal exposure was quantitatively and spatially assessed for a cohort of 500 school children. Personal exposure was modelled by predicting daily activity patterns using a probabilistic time-activity model and overlaying the visited locations and trips between locations with hourly PM_{10} concentration surfaces. Indoor particle concentrations were modelled using a stochastic mass-balance model.
Results: Personal exposure varied greatly between weekdays and the weekend due to a shift in the outdoor/indoor activity ratio, although that variation disappeared when averaging personal exposure over a two-week period. Using a location-based exposure proxy over-predicted exposures for those children with the lowest and highest exposures and the accuracy of the location-based proxy strongly depended on the activity patterns of individuals.
Conclusions: The spatial patterns of personal exposure showed that children are exposed to much higher levels of particles when away from home. A location-based proxy offers a reasonable estimate of exposure for children living in inner city areas, however, for children living in suburban areas, where ambient concentrations vary greatly, a single location will introduce spatially biased exposure error. There is a need to characterise this error in future exposure studies and analyses should include spatiotemporal detailed exposure information.

1.7
Methods to harmonise air pollution and noise assessment in EU Biobanks

de Hoogh K , Cai Y, Hodgson S, Blangiardo M,Gulliver J, Hansell A, Elliott P.

Background and aims: Biobank Standardisation and Harmonisation for Research Excellence in the European Union (BioSHaRE-EU) is a FP7 funded project that aims to develop methods and tools to enable researchers to use standardised, pooled data from different biobanks. Within this project we are developing methods to harmonise noise and air pollution exposures in European biobank studies to examine their relative contributions to cardio-respiratory health.
Methods: Air and noise pollution exposures will be modelled at home address using the same standardised procedures for each biobank. Air pollution exposures will be estimated using the ESCAPE Land Use Regression (LUR) method and noise exposures using a simplified CNOSSOS-EU method. Associations between exposure and prevalence of respiratory and cardiovascular events will be examined using Bayesian statistical methods: i) joint assessment of the effect of the two exposures, ii) modelling differences and communalities across countries taking into account uncertainty, iii) quantification of the measurement error bias in the exposures.
Results: 317,000 addresses from HUNT (Norway), 323,890 from Lifelines (Netherlands) and 38,941 from EPIC-Oxford (UK) biobanks have been successfully geo-referenced. Agreement to geo-reference 500,000 addresses from UK Biobank has been reached. The next step is to model and assign estimates of air and noise pollution exposures at home address. Exposure characteristics of cohort participants will then be compared with nationally available population exposures such as European Union Noise Directive maps and national air pollution assessments.
Conclusions: The pooling of standardised data from established cohorts offers the very large sample sizes needed to investigate environmental influences on multifactorial diseases. Development of such methods to harmonise environmental exposures across biobanks will help in environment-environment and gene-environment studies.

1.8
Integrating ambient air pollution modelling with exposure assessment

Stefan Reis, Massimo Vieno, Susanne Steinle, Pietro Zambelli

Current assessments of exposure to ambient air pollutants are widely based on concentration data from air quality monitoring sites. These sites are operating for regulatory purposes and are located to represent different rural and urban air quality regimes (including urban background, kerbside, or rural).
While the temporal resolution of monitoring data is typically high (hourly data, based e.g. on measurements once per minute), the spatial representativeness of the few existing monitoring sites in a highly variable urban environment must be seen as limited at best.
Atmospheric dispersion models use monitoring sites as validation points to compare model results against observations, as well as to understand the spatial and temporal variability on a regional to local scale. They can provide very high spatial (1 km on a national scale, 10s of metres on local scale) and temporal (minutes to hours) resolution for a wide range of pollutants. Covering both primary (i.e. directly emitted) and secondary (i.e. formed from precursor emissions through chemical and physical atmospheric processes) pollutant concentrations, atmospheric dispersion models can, complement monitoring data to identify cause-effect relationships that are not immediately possible to infer from observations at specific sites. This is vital for the assessment of policy measures to reduce concentrations and exposure of, for instance, urban populations, where different measures can contribute to different outcomes in accumulated population exposure.
Last, but not least, using both observations and atmospheric dispersion models in an integrated fashion, assessing human exposure to pollutant mixtures and over long(er) periods of time can be achieved. This is a vital building block to contribute to the quantification of the exposome in particular regarding human exposure to air pollutants. In this presentation, we will demonstrate the ability of current atmospheric dispersion models to deliver robust and reliable assessments of population exposure to ambient air pollutant concentrations.

1.9
Personal exposure to airborne particles in varying micro-environments

Susanne Steinle, Stefan Reis,Clive Sable

In order to quantify exposure and conduct health impact assessment, which provide the basis for public health advice and policy development, it is essential to develop a deeper understanding of individual exposure pathways and situations occurring in people's everyday lives.
We describe the development and application of a personal monitoring method to assess exposure to fine particulate matter in a variety of microenvironments (MEs). The sensor package and methods applied are tested with respect to feasibility, intrusiveness, performance and its potential for future applications.
For this pilot study a low-cost portable device to assess ambient concentrations of airborne particles ($PM_{2.5}$) in outdoor and indoor environments has been applied. The measurement performance has been tested in co-location studies against reference instruments. A GPS receiver, time-activity diaries and questionnaires, as well as follow-up meetings, were used to record data about peoples' activities and location. To directly compare the measured data with other measurements, functions derived from results obtained in the co-location studies are applied to generate $PM_{2.5}$ mass concentrations from particle number counts for urban and rural outdoor locations.
Results from autumn/winter 2012 and spring 2013 suggest that personal exposure is driven by the individual's activities and habits but also influenced by the natural and build-environments the person spends time in and the busyness of those. Some MEs, like home or public buildings have wider ranges of measured concentrations because of the variety of activities, sources and exposure situations occurring in those. While others like the work and transport ME are much more uniform with respect to the concentrations measured there. Cooking and baking activities are standing out in this pilot study as there are several profiles where these activities cause distinct peak exposures.

1.10
Size distribution, mixing state and source apportionments of black carbon aerosols in London during winter time

Dantong Liu, James Allan, Dominique Young, Jonathan Taylor, Michael Flynn, Paul I. Williams, Hugh Coe, Martin Gallagher, Zoe L. Fleming

Increased anthropogenic emissions into the atmosphere have led to severe air quality issues over the past two centuries, especially for urbanized megacities with high population densities. Understanding, identifying and characterising the sources of air pollution and their effects on surrounding areas, is important for validating environmental pollution control policies. Aerosol emissions have been widely recognized to have adverse impacts on the environments. In the past decades, environmental regulation has been mainly targeted emissions from fossil fuel combustion by transport, power plants and a variety of industrial activities. However residential biofuel burning for space heating purposes (BB, or more specifically termed as biofuel or solid fuel burning in contrast with open biomass burning) has received little attention in terms of such regulation. Greater London is the most populated conurbation in Europe with a highly dense population. Black carbon aerosols (BC) generated from the incomplete combustion, known as the soot, have severe adverse impacts on human health. The BC sources during winter in London were significantly influenced by BB; in contrast vehicle emissions almost formed the only BC source in summer. A source apportionment methodology has been developed based on the measured BC size distribution and mixing state. During intensive measurements in London as part of the Clean Air for London (ClearfLo) campaign, as high as 39±14% of BC mass fraction was observed to be from BB sources. The BC from BB is found to have a larger core size and thicker coating thickness compared to the traffic sources.

1.11
Modelling air pollution exposures: enhancements to intra-urban land use regression models

John Gulliver and Robert Tang

Background. Land use regression (LUR) models are increasingly used for air pollution exposure estimation in epidemiological studies. However, models have rarely offered variables that account for the dispersion environment close to source (e.g. street canyons, position and dimensions of buildings, road width). It is computationally impractical to include individual buildings in dispersion models for large geographical areas but it is feasible with LUR.
Methods. This study used recently available data on building heights and geometry to enhance the representation of land use and the dispersion field in LUR. Models were developed for PM10, NOX and NO2 for 2008-2011 for London. A separate set of models using 'traditional' land use and traffic indicators (e.g. distance from road, area of housing within circular buffers) were also developed and their performance compared with 'enhanced' models. In a further step, we also developed 'hybrid' LUR models where information on road geography and traffic flows were substituted with output from a dispersion model (ADMS-Urban) used to model emissions from road sources. **Results.** Models were evaluated using grouped (n-25%) cross validation (GCV). GCV R2 values were 0.71, 0.53, 0.64 and 0.68, 0.77, 0.77 for traditional and enhanced PM10, NOX and N02 models, respectively. Data on building volume within the area common to a 20 m road buffer within a 25 m circular buffer substantially improved the performance (R2 > 13%) of NOX and NO2 LUR models. Performance of 'hybrid' models (with output from the dispersion model) was about the same as LUR models with information on traffic volume and road length. **Conclusions.** Data on building heights and street configuration could have utility in improving the performance of LUR models, but may not improve performance of models for some pollutants (e.g. PM10), and may perform less well in areas where building height and density is less variable.

1.12. Real-time detection of primary biological aerosol: An Ultraviolet Light Induced Fluorescence detection method.

I. Crawford, M.W. Gallagher, V.E. Foot, D. Baumgardner, W.R. Stanley, P.H. Kaye.

Primary biological aerosol (PBA) refers to any material of biological origin released directly into the atmosphere. Efforts are being made to quantify their abundance and fluxes to the atmosphere as they affect disease and allergen transmission, the biodiversity of our surroundings, and potentially the hydrological cycle through bio-precipitation feedback mechanisms. Reliable online methods of identifying and quantifying airborne PBA are required, as offline methods cannot capture the rapid temporal and spatial variations associated with environmental parameters in order to predict concentrations and fluxes with accuracy.
Ultra-Violet Light Induced Fluorescence (UV-LIF) is one such method, offering the possibility of near-instantaneous discrimination between airborne PBA and other aerosol particles without the need for collection, staining or incubation of the sample. It relies on the presence of intrinsically fluorescent molecules found in biological material, such as amino acids (Tryptophan and Tyrosine), and flavins and coenzymes (NAD(P)H and chlorophyll).
The Wideband Integrated Bioaerosol Sensor (WIBS) is a state of the art, portable UV-LIF instrument, designed to detect the auto-fluorescence associated with the above biofluorophores contained in single aerosols. Particle size and morphology are also resolved. This allows PBA to be discriminated from non-biological aerosol and between broad taxonomic classes of bioaerosol (e.g. fungal spores, pollen and bacteria). The use of a Hierarchal Agglomerative Cluster Analysis technique to collect statistically similar particles together allows a quantitative concentration time series of clusters representative of PBA classes to be studied in conjunction with other parameters. We present details of the above methods, and field results from an urban environment (London ClearfLo experiment - North Kensington), and from inside a large, multifunction communal building in the University of Manchester campus. In each case distinct trends in PBA concentration arising from human activity were observed. A new, more sophisticated UV-LIF instrument for improved particle discrimination will also be described.

1.13
The potential for organic contaminants to migrate to off-site human receptors during remediation

Dr Louise Uffindell, Kerry Foxall, Jeff Russell, Jamie Bond, Yolande Macklin, Sian Morrow, Paul Harold and Camilla Ghiassee

The remediation of land affected by contamination can occur as a result of sites being determined as "Contaminated Land" by Local Authorities, voluntary remediation or through the redevelopment of sites for new uses, usually controlled through the planning regime.
Methods of remediation are varied, and may involve treatment or removal of contaminated soils from site. During remediation there is the potential for contaminants to migrate off-site, as vapours or in dust, and pose a toxicological risk to adjacent existing site users e.g. residents.
This poster will examine several case studies, where remediation activities on sites containing organic chemicals were identified as having the potential to cause public health impacts or concerns within local populations. The steps taken by Public Health England staff, working with partners, to assess these risks and communicate them to local people are detailed.

1.14
Comparative assessment of particulate air pollution exposure from municipal solid waste incinerator emissions

Danielle C. Ashworth, Maria Leal Sanchez, Gary W. Fuller, Mireille B. Toledano, Anna Font, Paul Elliott, Anna L. Hansell, and Kees de Hoogh

Background: Although the numbers of incinerators in the United Kingdom are increasing, there are few studies investigating possible health risks associated with incineration. The research to date has been limited by poor exposure assessment. This paper provides a comparative assessment of atmospheric dispersion modelling and distance from source (a commonly used proxy for exposure) as exposure assessment methods for pollutants released from incinerators.
Methods: Distance from source and the Atmospheric Dispersion Modelling System Urban (ADMS-Urban) model were used to characterise exposure to particulates from two municipal solid waste incinerators (MSWIs) in England and Wales between 2003 and 2010 operating under current stringent UK emission regulations. Additionally an exploration of the sensitivity of the dispersion model simulations to input parameters (surface roughness length, Monin-Obukhov length and meteorological data) was performed.
Results: The model output indicated extremely low ground-level concentrations of PM_{10}, with maximum concentrations of <0.01 $\mu g/m^3$. Proximity and modelled PM_{10} concentrations for both MSWIs at postcode level were highly correlated when using continuous measures (Spearman correlation coefficients ~0.7) but showed poor agreement for categorical measures (deciles or quintiles, Cohen's kappa coefficients ≤0.5) as commonly used in epidemiological studies.
Conclusion: To provide the most appropriate estimate of ambient exposure from MSWIs, it is essential that the incinerator characteristics, the magnitude of emissions and the surrounding meteorological and topographical conditions are considered. Reducing exposure misclassification is particularly important in environmental epidemiology to aid detection of low-level risks.

1.15
Feasibility of a road traffic noise exposure model based on low-resolution inputs for national level modelling.

David Morley, John Gulliver, Kees de Hoogh

An aim of the BioSHaRE project, utilising pooled data from several national level cohort studies, is to investigate the effect of road traffic noise on health outcomes. To estimate exposure to road traffic noise for each participant, a new road traffic noise model has been developed that is able to operate on a country-wide scale.
Noise models commonly require extremely detailed inputs concerning multiple reflections and diffractions from individual buildings and barriers, meteorology, variability in ground terrain, traffic flow counts, road network layout and characteristics of the traffic fleet. Using such high-resolution data it is possible to get very accurate noise level estimates on a local scale. However, this is not always possible on a national scale, firstly as the data may not be available and secondly because computation time becomes a limiting factor.
As a solution, we adopt a national level version of the CNOSSOS-EU noise model based on less-detailed inputs, but with the ability to quickly produce accurate noise level estimates at receptor sites. To test the feasibility of this approach, we tested the model with both high- and low-resolution inputs for a series of control locations in Leicester, UK.
The high-resolution data set consisted of land cover classes derived from Ordnance Survey MasterMap™ which represents features detailed to the scale of a few metres and traffic flow data based on observed counts. The low-resolution data set comprised of generalised land cover from Corine, precise to only 100m and with fewer distinct classes. Traffic flows were based on nationally modelled estimates.
As expected, the model performed best with the high-resolution dataset. However, the low-resolution data provided comparable estimates. Applying coarser scale, but readily available inputs, the CNOSSOS-EU model can be used to quickly make acceptable noise exposure estimates over a large geographical area and for many receptor sites.

2.1
Worker behaviour and chemical exposure

Alice Davis, Joanne Crawford, Karen Galea, Martie van Tongeren, John W Cherrie

Unexplained variances in occupational exposure levels are often described as incomplete information about work processes or working environment. However, it has been suggested that this variation can be attributed to differences in individual worker's behaviours.
The aim of this paper is to discuss the use and application of behaviour models and theories from social sciences to occupational exposure science to help explain variances of between worker exposures. A brief overview of a number of more widely used behaviour theories and models such as the Theory of Planned Behaviour and the Stages of Change Approach will be presented. These theories will then be discussed in relation to their applicability to occupational exposure. Through this, their respective advantages and disadvantages will be identified to reach a conclusion of how the use of behaviour theories can be taken forward to encourage safer workplace behaviours. The general and practical issues that should be considered when applying behaviour theories within a workplace setting will also be identified.
This poster will give further knowledge to the occupational exposure community about behavioural models and theories and the benefits of applying these to ultimately encourage safer workplace behaviours.

* Note, this work is ongoing at the time of abstract submission.

2.2
Background levels of metals in urine samples to assist with exposure assessments.

Jackie Morton, Elizabeth Leese, Emma Tan, and John Cocker

Aims: The aim of this project was to establish current background levels of elements in urine both for commonly monitored elements and for rarer elements being increasingly utilised in new technologies. These results will be compared with other published data and data from routine BM measurements undertaken at HSL.
Methods: Background levels of 61 elements in urine from a UK population are presented here from 137 people. The samples were analysed by ICP-MS in different diluents and matrices depending on the elements.
Results: Mixed effect analysis was carried out on the elements and it has been possible to establish 95th percentile background levels for 45 of the elements. However, based on the high percentage of results <LOQ, the analysis was not carried out for the following elements: Zr, Bi, Nb, Ag, Os, Y, In, Pr, Nd, Sm, Eu, Tb, Dy, Tm, Lu, and Au. The mixed effect analysis showed that, for all of the remaining elements, creatinine correcting the data in all cases gave a reduction in variability or no significant difference in variability. It was also shown that smokers have elevated cadmium and lower boron and selenium levels than non-smokers.
Conclusions: Reference levels based on 95th percentiles for many elements have been established for a UK population. Overall the results compare well with published European and American results, however there are differences for some elements.
The results show that there have been no major changes in the unexposed levels of 'routine' metals used in everyday biological monitoring at HSL.

2.3
Establishing background levels for five arsenic species in urine samples in a UK population

Elizabeth Leese, Jackie Morton, Emma Tan, Philip H.E Gardiner, Vikki A Carolan

This study provides background levels for five arsenic species in urine, based on urinary data for 95 non-occupationally exposed volunteers based in the UK.
Using a novel, sensitive, robust and reliable routine speciation methodology, five species of arsenic (arsenobetaine [AB], arsenite [As3+], arsenate [As5+], monomethylarsonic acid [MMA5+] and dimethylarsinic acid [DMA5+]) were determined in urine samples collected from 95 adults. The analytical instrumentation used to analyse the urine samples was a hyphenated μLC system coupled to an ICP-MS. Separation was achieved using an anion exchange micro sized column.
The results presented give the 95th percentile of concentrations, both uncorrected for creatinine (μg/L) and creatinine corrected (μmol/mol) in urine for the 95 volunteers. Statistical analysis was performed on the dataset using a Bayesian model to determine and quantify effects of gender, smoking and diet. The statistical results show that the consumption of fish, shellfish and red wine has a significant effect on elevating AB, DMA and MMA urinary concentrations; however no significant effect was observed for smoking. The regression model results indicate that creatinine correction was effective for arsenic species As3+, MMA, DMA and AB.
Background levels established here can be used as reference values to help aid interpretation of arsenic speciation results and better assess exposure.

2.4
Double strand breaks and N7-methylguanine levels in human sperm DNA

Bashar Altakroni, Jill Stocks, Geoff Margison, Daniel Brison Andrew Povey

Background: Sperm DNA contains damage that represents the biologically effective dose of genotoxin exposure but the associations between different types of damage are largely uncharacterised.
Objective: To determine the correlation in sperm DNA between DNA double strand breaks (DSBs) and one particular type of DNA base damage, i.e. N7-methylguanine (N7-MeG).
Methods: Men (n=105) of couples attending St Mary's Hospital, Manchester, for assisted reproduction treatment were recruited. DSBs were determined by neutral Comet assay and the percentage of DNA in the Comet tail (%tail DNA) was quantified by image analysis. Sperm were classified as containing few DSBs (FDSB) or high levels of DSBs (HDSB) if their Comet tails contained <0.005% or >7.5% DNA, respectively. N7-MedG levels were quantified in extracted sperm DNA by immuno-slot blot.
Results: The %tail DNA distribution was multimodal with some samples showing a clear trimodal distribution. The median %tail DNA was 0.9% with a range between 0.1-5.3%. The median % of sperm with FDSBs was 14.5% (range 2.3-39.2%) and for sperm with HDSBs 12.6% (range 4.0-47.2%). N7-MeG was detectable in all semen DNA samples analysed (n=101) and displayed a log normal distribution. The mean was 0.55 fmole/µg DNA and the range was 0.12-2.30 fmole/µg DNA. N7-MeG levels were weakly correlated with the median %tail DNA (r^2= 0.06, *P: 0.04*) and inversely with the %FDSBs (r^2=0.04, *P: 0.03*) but not with the %HDSBs (r^2=0.01, *P: 0.2*). Furthermore, there was little evidence that men with high levels of %HDSBs also had high N7-meG levels: indeed the men with the highest N7-MeG levels had low %HDSBs.
Conclusions: N7-MeG levels were not strongly correlated with DSBs and hence measurement of one type of DNA damage does not necessarily provide an accurate indicator of DNA damage load and may result in exposure misclassification.

2.5
Spatial variation of metal concentrations found in honeys around Greater Manchester

David de Peña

Honey bees (*Apis mellifera*) forage up to 4km, and can access around 50km^2 from their apiaries, thus sampling a huge number of individual points, from all environmental compartments such as water, air and soil. As honey is considered a composited random sample, it has the potential of providing the most representative values for the average concentrations of bio available elements in an areas environment. In this study, the contents of Al, As, Ba, Ca, Cd, Co, Cu,Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, S, Sr, and Zn were determined by inductively coupled plasma optical spectrophotometry (ICP-OES) on honey samples collected from members of the Manchester and District Beekeepers Association (MDBKA) around Manchester during 2012 and 2013. Multidimensional statistical analysis of the honey samples showed that there were correlating factors present in the distribution of the metals determined within the honey samples, and relationships between geographical location and metal content were clearly seen. Confirmation of this was also seen from the GIS contour maps which showed the spatial distribution of the heavy metals determined from the ICP-OES analysis, with lead being distributed mainly amongst the south of the study area and arsenic around the north. The results of this study indicate that honey can serve in the detection of spatial patterns of metal concentrations within the environment, even at relatively low levels of pollution.

2.6
The INFLAME and A-TEAM Marie Curie Initial Training Networks: Objectives and Initial Outcomes

Stuart Harrad, Cassandra Rauert, Gopal Pawar, and Ana Miralles-Marco

Co-ordinated by the Persistent Organic Pollutants research group at the University of Birmingham, the INFLAME and A-TEAM Initial Training Networks combined comprise 29 individual PhD and postdoctoral projects carried out at 9 research organisations across Europe. The overall objectives of INFLAME are to discover: 1. The mechanisms of flame retardant migration from products; 2. How and to what extent such migration leads to human exposure; and 3. The effects of such exposure. Research highlights to date include results that indicate that: abrasion of products and materials can account for the highly elevated concentrations of some involatile brominated flame retardants (BFRs) in indoor dust; hair is a promising alternative to blood as a measure of human body burdens of BFRs; and human gut bioaccessibility of BFRs from dust is reduced at highly elevated BFR concentrations.
The A-TEAM project's principal aims are to improve our ability to answer the following questions: 1. Which chemicals accumulate in Europeans? 2. How does contact with chemicals translate into levels in humans? 3. How can we best monitor this presence in humans? and 4. Which exposure pathways are most important for a range of consumer chemicals? The A-TEAM project will address these aims principally via detailed study between December 2013 and April 2014 of a human cohort from 60 households in Oslo, Norway. Samples relevant to human exposure (e.g. blood, urine, hair, saliva, food, indoor air, and indoor dust) will be collected from the cohort and analysed for a range of consumer chemicals to include: perfluoroalkyl substances like PFOS, "emerging" BFRs like Bis(2-ethylhexyl)tetrabromophthalate, phthalate diesters, and organophosphate flame retardants.

2.7
Properties and effects of indoor dust on flame retardant bioaccessibilty

Aikaterini Kademoglou, Chris D. Collins

Flame retardants (FRs) are man-made chemical compounds widely used in industry during the manufacturing of various commercial products such as computers, plastics, fabrics, textiles and polyurethane foam products in order to minimise or prevent fire. Worldwide phase-out campaigns and legislative restrictions on the use of polybrominated diphenylethers (PBDEs) have resulted in the production of new PBDE-replacement products, also known as emerging FRs.
The aim of the present study is to investigate the concentration level of various emerging FRs in indoor dust and to identify how factors such as indoor dust composition and organic matter, particle size and morphology, particle source as well as other physicochemical properties closely related to human exposure pathways affect bioaccessibility of PBDE-replacement products in indoor dust.
In the preliminary results of our study three different size classes and mass distribution patterns are presented as following: class 1: <63 um, class 2: 63-300 um and class 3: >300 um. Different dust particles sources present different particle distribution patterns, suggesting that mass distribution of class 1 (<63 um) is higher (>50%) in stores and libraries and non-settled dust, whereas class 2 is more dense in houses and settled dust.
Such findings suggest that particle size fraction and particle source should be taken into consideration in flame retardant human exposure assessment and biomonitoring.

2.8
Efficiency of two-phase designs to correct for exposure measurement error

Eva Batistatou, Roseanne McNamee

Introduction: Occupational or environmental exposures often deal with considerable exposure measurement errors which lead to bias in assessing exposure effects. If exposure replicates are available, bias correction methods can be applied, but replication may be expensive. Two-phase studies are potentially an efficient solution for regression parameter estimation since, in the second-phase, measurement of replicates is restricted to a sample of first-phase subjects. Sampling from the extremes of the first-phase exposure distribution has been shown (Berglund et al. 2006) to be more efficient than random sampling.
Aim: To evaluate the overall cost-efficiency of several two-phase studies compared to single-phase studies ie the conventional study designs in which repeated measurements are taken on all study participants, for unbiased estimation of exposure effects in regression models, when the exposure is mismeasured.
Methods: Motivated by the European occupational respiratory study (van Tongeren et al. 1999), several hypothetical two-phase studies, with the exposure replicate chosen both randomly or from the extremes of first measurement's distribution, were considered. Exposure effect bias was corrected using a factor derived from the regression of the exposure replicate on first measurement. Two-phase efficiency, defined as the ratio of variances of the exposure effect under a single-phase design compared to a two-phase study of the same overall cost, was studied as a function of the sampling proportion p of second-phase subjects, the reliability of exposure, the cost ratio c_W/c_Y, where c_Y and c_W are the costs per subject of measuring the health outcome and exposure, respectively, and regression model parameters.
Results/Conclusions: Two-phase studies with extreme selection of second-phase subjects are, almost always, more efficient than a single-phase study of equal total cost. Although random selection is not the preferred sampling strategy compared to extreme selection, two-phase studies with random selection are, also, more efficient than a single-phase study in many cases.

2.9
Microscopic investigations of indoor dust contamination with Brominated Flame Retardants

C*. Rauert, S. Harrad, H. Takigami, G. Suzuki*

Brominated flame retardants (BFRs) are used in many fabric, foam and plastic consumer products in indoor environments. As a result, it is unsurprising that BFRs have been widely detected in indoor dust. Moreover, the concentration distribution is highly positively skewed, with concentrations in dust of one particular BFR (decabromodiphenyl ether – BDE-209) reaching up to 2-3 mg/g (0.2-0.3%) in some UK dusts. As BDE-209 has an extremely low vapour pressure, its volatilisation from products does not seem a highly plausible explanation for such elevated concentrations. Instead, it is hypothesised that the principal migration pathway involved in such cases is abrasion, where everyday 'wear and tear' of the treated product encourages the removal of small particles/fibres that then transfer directly to the dust. Understanding the migration pathways that BFRs enter dust informs efforts to impart effective flame-retardancy to consumer goods while minimising human exposure to these contaminants.
In this case study, two indoor dust samples were chosen for investigation due to the presence of high concentrations of BDE-209 at 0.3 and 1.4 mg/g. Forensic microscopic techniques were utilized to determine possible migration pathways responsible for the high concentrations. The instrumental techniques used included Energy Dispersive Micro X-ray Fluorescence Spectroscopy (μEDX) and Scanning Electron Microscopy with Energy Dispersive X-ray Spectrometry (SEM/EDS) to identify individual dust particles containing high bromine concentrations. Laser Microscopy provided surface information on the particles of interest, while Fourier Transform Infrared spectroscopy (FT-IR) was used for compositional analysis of the particles. Small plastic particles (possibly of the acrylonitrile butadiene styrene copolymer matrix) that had been flame retarded with both BDE-209 and antimony trioxide were identified in both dusts. The results indicate the dusts were contaminated via the abrasion migration pathway from a flame retarded plastic consumer product, possibly a computer or TV casing.

2.10
Application of 3D-human skin equivalents for *in-vitro* assessment of dermal absorption of organic flame retardant chemicals

Mohamed Abdallah, Gopal Pawar and Stuart Harrad

An increasing number of studies have reported the concentrations of various organic flame retardants (FRs) in different environmental matrices and estimated human exposure under a number of scenarios. Current understanding is that non-occupational human exposure to FRs occurs mainly via a combination of diet, ingestion of indoor dust, dermal contact with dust/consumer products, and inhalation of indoor air. However, the exact contribution of these pathways varies substantially between compounds and individuals according to lifestyle, and is further complicated by international variations in FR usage. As a result, very little is known about how external exposure to FRs via these different pathways drives human body burdens of these compounds. Recently, a few studies have adopted a pharmacokinetic approach to facilitate understanding of the relationship between external exposure and human body burdens of FRs. These pharmacokinetic models highlight the importance of dermal absorption as a "missing link" that may explain why observed human body burdens exceed those predicted to arise from our current understanding of external exposure. Currently, very little is known about human percutaneous absorption of FRs. This may be attributed to the inherent ethical issues associated with studies involving human tissues and the difficulty of extrapolating results from animal models due to different inter-species skin-barrier functions. In this work, we applied recently validated 3D- reconstituted human skin models to study the dermal absorption of FRs *in vitro* using a static Franz-diffusion cell type model for 24 hours. Analytical methods for analysis of target contaminants both in the skin model and the receptor fluid (plasma substituent) were developed and applied to the generated samples. Mass balances were calculated to provide preliminary assessments of both dermal uptake and the significance of potential transdermal metabolic reactions.

2.11
Fires containing ammonium nitrate fertiliser

Dr. Louise Uffindell and Henrietta Harrison

To raise awareness of the potential public health impact from the fumes released as a result of fires containing ammonium nitrate fertiliser.

Ammonium nitrate fertilisers are widely used by the UK agricultural industry to improve crop yield. Therefore some agricultural land owners will store large quantities of ammonium nitrate fertiliser on their land. Whilst there is guidance and regulations on the storage of ammonium nitrate fertilisers, occasionally they do become involved in a fire, particularly when they are stored with combustible products, such as hay and straw.

There are two main concerns when ammonium nitrate fertiliser is involved in a fire. The first is a public safety issue, as certain types of fertiliser (those that contain over 28% nitrogen) can explode under certain conditions. The Fire and Rescue Service will determine the risk of explosion and, if necessary set up an appropriate evacuation cordon.

The second concern is the impact on public health. Under certain conditions ammonium nitrate fertiliser melts and decomposes resulting in the release of fumes, such as oxides of nitrogen and ammonia, which could potentially result in wider exposure to the local population. Public Health England is asked to provide public health advice on the potential public health impact from a fire containing ammonium nitrate fertiliser.

Whilst internal guidance exists within PHE, further guidance on public health impacts from fires containing ammonium nitrate fertiliser is planned to be produced for wider dissemination. This poster will discuss the public health issues around these incidents using actual incidents as example case studies.

2.12
Myeloproliferative Neoplasms: an in-depth case-control (MOSAICC) Study.

Glen Titmarsh, Mary Frances McMullin, Andrew Duncombe, Mike Clarke, Frank de Vocht, Lin Fritschi, Ruben Mesa, Mark Purdue, Christopher Tapper, Claire Leathem, Emma Gaunt, Lesley Anderson.

Introduction: Myeloproliferative Neoplasms (MPNs), characterised by an over production of one or more cells of the myeloid lineage, are classified into polycythaemia vera (PV), essential thrombocythaemia (ET) and primary myelofibrosis (PMF). Despite the identification of numerous genetic mutations, a paucity of information relating to the aetiology of these diseases remains.
Materials and Methods: The MOSAICC Study is a pilot exploratory case-control study aiming to recruit 100 cases and 200 controls (100 GP controls and 100 friend/non-blood relatives) between two sites, Belfast and Southampton, in preparation for a planned UK-wide investigation. The study includes methodology research. Participants complete a telephone-based questionnaire seeking information on a range of medical, environmental and occupational risk factors. Occupational exposures will be compared using job-exposure matrix (FINJEM) and a new web-based exposure assessment package, OccIDEAS. Additionally, information on quality of life is being collected, as are multiple biological samples (saliva, dried blood spots, venous blood and toe-nail clippings) to determine which are most convenient for patients and to provide sufficient material for genetic investigation.
Results: To date, 148 participants have been successfully recruited. We will recruit participants from April 2013 to June 2014, with results expected by the end of 2014.
Conclusion: Methodological aspects of recruitment procedures, response rates, telephone administered questionnaires, occupational assessment and suitability of biological sample collection will be evaluated to develop and optimise the protocol for a future, multi-centred, UK-wide study investigating the aetiology of MPNs.

2.13
Cancer mortality in the British Rubber industry – a 45 year follow-up

Damien McElvenny, John W. Cherrie, Raymond Agius, Frank de Vocht

Objectives: Working in the rubber and rubber product manufacturing industry has been determined by the International Agency for Research on Cancer (IARC) to be carcinogenic. However, given the complex nature of the chemicals, the phasing out of the use of certain chemicals, and the trend in reduction in exposures, there remains a great deal of uncertainty about the nature of the risks, if any, encountered by workers today.
Method: We have at our disposal a large retrospective cohort study of 40,000+ workers who were aged 35+ in 1967, which was last followed up to 1976. We are carrying out an updated cancer mortality analysis adding 35 years to the previous cancer mortality update. We will determine the nature of the dose-response relationships for important known and suspected carcinogens using quantitative exposure modelling based on available measurement data form the EXASRUB project (dust, fumes, solvents, and n-Nitrosamines).
Results: We will report on progress to date with the study, which has received ethical approval and is currently seeking other clearances from the UK research governance system for such studies, and will further report on proposed exposure modelling strategies.
Conclusions: This is the largest and statistically most powerful cohort of its type with a 45-year follow-up and exhaustive, quantitative exposure assessment. This analysis will add substantially to our knowledge of the longterm risks associated with the chemicals present in the industry in the UK, including those from working conditions several decades ago, and will thereby also be important for exposure conditions in the developing world.

2.14
Exploring "external exposure" and internal biological pathways of depression using causal inference modelling.

Frank de Vocht & Jane Sarginson

With a progressively ageing population the identification and treatment of depression in older adults has become increasingly important, particularly as older patients often have poorer outcomes. Chronic, low grade, inflammation may constitute a cumulative risk factor for depression, as well as explaining its high co-morbidity with medical conditions with known inflammatory elements like cardiovascular disease, diabetes, Parkinson's and various forms of dementia, all of which are more common in later life. Psychological stress and obesity are two related factors, which are known to contribute to systemic inflammation. This study looks at genetic variation in the kynurenine pathway, which plays a role in both the inflammatory response and neuronal signaling, interacts with psychosocial stress and obesity to alter an individual's risk of developing depression.
This poster describes a novel approach using structural equation modelling incorporating 'stressresponse' as a latent variable and latent genetic variables to enable modelling of the biological pathway structure as well as external direct effects of stress on depression.

2.15
Potential health effects of vanadium in contaminated land

Kerry Foxall and Dr Louise Uffindell

Vanadium is a naturally occurring metallic element in the earth's crust. Vanadium compounds are also present in fossil fuels e.g. coal, petroleum oils and shale. In the metal industry vanadium compounds are used as catalysts in various manufacturing processes. The presence of vanadium in soil may be from natural origin or due to anthropogenic activities.
Occupational studies have reported respiratory tract irritation in workers exposed to vanadium compounds via inhalation. Limited human data on oral exposure to vanadium compounds suggests that ingestion of vanadium may cause gastrointestinal effects including nausea, vomiting and diarrhoea. There are no data on carcinogenicity and limited data on potential reproductive effects
Vanadium is not a contaminant that Public Health England (PHE) is commonly asked to provide advice on. However, recently the PHE Centre for Radiation, Chemical and Environmental Hazards has been approached by several local authorities to advise on the health risks of vanadium in potentially contaminated land.
There is no soil guideline value or health criteria value to assess the risks from vanadium in soil. To answer enquiries from local authorities a preliminary review of the literature was conducted. This identified gaps in knowledge on the toxicology of vanadium. There are limited human data available on the effects of exposure to vanadium. The lack of toxicological data can make it difficult to derive a health-based guideline value.
Here we present the human and animal data toxicology data and the identified knowledge gaps where further research is required.