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Introduction: Nurturing a culture of sustainable prevention in OHS through research

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The world of work is forever changing and so are the occupational health and safety (OHS) challenges that workers and employers face on a daily basis, in both the formal and the informal economies. We know the burden of occupational diseases and injuries in South Africa is immense, but we have, as yet, not quantified that burden or calculated the cost to our country and to our people. International best practice, as well as our own extensive experience in OHS, has shown that the vast majority of occupational injuries and diseases are preventable.

The Sustainable Development Goals (SDGs), which replaced the Millennium Development Goals (MDGs) have been published and the United Nations (UN) will convene a summit to adopt these goals as the post-2015 development agenda. Of great importance for the world of work is that decent work is one of the goals, and there are important synergies with other goals such as health, youth employment, gender equity and sustainable economies.

The cumulative scientific knowledge of our common humanity should be utilised to make it possible for all women and men to maximally benefit, including their health and safety at workplaces. Similarly, the creation of new knowledge through research is of paramount importance to inform and support preventive interventions at workplaces. Research that is reliable and has scientific rigour also provides all important information for policy development and policy coherence in OHS for different government departments. In addition, research findings inform teaching and training for all role players in the world of work in both the formal and the informal economies. Research is of paramount importance to determine the burden of occupational diseases and injuries and to help inform a focus on prevention rather than merely applying for compensation once workers are sick or injured.

It is my fervent hope that we can find the common ground at workplaces amongst all the role players and that we can build on the strength of each individual to bring greater unity of purpose to have economically sustainable, healthy and safe workplaces.

We acknowledge and celebrate the NIOH researchers and their supervisors and mentors for the enormous amount of work and dedication that made these research presentations possible. It is our belief that the creation and optimal utilisation of new knowledge through research provide excellent opportunities to make a significant positive impact on OHS in the world of work.

Acknowledgements
We wish to acknowledge the support of Ms Joyce Mogale, CEO of NHLS and NIOH, for her support for inclusive research and we salute the NIOH choir for their beautiful rendition of different songs from Africa.

The implementation and evaluation of a health information system in a health laboratory service

Presenter: Mr David Jones
Section: Safety, Health and Environment
Authors: D Jones, K Wilson, M Morgan, B Kistnasamy, L Darwin, P Adu, A Yassi, J Spiegel

Introduction: OHASIS is software which collects a range of workplace health and safety information including incident reporting and investigation, employee health and hazardous waste tracking. OHASIS was developed by the Global Health Research Program at the University of British Columbia, Vancouver, Canada. In July 2011 OHASIS was installed at the National Health Laboratory Service (NHLS). At that time the NHLS employed in excess of 7100 employees in 349
Occupations and breast cancer in women treated at a tertiary hospital in Johannesburg

Introduction: Breast cancer is one of the commonest forms of malignancy in women in South Africa. Many occupational carcinogens to the breast have been described and other unidentified synthetic chemicals used in workplaces may also be breast carcinogens. Additionally, shift work that disrupts circadian rhythm probably causes breast cancer.

Objectives: The aims of the study were to identify occupations associated with an increased risk of breast cancer in black South African women, and to specifically assess if there is an association between shift work and breast cancer in these women.

Methods: This was an unmatched case-control study using secondary data from the existing Johannesburg Cancer Case Control Study (JCCS) database. All women patients recruited from 1 January 2001 to 31 December 2009 were included in the analysis, resulting in 1 903 cases and 3 990 controls. An expert group estimated the likelihood of occupational shift work for occupational groups present in the JCCS database. ORs were estimated using logistic regression. Those who had never worked were the reference category for occupations and those with a low likelihood of shift work for shift work.

Results: Following adjustments for possible confounders, no statistically significant ORs were found between specific occupations and breast cancer. Manufacturing had the highest OR (1.44, 95% CI: 0.42-4.94), followed by office workers (OR 1.44 95% CI: 0.31-5.94) and health workers (OR 1.31, 95% CI: 0.36-4.76). After adjusting for confounders, the OR for women who possibly did shift work was 2.18 (95% CI: 1.34-3.56) and for those with a high likelihood of shift work the OR was 2.13 (95% CI: 1.26-3.61).

Discussion: No convincing associations between type of occupation and breast cancer were identified. Despite limitations in measuring shift work a strong association between this risk factor and breast cancer was found.

OECD sponsorship programme for the testing of manufactured nanomaterials: the South African contribution

Introduction: The safety of manufactured nanomaterials is an important concern throughout the world in order to ensure that the impact on human health is fully understood.

Objectives: The OECD’s Working Party on Manufactured Nanomaterials (WPMN) launched a Sponsorship Program in 2007 to ensure that tests used to address safety with manufactured nanomaterials are consistent and validated.

Methods: The WPMN selected a priority list of 11 Manufactured Nanomaterials for testing based on materials which are in, or close to commercial use. South Africa successfully proposed the inclusion of gold nanoparticles to be included in their representative list.

Results: 14 nm citrate stabilised gold nanoparticles were thoroughly tested based on the OECD guidelines. The physical-chemical properties of the nanoparticles were thoroughly characterised. Environmental fate and toxicity was assessed, as well as mammalian toxicity through both in vitro and in vivo testing.

Discussion: This testing programme was a first of its kind collaboration between government, industry and academia in the generation of testing dossiers that can be used in the future to address safety concerns of manufactured nanomaterials.
Immunohistochemical screening for epidermal growth factor receptor (EGFR) and anaplastic lymphoma kinase (ALK) mutations in lung adenocarcinoma in South Africa

Presenter: Dr Naseema Vorajee
Section: Pathology
Authors: N Vorajee, J Murray, J Phillips

Introduction: Lung cancer is the most common cause of cancer related deaths. The poor survival of lung cancer patients is attributable to late presentation which may preclude surgery based therapy. There are several types of lung cancer with squamous cell carcinoma (SCC) and adenocarcinomas (AC) of the lung being the most common. There has been a shift in trend from predominantly SCC to AC in smokers. Recent advances in therapy have shown that patients with lung AC and EGFR or ALK mutations may be amenable to treatment with new, chemotherapy agents that target cells with these mutations.

Objectives: To determine the frequency of EGFR and ALK mutations in lung AC using surgical biopsies from the NIOH archives. To identify the demographic characteristics of patients with lung AC and EGFR or ALK mutations. To identify morphological patterns of lung AC with EGFR or ALK mutations.

Methods: All lung biopsies received for diagnosis at the NIOH from 2008 to 2014 were reviewed and all cases of lung AC were included in the study. Using appropriate positive and negative controls, immunohistochemistry was performed on representative sections of lung AC using Roche antibodies for EGFR mutation (SP111 and SP125) and ALK fusion protein (D5F3).

Results: Preliminary analyses of the results suggest that EGFR and ALK mutations are present in the South African population. These will have to be validated with established molecular techniques to confirm the mutations.

Discussion: Immunohistochemistry is an acceptable and relatively easy technique for identifying mutations in lung AC. There are targeted therapy options for patients with lung AC and EGFR or ALK mutations. The NIOH is a national referral centre for lung disease and needs to be able to identify mutations in lung AC to assist physicians to treat their patients.

Lung cancer risk attributable to occupation: in a case control study in black South Africans 2001-2008

Presenter: Mr Cornelius Nattey
Section: Epidemiology
Authors: D Kielkowski, M Urban

Introduction: Lung cancer is the 4th most common malignancy in South Africa. Although smoking is a well established risk factor, the role of occupational exposures in the local setting is not clear.

Objective: To estimate the lung cancer risk associated with common South African occupations.

Methods: Data from the Johannesburg Cancer Case-Control Study (JCCCS) on black cancer patients from 2001-2008 were used. Information from 579 lung cancer cases and 1120 frequency matched controls were analysed. Controls were randomly selected from cancers thought not to be associated with the effects of tobacco matched by sex and age (±5 years). Occupation or workplace was used as an indicator of occupational exposure. Odds ratios (OR) and 95% confidence intervals (CI) were estimated using unconditional logistic regression; ORs were adjusted for smoking, HIV status and domestic fuel use. Attributable fraction (AF) was estimated using Miettinen’s formula.

Results: The mean ages of cases and controls were 56.0 and 57.1 years respectively. Among men the adjusted OR for lung cancer was 3.0 (95% CI 1.1-4.5) in miners. Working in the transport industry was also associated with an increased risk of lung cancer: the OR was 1.7 (95% CI 1.1-3.5). In women, working in the food and beverage industry was associated with increased risk of lung cancer with an adjusted OR of 7.3 (95% CI 1.1-43.3). Domestic work was also associated with an increased risk of lung cancer: the OR was 4.9 (95% CI 1.0-9.3). Occupation resulted in an AF of 13% in men and 46% in women.

Discussion: A number of occupations had elevated ORs for lung cancer. The high ORs in domestic workers is a notable finding. Specific risk factors need to be identified in these occupations. The study was limited to subjects treated in Johannesburg and hence may not be generalisable to the rest of the country.

Linkage of human resource records and tuberculosis registry to assess the risk of occupational TB in resource limited healthcare setting

Presenter: Mr Molebogeng Malotle
Section: HIV TB
Authors: M Zungu, L O’Hara, A Yassi, M Malotle, L Darwin, S Barker

Introduction: Healthcare workers (HCWs) are known to have an increased risk of tuberculosis (TB) due to occupational exposure. Current measures for determining TB incidence in HCWs are less than satisfactory, as there are no databases with information on both confirmed TB diagnosis and employment in the health sector.

Objectives: To assess the feasibility of developing a healthcare
Determination of viable airborne *Mycobacteria tuberculosis* cells

**Presenter:** Ms Olga Kgasha  
**Section:** Immunology & Microbiology  
**Authors:** O Kgasha, T Singh

**Introduction:** Overcrowded and poorly ventilated areas increase the risk of contracting airborne infections. *Mycobacterium tuberculosis* (MTB) can remain airborne for several hours after the procedure has ended or infectious source has left the area. MTB can live up to several months and even years outside the human body therefore assessing viability of such organisms is important to understand its survival and potential risk of exposure.

**Objectives:** Evaluate the use of qPCR-PMA for the detection and determination of viable MTB in environmental samples and to validate qPCR-PMA for application in indoor air assessments.

**Methods:** Five air samples of known concentration (1x10^6 of MTB H37Ra 25177 strain) were collected on five consecutive days in a simulated test room. The samples were analysed using the quantitative PCR combined with propidium monoazide (PMA) and a comparative assay (Baclight assay). Different concentrations of the PMA dye was used at differing light intensities to optimise the qPCR-PMA method. The BacLight assay was used with BH-2 fluorescence microscopy to differentiate between viable and non-viable cells.

**Results:** The light sources used ranged from 70W-650W with the higher intensity (150-650W) affecting the dye penetration through the cells thus increasing the number of dead cells. Comparable results were obtained when using 50μM PMA dye and the low intensity light source (70-105W). PMA dye activation using the 70W light showed similar results to the untreated cells compared to the 105W lamps. A visual inspection of cells using the BacLight assay showed that the proportion of viable versus non-viable cells were similar to the PCR method.

**Discussion:** PMA is useful in determining the viable proportion of air samples by binding to the DNA of dead/damaged cells and influence the detection signal of qPCR. The method provides a quantitative estimate and is hence favoured over the BacLight assay to estimate risk to airborne MTB cells.

Free-living amoebae isolated from a hospital water system in South Africa: A potential source of nosocomial and occupational infection

**Presenter:** Mr Petros Muchesa  
**Section:** Immunology & Microbiology  
**Authors:** P Muchesa, M Leifels, L Jurzik, TG Barnard, C Bartie

**Introduction:** Free-living amoebae (FLA) are unicellular eukaryotes that are ubiquitous in the environment, mainly in natural aquatic environments (rivers, streams, hot springs) as well as in man-made water systems such as domestic tap water, swimming pools and hospital water distribution networks. Although mostly beneficial in their natural habitat, some FLA are transmitters of pathogenic bacteria and are known human pathogens that can cause opportunistic and non-opportunistic central nervous system infections, as well as lung and skin infections. The aim of this study is to find out if patients and healthcare workers may be exposed to potentially pathogenic FLA in hospital water distribution.

**Objectives:** To investigate the occurrence of FLA and potential intracellular bacteria in a public hospital in South Africa.

**Methods:** A total of 97 water and biofilm samples were collected from the municipal water inlet of the hospital, theatres, theatre sterilization service unit, central sterilization service unit, endoscopy/gastroscopy unit, intensive care unit and the renal unit. These were analysed for the presence of FLA using amoebal enrichment technique, PCR and sequencing.

**Results:** Of the 97 samples, 77 (79.4 %), 40 (52%) water and 37 (48.1%) biofilm, contained FLA. The genera *Acanthamoeba, Vermamoeba* (formerly *Hartmanella*) and *Naegleria* were detected by morphology, 18S rRNA PCR and sequence analyses. Further sequence analysis of the *Acanthamoeba* positive isolates revealed a close resemblance with the potentially pathogenic T20 genotype. Transmission electron microscopy of positive FLA samples showed the occurrence of potential intracellular bacteria whose identity were not determined in this study.

**Discussion:** These results show a potential health risk to immuno-compromised patients and healthcare workers as some of the species detected are pathogenic and may harbour potential intracellular bacteria responsible for nosocomial infections. To date, this is the first report on the detection of potentially pathogenic amoebae from South African hospital water systems.
Exposure to volatile organic compounds and formaldehyde in histopathology and cytology laboratories

Presenter: Mr Gabriel Mizan
Section: Occupational Hygiene
Authors: GE Mizan

Introduction: Exposure to volatile organic compounds (VOCs) has been linked to various adverse health effects on the body, including changes in the liver, harmful effects on the kidneys, lungs, heart, and nervous system, as well reproductive health effects. Formaldehyde is a respiratory sensitizer and is classified as a suspected human carcinogen by the International Agency for Research on Cancer (IARC).

Objectives: The purpose of this study was to assess the extent of exposure to these harmful compounds within histopathology and cytology laboratory workers of the NHLS.

Methods: Air sampling for VOCs and formaldehyde was carried out in 11 histopathology and cytology laboratories located at different provinces of South Africa. The measurements were conducted using air sampling pumps and sorbent tubes, following a standard NIOSH chemical sampling methodology. Additional grab samples for formaldehyde were taken using a direct reading formaldehyde meter. The air sampling in each laboratory was complemented by a walk-through and an information gathering process to ascertain the frequency and degree of contact with the abovementioned substances.

Results: None of the air samples that were taken using sorbent tubes exceeded the respective South African Occupational Exposure Limits for the various VOCs or formaldehyde. In addition, none of the instantaneous grab measurements taken using the direct reading formaldehyde meter exceeded the South African OEL, however approximately half of these measurements exceeded the well recognized American Conference for Governmental Industrial Hygienists (ACGIH) Ceiling Limit. Several tasks performed within these laboratories, including tissue cut-up, staining and making-up of formaldehyde, were identified as potential exposure risk.

Discussion: Control strategies to reduce potential exposure to VOCs and formaldehyde in histopathology and cytology laboratory work are discussed, as well as the limitations of chemical surveys in drawing definite conclusions on true worker’s exposure.

A study of respirator fit and face sizes of South African health laboratory respirator users during 2013-2014

Presenter: Ms Jeanneth Manganyi
Section: Occupational Hygiene
Authors: J Manganyi, K Wilson, D Rees

Introduction: In the hierarchy of controls, the use of respirators is listed as the least preferable means of exposure or infection control; however it is often the primary means of protection in many industries including the health laboratory industry. Health laboratory employees include N95 respirator users working with infectious diseases such as tuberculosis (TB).

Objectives:
• To determine the proportion of respirator users achieving an adequate fit while wearing their current supplied respirators
• To describe facial characteristics of respirator users and to group these faces into three face sizes (small, medium and large)
• To explore the relationship between face size and demographic variables
• To explore the influence of face size on respirator fit

Methods: 610 employees participated in this study. Quantitative respirator fit testing was conducted using a Portacount fit testing machine. Four facial dimensions were taken using callipers and a tape measure. STATA 12 was used to perform descriptive and inferential statistics.

Results: Of the 610 employees who participated, a large percentage (78%) of respirator users failed fit testing and were not protected by their currently supplied medium size respirator. The use of poorly fitting respirators could create a false impression of protection in the laboratories where employees are possibly exposed to hazardous biological agents including TB.

Discussion: The study outcome indicates a need for immediate testing of all respirator users and for a range of sizes and styles of respirators to be provided to all employees requiring respirators. A respiratory protection programme including respirator fit testing needs to be compiled and implemented. There is a need to investigate the relevance of panels used in designing respirators worn by South Africans. Lastly, one respirator size does not fit all.

In vitro toxicity assessment of dust emissions from South African gold mine tailings sites

Presenter: Ms Charlene Andraos
Section: Toxicology & Biochemistry
Authors: C Andraos, M Gulumian

Introduction: The city of Johannesburg, South Africa, is recognised for its large contribution to the gold mining industry but is also confronted with the challenge of managing the waste produced. The waste is stored as tailings at different sites and currently there are over 380 such sites in and around the city. Despite efforts to contain the dust emitted, the exposure to surrounding communities is inevitable. Previous published health risk assessments involving hazard identification, exposure
assessments and dose-response assessments have shown that dust from tailings sites could be a risk to communities.

**Objectives:** The aim of this study was to conduct hazard identification of tailings dusts to determine whether communities in and around these sites may be at risk from exposure to these dusts.

**Methods:** The physicochemical analysis of tailings dusts was determined with size distribution analysis, elemental analysis using ICP-MS, quartz analysis using X-ray diffraction and surface reactivity analysis using ESR spectroscopy. Toxicity assessment involved determining the uptake of dusts into cells using the CytoViva Hyperspectral Imaging system and assessing the toxicity using the xCelligence impedance-based system in a bronchial epithelial and monocytes/macrophage cell line.

**Results:** The tailings dusts showed the presence of nanoparticles (<100 nm), known to lodge deep in the respiratory system and to reach internal organs via the bloodstream. High levels of transition metals such as iron, manganese, and nickel known to generate free radicals were identified and the presence of quartz, tridymite and cristobalite was confirmed. In addition, the dusts exhibited high surface reactivities. Time-dependent uptake of the dusts into cells was observed and toxicological analysis showed dose-dependent toxicities in both cell lines studied.

**Discussion:** These results may therefore suggest possible toxicity of these dusts where, upon exposure, may exert adverse health effects on those residing in proximity to these tailings sites.

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**Characterization of respirable crystalline silica dust in the abandoned mines around, Roodepoort, central rand Johannesburg, South Africa**

**Presenter:** Ms Thingahangwi Madzivhandila  
**Section:** Occupational Hygiene  
**Authors:** T Madzivhandila, G Sekobe, B Kgarebe, J Larkin

**Introduction:** There are many abandoned mines in SA, so it is important to determine whether they pose a potential health risk. The mines on the West Rand are gold mines which are associated with silica dust. Breathing crystalline silica dust can cause silicosis and crystalline silica has been classified as a human lung carcinogen (IARC, 2002).

**Objectives:**
- To identify the mineral composition in the dust obtained from abandoned mines
- To characterize the particle size of the dust
- To evaluate the seasonal exposure risks to the community staying near abandoned mines

**Methods:** Six abandoned mines were studied. Each mine had four sampling stations. One at the source, and three others situated at 500, 1000 and 15 000 metres downwind from the source. Sampling was taken in all four seasons. In total, 144 air samples were collected on 25 mm 5.0 µm pore size PVC, silicon-free filters, in a Dorr-Oliver cyclone sampling device at 2.2 l/min for 8 hrs using low volume sampling pumps and 11.5 l/min for 8 hrs using high volume sampling pumps. One soil sample was grabbed at each of the 6 study sites in each season. The particle size distribution of these 24 soils samples was determined by sieving. The Method for the Determination of Hazardous Substances (MDHS101) was used for preparation of calibration standards, sampling and analysis. The samples were analysed using XRD.

**Results:** Air samples from all six study sites had detectable levels of crystalline silica at the source and up to 1500 m further away throughout the year.

**Discussion:** The average inhalable concentration of silica was below the USA EPA exposure limit of 10 mg/m³. The average respirable concentration of silica was below the USA EPA exposure limit of 3 μg/m³.

**Conclusion:** Communities staying within 1500 m of abandoned mines are exposed to detectable levels of silica dust.

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**Environmental asbestos monitoring during asbestos roof removal in two human settlement areas**

**Presenter:** Mr Tebogo Nthoke  
**Section:** Occupational Hygiene  
**Authors:** T Nthoke, T Madzhivhandila, G Mizan, G Sekobe

**Introduction:** The National Institute for Occupational Health (NIOH) carried out asbestos sampling after the removal of asbestos-cement roofs damaged by hail at two townships within Gauteng province. Objectives: The aim of the surveys was to determine the levels of asbestos fibre concentrations in ambient air in relation to recognised standards and to ensure that the refurbished houses were safe for reoccupation.

**Methods:** Measurement of asbestos concentrations in air was carried out using air sampling pumps and mixed cellulose ester filters. A total of 35 air samples were taken at randomly selected houses located in the two townships. The samples were taken after the asbestos-cement roofs were replaced with non-asbestos (corrugated metal) roofs. The sampling pumps were placed in static positions on both the outside and inside of the selected houses. The samples were analysed using Phase Contrast Microscopy and Scanning Electron Microscopy - Energy Dispersive Spectroscopy (SEM-EDS), following the MDHS 39/4 and RTM2 methods, respectively.

In addition, four bulk samples from the asbestos cement roofs (Chrysotile, Amosite and Crocidolite) were identified in bulk samples...
of asbestos cement roofs, all air samples, excluding one, taken after the replacement of the asbestos-cement roofs with corrugated metal roofs, returned results below the Clearance Indicator of 0.01 fibres per millilitre of air (f/ml). One result was equal to the Clearance Indicator.

**Conclusion:** Based on the results from the air sampling it was concluded that the removal of asbestos cement roofs did not result in any significant asbestos concentrations in the air following removal. This was also attributed to the following of safe work procedures during the dismantling of the existing roofs.

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**Systemic contact dermatitis: occupational dermatitis caused by inhalation of metal dusts (2 case reports)**

**Presenter:** Ms Anna Fourie  
**Section:** Immunology & Microbiology  
**Authors:** HA Carman, AM Fourie

**Introduction:** Two workers from metal processing factories developed severe generalised contact dermatitis. Neither worker was actually working with the metals. Linking workplace exposure with the clinical presentation of dermatitis is challenging, particularly when the exposure is not through direct contact.

**Objectives:** Establish if occupationally related systemic contact dermatitis was related to metal exposure in the workplace.

**Methods:** A clinical assessment was conducted of two workers from different companies who presented at the NIOH skin disease clinic. Case 1 worked at a steel cutting factory whose condition improved when away from work. Case 2 worked at a chrome plating factory as an electrician. His dermatitis condition improved when away from work as well. Patch tests and skin prick testing (SPT) was performed on both workers. The level of exposure to the relevant metals occurring in the workplace was obtained from the respective companies.

**Results:** Case 1 worked at a steel cutting factory and developed severe dermatitis in a symmetrical flexural distribution (atopic dermatitis). His hands, face and folds of the neck were not affected. The patch test was positive (1+) to nickel sulphate whilst the SPT was negative. The ambient nickel levels (≤0.008 mg/m³) at the workplace were lower than the South African (SA) recommended maximum exposure level. Case 2 was an electrician exposed to chrome twice daily when briefly walking through the chrome plating section of the factory. He had severe dermatitis on his inner arms and his legs which spread over his body as erythrodermia. Atopic dermatitis was questionable. Both the patch tests and SPT were positive to potassium dichromate. Hexavalent chromium in air samples (<0.01 mg/m³) at work was lower than the SA recommended maximum exposure level.

**Discussion:** The source of exposure to the allergens was the surrounding air in both cases. The inhalation of the metal salts caused systemic contact dermatitis. Contact dermatitis occurred even though the level of nickel and hexavalent chromate in the two respective factories was below the SA recommended safety limits.

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**Occupational exposure to iron oxide nanoparticles in a research laboratory**

**Presenter:** Ms Nthabiseng Muriel Mogane  
**Section:** Occupational Hygiene  
**Authors:** NM Mogane, K Voyi

**Introduction:** The synthesis and use of iron oxide nanoparticles (NPs) is increasing but there is limited information on the extent of exposure and on preventing occupational exposure to these particles in research laboratories in South Africa.

**Objectives:** To assess potential emission points of iron oxide NPs in the air and exposure to these particles during their synthesis in a South African research laboratory.

**Methods:** Particle condensation counters (CPC), scanning mobility particle sizer (SMPS) and an ultrafine particle counter (UPC) were used to measure the particle concentration and size distribution over time, in a research laboratory. Area and personal filter-based samples were also collected for analysis, using an inductively coupled plasma mass spectrometry (ICP-MS) for elemental iron analysis, and scanning electron microscopy (SEM) for size, shape and chemical composition.

**Results:** The concentration of particles in the laboratory increased during synthesis. The particles as measured by CPCs ranged from a minimum of 321 particles/cc for background level to a peak of 114,325 particles/cc during synthesis. The highest particle concentration, 114,325 pt/cm³, measured by the UPC was during the purification process. Task-based measurement showed high short-term exposure. Elemental iron was found in the filter-based samples with the highest concentration (0.09 mg/m³) positioned closest to the emission source. The particles were agglomerates and aggregates of smaller particles as observed on electron microscopy. The use of engineering control during synthesis of iron oxide NPs reduced exposure to these NPs.

**Discussion:** Exposures well above background were demonstrated. Using full shift sampling may result in missing peak particle concentrations during tasks which release high concentrations of NPs. Agglomerates and aggregates of NPs were detected by the UPC. This finding was supported by the agglomerates and aggregates observed on the filters by electron microscopy. Employees at NPs synthesizing laboratory are exposed to NPs in the form of single particles and agglomerates and aggregates.