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Health effects associated with exposure to hazardous biological agents and their constituents in poultry farming

Comparison of South African skin and sensitisation notations with those of other countries

Legislation update: Protecting the children

Official Journal of *The SA Society of Occupational Health Nursing Practitioners, The SA Society of Occupational Medicine, The Southern African Institute for Occupational Hygiene* and the *Mine Medical Professionals' Association.*

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This journal is on the list of Approved South African Journals, and authors qualify for a subsidy for their affiliated tertiary institutions.

From the Editor...

Linda Grainger, Editor

This issue contains papers on a variety of topics. We include the first of an informative series of articles on occupational health and safety related legislation, provided by Lexis Nexis. In it, Fiona Omar, their Managing Editor (Legislation Materials) informs us of a draft amendment for comment. This is followed by a review of the new regulations relating to child labour. Finally, an update on some of the recently published resources in OH&S is provided.

Poultry farming is a significant agricultural sector that plays an important role in South African food production, and substantial numbers of people are involved in such activities. Although research has demonstrated that biological hazards are present in poultry farming environments, there are gaps in our knowledge. Matuka and Singh, in their review article, describe the health effects associated with occupational exposure to hazardous biological agents and their constituents in poultry farming. Through this, they aim to promote awareness about reducing exposure to such hazards.

Skin notations in association with occupational exposure limits were originally used as a qualitative warning sign that a substance could penetrate the skin and result in body toxicity. Over time, the manner in which such notations are applied by countries has varied and there is no universal system or list of chemicals with the potential to contribute to toxicity or lead to sensitisation. Aware of such inconsistencies, du Plessis, Eloff, Laubscher, van Aarde and Franken set out to quantitatively and qualitatively compare South African skin notations and sensitisation notations with those of other selected developed countries in order to ascertain the assignment criteria and use of these notations relative to those of other developed countries. Their findings indicate that South Africa should develop a system of regular reviews and updates of notations, as well as the adoption of commonly agreed criteria. This would facilitate the recognition of different skin and sensitisation hazards, and enhance exposure assessment and control.

On the news front, the MMPA has a new President – Deodat Kritzinger! He should be familiar to our readers as he recently authored two articles for us on trends in occupational injuries and diseases (September/October 2009 and January/ February 2010), in his capacity as Rand Mutual Assurance – General Manager, Medical Services. Congratulations Deodat, we are sure that you will continue to build on the sound legacy of the Past President, Vanessa Govender.

The International Labour Organization (ILO) marked the annual World Day for Safety and Health at Work on 28 April 2010. The Director-General, Juan Somavia, made a statement on emerging risks and new patterns of prevention in a changing world of work.[1] He drew attention to global challenges and the new context of occupational safety and health practice. Technological advances, emerging workplace risks, and changing patterns of employment and workforce necessitate new preventive approaches to deal with such challenges. A booklet is available, which deals with the development of innovative national and regional strategies and programmes, and the roles of stakeholders (http://www.ilo.org/safework/info/publications/lang--en/docName--WCMS_123653/index.htm).

A new list of occupational diseases was approved by the ILO Governing Body on 25 March 2010.[2] The list replaces the 2002 one and covers a variety of internationally recognised occupational diseases. For the first time, mental and behavioural disorders have been specifically included, as well as open items that allow the recognition of the occupational origin of diseases not specified in the list.

The Cochrane Library recently published two occupational health related reviews. The first concerns the benefits for employees' health if they are allowed to have input into their own working patterns,[3] (one of the changing patterns of working referred to above by the ILO). Flexible working arrangements for employees with families are common in Scandinavian countries, whilst in the UK parents with children under 16 now have the right to request such arrangements. Ten studies involving 16,603 people focusing on different forms of flexible working were reviewed. Positive impacts on health outcomes such as blood pressure, sleep and mental health were found when employees were able to self-schedule work hours. However, more should be known about the health effects in different types of workers, for instance, comparing gender, age and skills levels. Some forms of flexible working might only be available to employees with higher status occupations, which could increase existing health differences health between social groups.

The second study assessed the effects of caffeine for preventing injuries caused by impaired alertness in persons with jet lag or shift work disorder.[4] Thirteen trials were examined, but none measured an injury outcome. They concluded that whilst caffeine may be an effective intervention for improving performance in shift workers, there are no trials that allow an evaluation of its effect on injuries. There is no evidence that healthy individuals, already using caffeine within recommended levels to improve their alertness should stop doing so.

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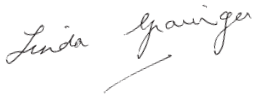

Upcoming events

INTERNATIONAL CONFERENCES

Date	Place	Topic	More information
6–9 August 2010	Yokohama, Japan	ICOHN & ACOHN Joint Conference 2010 Global Challenges to Occupational Health Nursing	http://icohn-acohn2010.com E-mail: secretariat@icohn-acohn2010.com
29 August – 3 Sep 2010	Angers, France	PREMUS 2010, 7th Int. Conf. on Prevention of Work-Related Musculoskeletal Disorders (ICOH SC)	http://www.premus2010.org/
6–8 Sep 2010	Hanasaari, Espoo, Finland	8th Int. Symp. on Biological Monitoring in Occupational and Environmental Health (FIOH, ICOH, NIVA)	The Finnish Institute of Occ Health E-mail : ISBM2010@ttl.fi Website : www.ttl.fi/isbm2010
28 Sep to 2 Oct 2010	Rome, Italy	IOHA 8th International Scientific Conference: Health, Work and Social Responsibility	http://www.ioha2010.org/ E-mail: info@ioha2010.org
6–8 Oct 2010	London, United Kingdom	Dissemination and implementation of evidence-based OH practice (ICOH SC)	http://www.regonline.co.uk/builder/ site/tab1.aspx?EventID=819527
20–22 Oct 2010	Busan, South Korea	1st Int. Conf. on Accident Prevention (ICOH SC)	E-mail: overseas@kosha.net
4–8 Dec 2010	Hobart, Tasmania	28th Annual Conf. of the Australian Institute of Occ. Hygienists Inc. "Green but clean: What is behind our clean green future?"	http://www.aioh.org.au/
18–24 Mar 2012	Monterry, Mexico	30th ICOH Congress– Occupational Health For All: Research, Training and Good Practices	E-mail: admin@icohcongress2012.org

LOCAL CONFERENCES

Date	Topic	Region	Target	Cost	ContactName
29–30 July 2010	Aspects of occupational medicine	Birchwood Hotel, Boksburg	OH&S practitioners	To be announced	Jenny Acutt Tel/Fax:+27 (0)12 803 7418 E-mail: info@sasom.org
7–10 Sep 2010	NOSHCON 2010 – 49th Int. Conf. & Exhib. on Occ Risk Management	Champagne Sports Resort, Central Drakensberg, KZN	OH&S professionals	See website	Chantell Olivier Tel: +27 (0)12 683 0258 Mobile: +27 (0)71 366 1704 E-mail: chantell@nosa.co.za www.noshcon.co.za
19 Sep 2010	The role of the OHNP in risk assessment	Edenvale, Johannesburg	OH&S professionals	To be advised	Rene Jordaan E-mail: rene.jordaan@implats.co.za
3–5 Nov 2010	SASOHN Annual National Conference and AGM – Ωccupational Health Nursing: From Alpha to Ωmega	Club Mykonos, West Coast, Western Cape	OH&S professionals	To be advised	SASOHN National Office Tel: +27 (0)11 892 3174 E-mail: sasohnoffice@mweb.co.za
26 Nov 2010	Academic Day: Occupational medicine. SASOM AGM	KwaZulu-Natal	OH&S practitioners	To be announced	Jenny Acutt Tel/Fax:+27 (0)12 803 7418 E-mail: info@sasom.org

2010 SAIOH COUNCIL AND CERTIFICATION BOARD MEETINGS AND EXAMINATION DATES

2 July 2010	OHPC Meeting/Oral assessments
6 Aug 2010	National Council Meeting/Written assessments
1 Oct 2010	OHPC Meeting/Oral assessments

HEALTH AWARENESS DAYS, WEEKS AND MONTHS

Day	Topic
JUNE	
National Youth Month	
Men's Health Month	
National Blood Donor Month	
1	International Children's Day
4	International Day of Innocent Children – Victims of Aggression
5	World Environment Day
14	World Blood Donor Day
15	World Elder Abuse Awareness Day
16	Youth Day

Day	Topic
JUNE	
21–27	National Epilepsy Week
21	National Epilepsy Day
21–27	National Youth Health Indaba
21–27	SANCA Drug Awareness Week
26	International Day against Drug Abuse and Illicit Drug Trafficking
JULY	
Mental Illness Awareness Month	
11	World Population Day

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Legislation update

A DRAFT amendment to the Construction Regulations, 2003, in terms of s 43 of the Occupational Health and Safety Act, 85 of 1993, has been published for comment. Its origin is the Department of Labour, the details are 391 of 2010, and it was published in the Government Gazette 33176, 11 May 2010, Notice 391, page 3.

Protecting the children

Melanie L. Govender
Editor (Legislative Materials)
Lexis Nexis

In January this year, the Department of Labour published *Regulations on Hazardous Work by Children in South Africa*.[1] These Regulations were compiled in an effort to protect the health and safety of child workers and to place conditions on the type of work that children are allowed and not allowed to perform. It also identifies those types of work that children are not permitted to do, as well as those which can be described as the "worst forms of child labour" as recognised by the International Labour Organisation (ILO).

A child worker defined

In the Regulations, a child worker is defined as any child who works under the direction or supervision of an employer or any other person, and who receives, or is entitled to receive, any remuneration. A child over 15 years old is permitted to work, however this is limited to certain types of employment.

A child who is younger than 15 years and is subject to compulsory schooling in terms of the law, may not be employed and may not assist anyone to carry on a business. However, such a child may work in the performance of advertising, artistic or cultural activities in terms of a permit granted in terms of the *Sectoral Determination 10: Children in the Performance of Advertising, Artistic and Cultural Activities* issued in terms of the Basic Conditions of Employment Act, No. 75 of 1997.

Creating a safe working environment

The *Regulations on Hazardous Work by Children in South Africa* requires employers to prepare and implement a specific risk assessment plan for child workers they employ. The Regulation also provides guidelines on the steps an employer needs to follow to do this. A great degree of emphasis is put on employers making an effort to make the workplace safe for children.

Considering that children are still in a development phase, they cannot perform certain kinds of work in the workplace or the duties and responsibilities of adults. The Regulations set guidelines, not only for doing risk assessments, but also for supervising children at work, preparation of the employment of a child, basic principles on how to train a child, and health and safety topics to be addressed when training children for work.

Employers are required to draw up a plan of safe work procedures. The Regulations set out detailed guidelines on what should be included in this plan. The plan of safe work procedures must follow all South African labour laws relating to child labour and health and safety. The plan should provide for the thorough orientation of children starting a new job. The child must know all the necessary information to perform his/her job well and to keep safe. The child should have no confusion about their safety and what they have to do as part of their work schedule and in the case of an emergency or accident. The employer should also keep a written record on whether each of the safety orientation steps regarding each child worker have been carried out. Adult co-workers can make the job experience more pleasant by being mentors to the child.

Childhood necessities

A child's nutrition, education and health are of the utmost importance. Employers are required to ensure that the child worker's employment does not obstruct access to sufficient nutrition (the child must have adequate sustenance to keep them comfortable and able to continue working) and does not interfere with education should the child be enrolled at school or another educational institution. A child worker's employment should also not obstruct the child from seeking any necessary health care.

If a child is required to work away overnight from his/her parents (or legal guardians), written consent is required from the parent or legal guardian and the employment must not adversely affect the child's schooling. The details of the accommodation must be presented to the parents or legal guardians. The accommodation must be free of charge, clean, comfortable, safe, and have sufficient bedding, lavatory and washing facilities. The accommodation must not be occupied by any adult other than the parent, legal guardian or a childminder designated by the parent of the child. The child worker must be provided with nutritious food at appropriate intervals.

Fiona Omar,
Managing Editor,
(Legislative Materials),
E-mail: fiona.omar@lexisnexis.co.za

"10. Prohibited work.—An employer may not require or permit a child to work in any of the following—

(a) deep sea fishing;
(b) commercial diving or other hazardous work under water;
(c) slaughtering of animals;
(d) meat, poultry, or seafood processing;
(e) the manufacture or packing of tobacco products or any other work in which there is exposure to tobacco dust;
(f) logging;
(g) protecting or safeguarding any person or property or work involving the handling of firearms;
(h) refining petroleum products;
(i) filling cars with petroleum or other chemical fuels at a filling station, or doing work close to such activity;
(j) brewing, manufacturing or selling any liquid which in its final form would contain more than one per cent of alcohol;
(k) work in a bar, shebeen, tavern or pub or other establishment whose primary business is to sell alcoholic beverages to the general public, for consumption on the premises;
(l) the manufacture or application of tar or asphalt;
(m) work involving an exposure, or potential exposure, to blood-borne or air-borne pathogens;
(n) work in a health care or related facility, in circumstances where there is likely exposure to biological agents, including but not limited to Hepatitis, HIV, and tuberculosis, anaesthetics, anti-neoplastic medications or addictive drugs;
(o) work involving exposure to a hazardous substance, to lead, asbestos, silica, coal or other hazardous dusts or to pressurised gases;
(p) the production, transport, handling, storage, use of, or other work involving exposure to explosives or flammable substances;
(q) work in a casino or other gambling establishment;
(r) electrical work involving high voltage cables or other power sources in excess of 250 volts;
(s) welding, brazing or soldering;
(t) rock and stone crushing;
(u) operating vibrating equipment such as rock drills and riveters;
(v) operating tractors, winches, forklift vehicles, front-end loaders, earth moving equipment or similar heavy equipment;
(w) driving any motor vehicle or mobile plant;
(x) work in vehicles transporting passengers or heavy goods;
(y) work in a confined space.

11. Worst forms of child labour.—(1) In addition, no person may require or permit a child to work in any of the following—

(i) underground mining;
(ii) work in connection with the operation of a smelter or furnace, or rolling mills that form and cut metals;
(iii) the production of aluminium, brass, bronze or similar alloys, charcoal or the fuel, coke;
(iv) the manufacture of auramine, isopropanol or magenta;
(v) the gasification of coal;
(vi) diving operations using aqualungs;
(vii) free diving below depths of 10 metres;
(viii) work in which there is a reasonably foreseeable risk of exposure to blood-borne and airborne pathogens;
(ix) work involving exposure to ionising radiation;
(x) work in chemically-based mineral extraction or similar operations;
(xi) any work in an environment in which the actual dry-bulb temperature is below minus 18°C;
(xii) hard manual labour for a period of longer than 15 minutes in any hour in an environment in which the time-weighted average WBGT index, (as defined in the Environmental Regulations for Workplaces, made in terms of the Occupational Health and Safety Act, 1993) determined over a period of one hour, is greater than 36;
(xiii) work in circumstances in which it is reasonably foreseeable that the child will be exposed to physical, psychological or sexual abuse.

(2) Any form of work listed in sub-paragraph (1) above constitutes a worst form of child labour as contemplated in the Worst Forms of Child Labour Convention, 1999, adopted by the International Labour Organisation. These prohibitions may overlap to some extent with the prohibitions listed in paragraph 10, but the activities referred to in this paragraph are considered as exposing children to very serious harm. Penalties for breach should therefore be higher.

(3) No person may—

(a) employ a child in circumstances in which the child is unreasonably confined to the employer's premises;
(b) require or permit a child to engage for that person's benefit in one of following activities when this work is performed by a child as part of an organised business activity conducted by that person—
(i) begging;
(ii) scavenging or collecting waste from garbage or waste dumps; or
(iii) use, recruit, procure or offer a child for the commission of any serious offence (they are listed in schedules 1 and 2 of the Criminal Procedure Act, 1977).

(4) The BCEA regulations define which specific substances agents are considered very harmful to children."

Maximum working hours

Strict working hours have been issued for child workers. A child worker is not allowed to work more than—

- 8 hours per day and 40 hours per week if the child worker is not a scholar;
- 8 hours per day and 20 hours per week during a school term if the child worker is a scholar;
- 8 hours per day and 40 hours per week during school holidays;
- 2 hours on any school day;
- 4 hours on any school day followed by a non-school day, for example a Friday or the last day of a school term.

Night work

Working at night can be very challenging for a child worker, especially if he/she has school the next day. Therefore a child worker may not work at night between the hours of 6pm and 6am. However, if the work is in a restaurant, cinema, theatre or shop (and under adequate adult supervision) or if the work is baby-sitting, a child worker may work between 6pm and 11pm, and only if he/she does not have school the next day.

Other regulations on hazardous work

The Regulations also focus on hazardous work and to what degree children are permitted to perform such jobs, if at all. Here are some examples of prohibitions and conditions set in the Regulations:

There are specific conditions on certain work, such as, the lifting of heavy weights, working in a hot and cold environment or working with machinery. Children are not permitted to do any work where, by law, adult employers are required to wear respiratory protection. No child may work at an elevated position unless he/she has adequate supervision and sufficient fall protection measures are taken. A child, in this instance, is not allowed to work at an elevated position of more than 5m above the floor.

There are two lists of hazardous work that children are not permitted to partake in. One (Item 10 of the Summary) is regarding general hazardous work that children are not permitted to do. The other (Item 11 of the Summary) is the "worst forms of child labour" as per the ILO's *Worst Forms of Child Labour Convention, 1999*. South African law incorporates this Convention. The lists are quoted opposite.

Penalties for non-compliance

Employers who do not comply with the *Regulations on Hazardous Work by Children in South Africa* shall be convicted and either fined or face imprisonment for a period of 12 months. Should an employer breach the *Worst Forms of Child Labour Convention, 1999,* and expose children to very serious harm, the penalty would be much higher.

The Regulation stipulates that employers of child workers must display the recommended summary in the workplace. This summary is provided in the Regulation itself and must be displayed where all employees, including child workers, can read it. This can be where the employer displays the other necessary summaries of the law. Workers need to be aware of their rights in order to comply with the law.

This Regulation exists, among others, to protect the rights of children and to guide employers on how to handle children in the workplace.

This article aims to highlight some of the conditions published in the *Regulations on Hazardous Work by Children in South Africa*. In no way, is the information meant to be used in any legal proceeding. The article serves to provide information on the Regulations. It is recommended that you refer to the actual Regulations for a complete overview and understanding.

Reference

1. South Africa, Department of Labour. Regulation No. 7 in terms of the Basic Conditions of Employment Act, No. 75 of 1997. Government Gazette. 2010; 535(32862): 3-44. Summary accessed on 29 March 2010. Available at: http://www.labour.gov.za/documents/useful-documents/basic-conditions-of-employment/regulations-on-hazardous-work-by-children-in-south-africa-1.

Health effects associated with exposure to hazardous biological agents and their constituents in poultry farming

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Abstract

Introduction: **Poultry workers are at increased risk of respiratory disorders as a result of exposure to organic dust, microorganisms and their microbial cell wall agents. Previous studies have revealed that farm workers experienced respiratory symptoms such as cough, phlegm and wheezing, while some developed asthma and toxic pneumonitis. The aim of this review is to highlight the health effects associated with poultry dust exposure of various poultry job categories. It also aims to promote awareness on measures that could be implemented to minimise the burden of respiratory disease.**

Methodology: **A literature review of scientific papers (1980-2010) related to biological hazards in poultry settings was conducted. The search was done using Google, major occupational health journals and information from credible occupational health and safety institutes.**

Results: **The paper presents a review of the potential health effects associated with occupational exposure to poultry dust and hazardous biological agents in poultry farming. The review also discusses the emerging biological agents found in poultry settings that have been associated with work-related respiratory disorders.**

Conclusion: **Poultry dust exposure appears to have an effect on the respiratory response of workers. An understanding of exposure to multiple biological agents associated with poultry farming is critical in reducing respiratory disorders thus creating a safe environment for employees. Further studies on dose response relationships and OELs are required.**

Keywords: poultry, hazardous biological agents, health effects, dust, exposure, occupational, bacteria, fungi, virus, endotoxin, (1-3) β-D-glucan, MVOCs, allergens

Introduction

The poultry industry continues to dominate the South African livestock sector as chicken remains an affordable protein source compared to other meat products. The South African poultry industry mainly includes chicken farming (e.g. broiler and egg) and processing. This industry is still an important contributor to employment opportunities both in the formal and informal sector with 80% of the industry comprising small, medium and micro enterprises which employ approximately 77 000 people,[1] although not all are involved in farming.

Poultry farmers spend considerable periods of time in their work environments and are therefore at risk of exposure to very high levels of poultry dust.[2-4] Poultry dust is defined as a complex mixture of dust,[2] which includes feed and litter and/or bedding particles, feathers, faeces, mites, microorganisms (e.g. bacteria, fungi and viruses) and their biological constituents (e.g. endotoxin, (1-3) β-D-glucan, mycotoxins) and skin scales.[3,5] The solid portion of dust acts as a carrier for biological contaminants and toxic gases (e.g. ammonia and carbon dioxide), which then get inhaled into the lungs. These contaminants vary in poultry operations and may be influenced by bird age and densities, ventilation rates, microclimatic parameters (e.g. humidity and temperature),[4] types of litter and feed, type and size of poultry housing[6] and job tasks.[5]

Although the poultry industry is technically a well controlled environment (e.g. animal health and hygiene practices), studies from different countries have demonstrated a high prevalence of both upper and lower respiratory symptoms and decreased lung function in poultry workers.[2,7] The type of production (cage versus floor) also appears to influence the health outcome, with cage-operation workers demonstrating a higher prevalence of respiratory symptoms.[4,6] Only one study focusing on occupational exposure in the South African poultry sector has been reported thus far.[8] This study investigated work-related respiratory symptoms in

poultry workers and found a very high prevalence of exposure-related symptoms associated with organic dust exposure. However, specific causative agents were not identified which is important as this would assist in management of affected workers. A further limitation of this study was the lack of objective exposure assessments and the inability to demonstrate an association between allergic sensitisation and respiratory symptoms.

The main purpose of this paper is to describe the health effects associated with occupational exposure to hazardous biological agents (HBAs) and their constituents in poultry farming. In addition, it also aims to promote awareness about reducing exposure to poultry workers. The various methodologies used to detect and/or quantify these agents are explored. The limitations where relevant are described.

Methodology

Studies on occupational hazards associated with HBAs and their constituents in the poultry industry (1980-2010) were searched through Google. The keywords used included poultry, chicken, hazardous biological agents, health effects, dust, exposure, occupational, bioaerosols, bacteria, fungi, virus, endotoxin, (1-3) β-D-glucan, microbial volatile organic compounds (MVOCs), mites, 21st century, avian flu and allergens. Major peer-reviewed occupational health journals and reports from credible international occupational health and safety institutions (e.g. Health and Safety Executive-UK and National Institute for Occupational Safety and Health-USA) were also used for the search.

Only selected publications were used after evaluation, as this review focussed on the influence of biological agents and their constituents on the health of poultry

"... in poultry farming, bacteria, endotoxin, and fungi contaminants are the highest compared to other animal farming."

Table 1. General job categories of poultry workers and description of work performed and possible sources of exposure capable of causing irritation, respiratory sensitisation or disease.[5,9]

Job category*	Description of duties	Source of exposure
Laying litter/bedding	Spreading litter/bedding in poultry houses	Nature of material. Certain products carry fungal spores, inhalable dust.
Catchers	Repopulating and depopulating chicks/ chickens	Proteins from feather debris or dander, mites (dust mites, storage mites), faecal residues, dust particles, airborne bacteria, endotoxin.
Litter/manure removal	Removing soiled litter	Inhalable dust organic compounds released during degradation of litter and feed.
Cleaning	Routine cleaning	Exposure to feathers, mites, feed particles.
Routine housework/flock management	Adding fresh litter/bedding and feed. Routine checks (inspections, weighing, vaccinations).	Microbial degradation of material. Faeces, micro-organisms and their constituents, weevils.
Forklift drivers	Load boxes/cages of chicken into trucks for transportation to slaughterhouses.	Inhalable poultry dust.

* Job categories may vary, depending on the type of farming and country.

workers. The search was therefore narrowed as some publications mainly focussed on the health of the chickens or birds and food safety while others discussed the non-biological pollutants (e.g. ammonia and carbon dioxide). However, microbial volatile organic compounds (MVOCs) were included in the search since they are mostly produced by fungi and may be suitable markers of fungal growth.

Results

1. *Source of exposure*

Poultry industries vary between countries, although some processes are similar to several or all sectors. Virtually every stage of work across the industry could result in exposure to biological agents of both permanent and contracted workers (Table 1).

2. *Biological agents associated with exposure in poultry farms*

Biosecurity is an integral part of the poultry industry. Workers and visitors to farming operations often have to shower and put on other clothes before they are allowed to come in contact with the chickens. The entire operation is fenced in, access control is applied, and all traffic (humans and vehicles) is monitored to ensure the health of the animals and workers.[10]

Nonetheless, in poultry farming, bacteria, endotoxin, and fungi contaminants are the highest compared to other animal farming.[11] Other biological contaminants such as mites[12,13] and (1-3) β-D-glucan,[14,15] have been detected in poultry settings, albeit a paucity of information is available. The zoonotic diseases and infections naturally transmitted between vertebrate and human are also common.

Some of these contaminants form part of the natural flora of the animals and the litter or bedding material used while others are due to feed contamination and management processes such as storage facilities and procedures. On the other hand others appear as emerging risks (e.g. (1-3) β-D-glucans, MVOCs and mites) as new scientific knowledge on the topic comes to light, particularly with respect to mixed exposures and synergistic effects.[9]

2.1. Bacteria: The most common bacteria found in poultry facilities which are known to cause respiratory effects and/or infections in workers include *Pseudomonas sp, E.coli sp, Staphylococcus sp, Bacillus sp, Micrococcus sp, Proteus sp* and *Clostridia sp*.[2] The determination of bacteria is usually done by culture methods in air samples collected by impaction on agar plates or in surface dust samples and reported as CFU/m^3 air or CFU/m^2 surface, respectively. Recent studies used quantitative ploymerase chain reaction (PCR) for airborne bacterial quantification in poultry houses,[5] however the validity of this method as a tool for quantitative exposure assessment for bioaerosols needs to be evaluated.[5]

2.2. Fungi: Fungi in poultry facilities that are capable of causing respiratory disorders include: *Aspergillus sp, Penicillium sp,*[2] *Cladosporium sp, Histoplasma capsulatum and less commonly Alternaria sp, Fusarium sp, Geotrichum sp* and *Streptomyces sp*.[12,16] As part of their normal metabolism, fungi can produce a variety of volatile organic compounds (VOCs) (see section 3.3) and are emitted during the composting of poultry litter. Airborne fungal concentration can be measured by impaction onto mould agar, cultured and expressed as CFU/m^3. Alternative methods include microscopy using staining techniques[12] and spore counting by estimating the microbial cell wall agents (MCWAs) (e.g. (1-3) β-D-glucan). The application of PCR and probe hybridisation techniques in detection of airborne fungal spores in environmental samples is still in its infancy stage.[17-19]

2.3. Viruses: The well known viral disease and the highly pathogenic avian influenza (HPAI) H5N1 viruses which occur in poultry (e.g. chickens) have infected humans in many countries. The H5N1 viral infection of humans associated with direct poultry contact are rare however the mortality rate is high.[20] As for viruses, exposure assessments have hardly been developed for occupational environments. Human exposure to H5N1 virus is often on collection of specimen samples for epidemiological data management of the disease. There is therefore a need for environmental sampling protocols that can provide researchers with well documented, representative samples of exposure.[21]

2.4. Mites: Occupational health risks of exposure to mites are not well defined in the poultry industry.[11,12] The dust mites *Dermatophagoides evansi, D. farinae, D. pteronyssinus, Euroglyphus longior, Thyreophagus entomophagus* and *Lepidoglyphus destructor* were identified in dust samples from poultry farms, with the latter being the most abundant mite.[22] A recent study found hazardous levels of *D. pteronyysinus* (Der p1) in poultry houses.[12] Apart from the poultry dust, the Northern Fowl Mite (*Ornithonyssus sylviarum*) inhabiting chicken feathers may be a predominant allergen causing occupational allergy in poultry workers.[13] This is not commonly tested in South Africa which may lead to underestimation of the levels of the agent. The mites' concentration in

"Poultry workers have an increased incidence of respiratory symptoms and a decline in lung function related to exposure to organic dust."

the dust is analysed by microscopy and reported as mite units/m^3.[23] Dust can also be sampled onto filters by air filtration with a pump.[12] A range of quantitative antibody-based immunoassays, particularly enzyme-linked immunosorbent assays (ELISA)[24,25] for allergens from dust mite such as *D. pteronyssinus, D. farinae* and *Blomia tropicalis* has been manufactured recently (Indoor Biotechnologies Inc, 2009) and needs to be further researched for routine application.[26]

3. Constituents of biological agents

The biological agents of microbial origin may include the organism itself (e.g. bacteria, fungi and viruses), toxins (e.g. endotoxin produced by Gram-negative bacteria and mycotoxins produced by fungi), cell wall constituents such as (1-3) β-D-glucans produced by fungi, or enzymes produced by genetic modification of microorganisms.[27]

3.1. Endotoxin: Endotoxins (also referred to as lipopolysaccharides) are components of the external membrane of most Gram-negative bacteria.[28] Endotoxins are responsible for many of the virulent effects of Gram-negative bacteria.[28,29] Although poultry dust consists of a mixture of contaminants, endotoxin is thought to be the major component of the dust.[4,30] The type, duration, and level of exposure to endotoxins varies greatly between poultry farming and production exceeding the suggested threshold value of 100 EU/m^3 for airways inflammation.[12,15,31] This evidence is a cause for the concern of the well-being of workers, therefore methods to reduce exposure are needed. Workplace monitoring of endotoxins is usually performed by sampling airborne inhalable dust onto filter membranes with a subsequent aqueous extraction. Endotoxin is then analysed using the chromogenic-endpoint limulus amoebocyte lysate (LAL) assay which measures the biological activity of endotoxin and reported as endotoxin units per 1m^3 (EU/ m^3).[2] Endotoxin can also be measured by gas chromatography-mass

Table 2. Biological agent exposure and health effects of poultry workers

Country	Sample size	Exposure	Respiratory health effects	Prevalence / OR (95% CI)
Croatia[12]	41	Total dust (0.4 - 1.1 mg/m^3) Mites (<0.1 - 3.3 mg/g) Fungi (4.9x10^3 - 6.8x10^4 CFU/m^3) Endotoxin (230 – 284 EU/m^3)	Eye symptoms Nose symptoms Asthma symptoms	34% 39% 39%
Canada[2]	111	Total dust (8.6 mg/m^3) Endotoxin (8514 EU/m^3)	Chronic phlegm Chronic wheeze Chronic cough	19% 16% 13%
Brazil[38]	473	Poultry dust	Asthma symptoms Chronic respiratory symptoms	1.1 (0.6 - 1.9) 1.6 (1.1 - 2.5)
Sweden[15]	42	Endotoxin (410 ng/m^3) (1-3) ß-D-glucan (270 ng/m^3)	Decreased lung function	n/r
Switzerland[11]	37	Poultry dust	Wheezing Chronic bronchitis Phlegm Asthma-related symptoms Nasal allergy Nasal irritation	2.7 (0.7 - 10.6) 0.9 (0.3 - 3.1) 1.1 (0.4 - 3.2) 2.9 (0.9 - 9.6) 3.0 (1.0 - 37.7) 5.3 (1.6 - 18.0)
Switzerland[7]	36	Total dust (7 mg/m^3), Bacteria (4.7x109 n/m^3) Fungi (2.0x10^7 n/m^3) Endotoxin (258 ng/m^3)	Decreased lung function	n/r
Iowa[28]	257	Total dust (2.4 mg/m^3) Respirable dust (0.16 mg/m^3), Endotoxin (614 EU/m^3)	Greater cross-shift (before and after work) decline in FEV1	n/r
New Zealand[43]	1706	Poultry dust	Asthma	17.4%
South Africa[8]	134	Poultry dust	Work-related cough Work-related wheeze	32% 23%
Israel[13]	16	Poultry-related antigens	Rhinitis Asthma	94% 88%

FEV_1 – forced expiratory volume in 1 second, EU – Endotoxin units, OR (95% CI) – odds ratio (95% confidence interval), n/r – not reported

spectrometry (GC-MS).[32] Owing to different measurement protocols, large inter-laboratory variations in the results exist. Therefore, the need for standardisation of methods is supported by many researchers.[2,15] Due to the inherent variability, it is recommended that endotoxin air levels be monitored more frequently than normally applied for workplace control measurements.[32]

3.2. (1-3) β-D-glucan: (1-3) β-D-glucan is a non-allergenic water insoluble cell wall component of most fungi, some bacteria and plants[14,33,34] and can be found in organic dust. (1-3) β-D-glucan has been used as a surrogate measure for fungi exposure in airborne studies[34] and has previously been measured in poultry farms ranging from 2 – 972 ng/m^3.[14,15] Airborne dust sampling using filter loaded sampling heads with pumps are generally used for measurement.[14,33] However, in some studies reservoir dust is collected and concentrations are expressed as weight units per gram or per m^2 with the latter reflecting the actual exposure.[33] The methods used to quantify (1-3) β-D-glucan in environmental and occupational exposure assessment studies include the monoclonal ELISA methods, Fungitec G test and the LAL-based Glucatell assay.[14] Although the ELISA methods are considerably cheaper than the LAL-based assay, they are significantly less sensitive, thus the two methods are not correlated. ELISA methods are also not available commercially.[33] The challenge is to standardise the protocols since different extraction procedures and quantification methods are used.

3.3. Microbial volatile organic compounds (MVOCs): All animal facilities produce volatile organic compounds when microbes metabolise various organic substances found in these settings. Poultry litter can also produce excessive MVOCs from fungi species as a result of microbial biodegradation of the organic matter and feedstock.[35,36] Several studies demonstrated that the emitted MVOCs' pattern of fungi cultures is dependent on the fungal species and the substrate.[35,37] MVOCs commonly emitted from poultry litter include alcohols, acids, sulphides and high levels of terpenes and ketones.[36] The latter two concentrations exceeded the threshold limit values (TLVs) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) for several VOCs.[36] Passive charcoal sorbent tubes are placed in ambient air for 8-24 h and the extracts are analysed for MVOCs using GC-MS according to that described by Matysik and colleagues.[35]

4. Health risks associated with exposure to hazardous biological agents in poultry farms

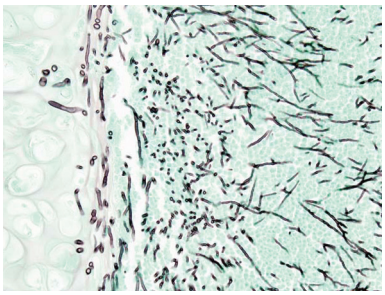
Poultry workers have an increased incidence of respiratory symptoms and a decline in lung function related to exposure to organic dust (Table 2).[7,15,33,38] The severity of occupational health problems in the poultry farms might be more influenced by the composition of the dust rather than the levels of airborne particles alone.[39] Microorganisms represent less than 1% of airborne particles however, and are often linked with the negative health effects associated with the

"Dose-response relationships have not been established for most biological agents."

poultry industry.[4] The extent to which they become hazardous to human health depends on the occupational context, the circumstances surrounding exposure (e.g. specific agent, dose and duration of exposure, concurrent exposures) and worker susceptibility (genetic predisposition, age and immunosuppression).[40,41] Short-term exposure to biological agents may lead to acute respiratory effects and can occur minutes after entering the poultry house[13] while longer-term exposure may be linked with impaired lung function.[13] In addition, it has been recently recognised that low grade exposure to certain poultry antigens can stimulate the immune system, resulting in hypersensitivity reactions.[42] The most common work-related symptoms that have been reported in poultry workers include acute cough, excess phlegm, eye irritation, chest tightness, shortness of breath, fatigue, nasal congestion, sneezing, wheezing, headache, nasal discharge, throat irritation, fever[28] and muscle aches.[39] Clinical disorders observed in poultry workers include occupational asthma or asthma-like syndrome, allergic and non-allergic rhinitis, hypersensitivity pneumonitis (Farmer's lung), toxic pneumonitis and chronic bronchitis.[4,7,39]

5. Dose-response relationship

Dose-response relationships have not been established for most biological agents.[40,44] Moreover, the precise role of biological agents in the development or aggravation of symptoms and diseases is only poorly understood. In most situations, combined exposure to complex mixtures of toxins and allergens, as well as interactions with non-biological agents, occur in the workplace and a wide range of potential health effects have to be considered. However, it is difficult to determine which of the constituents primarily accounts for presumed health effects.[40] Several studies have revealed a



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complex, dose-dependent, non-linear relationship between environmental exposure to some biological agents such as endotoxins, fungal spores and other pathogen-associated molecular patterns (PAMPs) and the outcome of immune responses.[45]

6. Occupational exposure limits (OELs) for biological agents in poultry settings

It is within the scope of the Regulations for Hazardous Biological Agents of South Africa under the OHS Act, 1993 to determine and assess the risks that are posed by biological agents in the workplace.[46] However, the large uncertainties in quantitative exposure assessments and the lack of established dose-effect relationships hamper the development of legal OELs and evaluating the perceived risk.[40,47,48] Some health based recommended occupational exposure limits (HBROEL) have been proposed for certain biological agents to assist with decision-making and interpretation of measurement results.[47,48] In the Netherlands, The Dutch Expert Committee on Occupational Standards recommends a HBROEL for airborne endotoxin of 50 EU/m^3, however the level is currently under review.[49,50]

The diversity of biological agents potentially present in poultry settings, and their various health effects on individuals, makes it difficult to establish safe or unsafe levels. Furthermore, seasonal variability adds to the complexity of setting specific standards.[51]

The HBA Regulation does not include filamentous fungi and microbial metabolites possibly due to lack of supporting evidence that these agents can cause diseases at the time of its elaboration. Therefore more research focusing on the association between biological exposure and clinical symptoms should be a priority.

7. Exposure control and medical surveillance of workers to poultry dust

Guidelines are available for risk assessments of biological hazards, however, the assessment of biological risk is seriously hampered as neither standardised sampling and analytical methods nor

legislated OELs are available.[40,44,49,52] In addition, the assessment is further complicated by concurrent exposure to biological agents as mentioned above, which should be assessed individually.[53]

Emphasis is also placed on enforcing good work practices as far as reasonably practicable (e.g. engineering controls, respirator use and personnel behaviour)[9] which should result in reduction of risk of exposure as per legislative requirements. These would include[9]:

- the introduction of manual work practices;
- maximise ventilation without compromising the welfare of birds;
- provide workers with suitable filtering respiratory protective equipment with appropriate fit;
- avoid disturbing the chickens and litter to minimise the generation of dust;
- reduce individual worker exposure through job rotation;
- introduce "low dust" methods such as washing or vacuuming as opposed to portable blowers and compressed airlines; and
- enforce procedures of good work practices (e.g. workers' training and risks associated with their duties).

It is also essential that employers carry out health surveillance. This should include pre-employment screening, questionnaire after employment to enquire about any developing symptoms and a confidential health record for each worker. Lung function testing may also be useful for assessing the respiratory health of workers.[9,45]

8. *Contemporary and emerging issues*

This review highlights a need for research to develop better tools for the detection and measurement of biological agents which will enable proper exposure assessments. Current culture techniques are laborious and time consuming and many organisms are non-culturable. Therefore, non-culture methods (e.g. light scattering spectrometry, scanning electron microscopy, GC-MS and PCR) appear more reliable, however, experience with these methods is still generally limited.[40] Moreover using other techniques such as PCR yield measurement errors, as the viability of microorganisms is undeterminable without additional laboratory analysis.[52,54-56] For these reasons, the complete range of airborne microorganisms may not be recognised and the true concentration of biological substances may be miscalculated.[52] Research should therefore include the validation and standardisation of available methods to reduce inter-laboratory and exposure variability. Until then, total inhalable dust measurements (>10 mg/m^3) may provide some evidence of association to health effects.[57]

Key to preventing and controlling microbial infections in poultry settings would be to ensure that biological contaminants fall within legal limits. However, the lack of stipulated OELs is a major hindrance to 'compliance'. In South Africa, another hurdle is the definition of HBAs as stipulated in the HBA Regulation. Most major biological agent categories synonymous with the poultry industry such as fungi, arthropods (mites) and vegetable/plant proteins (grain) do not appear in

"The assessment of biological risks is further complicated by concurrent exposure to biological agents . . ."

the Regulation's classification system for biological agents. This limitation points to the need for the development of specific regulations dealing adequately and effectively with the omitted biological agents.[27]

The relationship between exposure to biological agents and health effects is complex, dose-dependent, and in many instances follow a non-linear relationship. Still controversial is the seemingly paradoxical nature of endotoxin as well as the synergistic or multiplicative effect between co-exposures. Further research may serve to improve our understanding of how such biological agents interact with the immune systems and the health implications thereof.

Conclusion

The risk of developing work-related respiratory symptoms and lung function impairment increases with increasing exposure to poultry dust. An understanding of the key factors that contribute to the emergence and spread of bioactive agents and disease intelligence is needed, despite the lack of well defined OELs to these agents. Important areas that require further research include dose-response relationships with regard to mixed exposures in poultry settings.

Lessons learned

- **Poultry workers are at risk of respiratory disorders as a result of exposure to organic dust.**
- **Poultry dust consists of multiple biological agents that include microorganisms and their constituents.**
- **Factors such as ventilation rates, job tasks, type and size of poultry housing, and bird age and densities may influence the levels of biological contaminants in poultry farms.**
- **Research on poultry dust exposure and health outcomes is lacking in South Africa.**

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PEER REVIEWED

Comparison of South African skin and sensitisation notations with those of other countries

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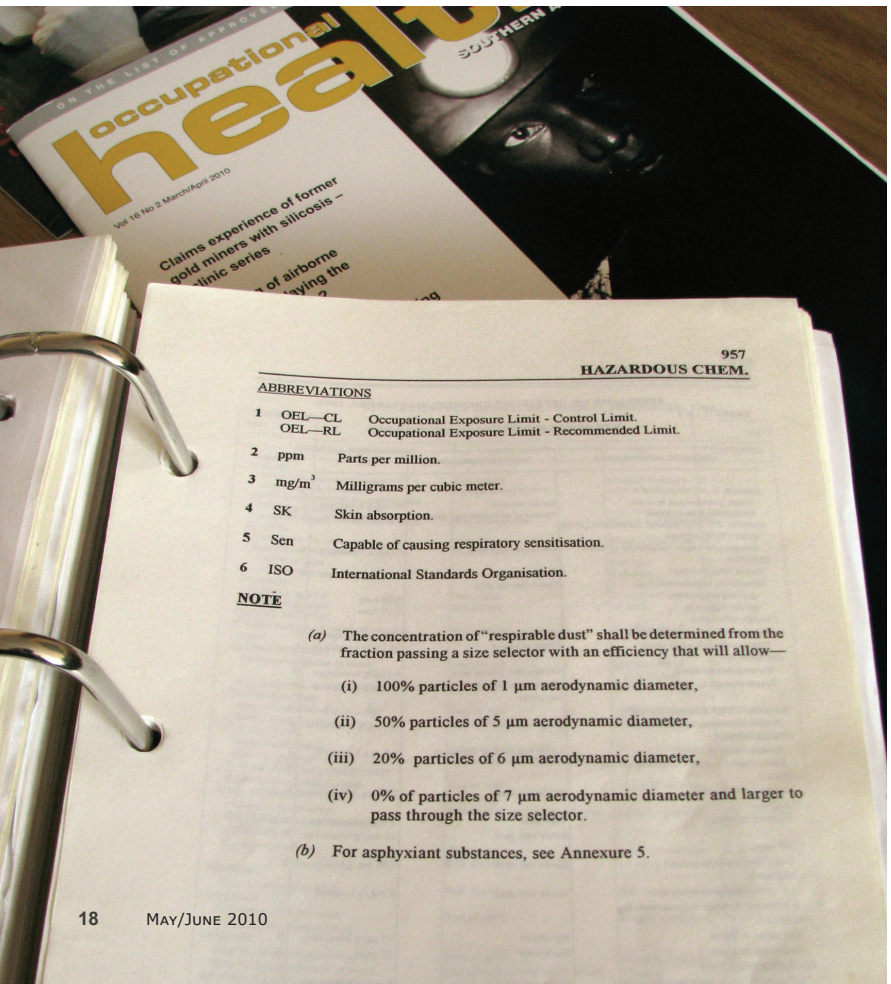
Abstract

South African skin notations listed in the Regulations for Hazardous Chemical Substances (RHCS) and Mine Health and Safety Regulations (MHSR) were compared to those of selected other developed countries in order to ascertain the assignment criteria and use of these notations relative to those of other countries. Skin notations in the RHCS and MHSR had a mean agreement of between 42.9% and 45.8% with other countries, while agreement for sensitisation notations was only 3.6% between countries. As with many other countries there is a lack of frequent review and updates of these notations. Thus, there is an urgent need to develop and implement a strategy which will ensure frequent revision of assignment of notations accompanied by accessible supporting documentation. Adoption of the USA's National Institute for Occupational Safety and Health skin notation criteria is recommended, whereby substances may be assigned with multiple descriptive skin notations. The development of similar sensitisation notation criteria whereby the route of exposure is indicated is also recommended.

Key words: skin notation, sensitisation notation, comparison, countries

Introduction

In South Africa, occupational exposure limits (OELs) and skin and sensitisation notations for the general industry (non-mining) are published in the Regulations for Hazardous Chemical Substances (1995)[1] under the Occupational Health and Safety Act (Act 85 of 1993), while for the mining industry they are published in the Mine Health and Safety Regulations[2] of the Mine Health and Safety Act (Act 29 of 1996). Hereafter, reference will only be made to the abbreviations, RHCS and MHSR for simplicity. Whilst conducting research on dermal exposure to metals, differences in the assignment of skin and sensitisation notations between the RHCS, the MHSR and other countries became apparent. It raised the question of whether this is also true for other substances and if so, to what extent?



The history of skin notations associated with OELs can be traced back to 1958, when the approach was first introduced by Germany. In 1961, the American Conference of Governmental Industrial Hygienists (ACGIH) adopted the same approach.[3] The only original intention of a skin notation was for it to be used as a qualitative warning sign, indicating that a specific substance may penetrate the human skin with the potential of contributing significantly to total systemic toxicity.[3,4]

At present skin notations are associated with almost every country's list of OELs, but assignment thereof by countries is inconsistent.[3,5] Clearly defined, universal (world-wide) criteria for assignment of skin notations do not exist and in some instances, incorrect assignment of notations to substances causing skin irritation, corrosion and sensitisation has also occurred.[3] However, insufficient information on skin absorption rates of substances has also contributed to the inconsistent assignment.[3,6] Numerous scientific papers, scientific committees and commissions have proposed strategies for improved, "harmonised" assignment and use of skin notations.[3,7-12] Universal criteria for assignment of skin notations would ensure consistent assignment and use thereof globally as qualitative warning signs. In particular, improvement in the

assignment and use of skin notations has been recommended by the National Institute for Occupational Safety and Health (NIOSH) skin notation criteria.[13]

In general, a sensitisation notation refers to the potential of a substance to produce sensitisation.[14] Sensitisation occurs through immunologic mechanisms. Initially, upon exposure to a sensitiser, little or no response is observed. However, after sensitisation has occurred, subsequent exposure to the sensitiser, even at minute concentrations (even far below the OEL), may elicit a response also known as a hypersensitivity reaction. These hypersensitivity reactions may have an immediate (e.g. asthma, rhinitis) or delayed onset (e.g. skin rash). Unlike skin notations, there is no published literature comparing sensitisation notations of different countries.

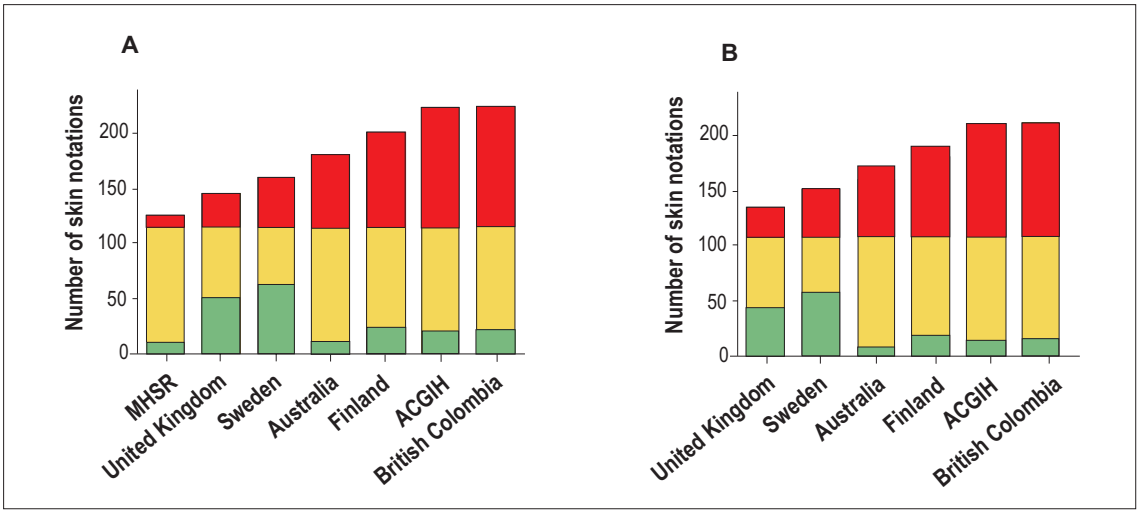
The aims of this study were to quantitatively and qualitatively compare South African skin notations and sensitisation notations with those of other selected developed countries in order to ascertain the assignment criteria and use of these notations relative to those of other developed countries.

Methodology

The most recent published lists of OELs with skin and sensitisation notations from South Africa,[1,2] the United Kingdom,[15] Sweden,[16] Australia,[17] Finland,[18] British Colombia (Canada)[19] and the ACGIH (United States of America)[14] were used. With the exception of Australia, the other countries or institution were selected as representatives of developed countries in North-America and Europe, all with reputable occupational hygiene standards. Comparisons were made between the use of skin notations and sensitisation notations in these countries, based on the names of substances published in the lists. CAS numbers were used to identify chemicals listed under different (synonymous) names. Isomeric compounds were either grouped by some countries or individually listed by others. Where possible, data were adjusted by grouping isomeric substances, thereby giving the combined group of isomers a skin notation or sensitisation notation. Consequently, there may be differences in the numbers stated here for each country from those published in the national lists. These differences are considered to be small and of minor importance when major differences between countries are discussed.[1] In this study the percentage agreement between two countries/institutions was calculated based on the number of substances sharing a notation in relation to the sum of the substances with a shared notation and those only listed by the two countries as depicted by the following formula:

$$\% \text{ Agreement} = \frac{\text{number of substances listed with a shared notation in RHCS and other country}}{\text{number of substances listed only in RHCS + shared + listed only by other country}} \times \frac{100}{1}$$

Thus, the absence from the list of OELs in one country (i.e. no OEL or skin notation) but presence of an OEL with a skin notation in that of the other country is considered a disagreement. The same is true if both countries list an OEL for a substance, but only one assigns a skin notation. Irrespective of whether a country/institution has evaluated a substance or not, the absence of a substance in one country's list of OELs is considered as not recognising any hazard



Key

Green bars – the number of substances with a skin notation listed only in South Africa (RHCS in A and MHSR in B).

Red bars – the number of substances with a skin notation listed only in the other country (or MHSR in A).

Orange bars – the number of substances with a skin notation in both countries, i.e. "overlap"/agreement.

Figure 1. The number of substances with a skin notation in South Africa compared with other countries. (A) RHCS compared to MHSR and other countries. (B) MHSR compared to other countries

or risk associated with inhalation and/or skin exposure as identified by other countries/institutions.

Results

Skin notations

A total number of 115 and 112 substances with skin notations are listed in the RHCS and MHSR respectively. Both lists share 103 substances, with 12 being listed only by the RHCS and nine being only listed by the MHSR (Figure 1A, first bar). The agreement or "overlap" between these two lists is 83.1%. However, when the lists of RHCS (Figure 1A) and MHSR (Figure 1B) are compared to those of other countries, there is far less agreement and it varies between 32.7% and 57.2% for the RHCS (mean of 42.9%) and between 33.3% and 58.2% for the MHSR (mean of 45.8%). In both cases, the smallest agreement is with Sweden and the highest agreement with Australia.

The differences in skin notations between countries are further highlighted when the number of substances with skin notations common to the countries is examined (Figure 2). The total number of substances listed by the RHCS and the six other countries is 292, whilst the total listed by the MHSR and the six other countries is 289. For the comparison of the RHCS with other countries, 50 substances with a skin notation are listed by only one of the seven countries, while 51 substances are listed for the MHSR comparison with other countries. Remarkably, in both comparisons, only 27 substances (9.3%) of all the

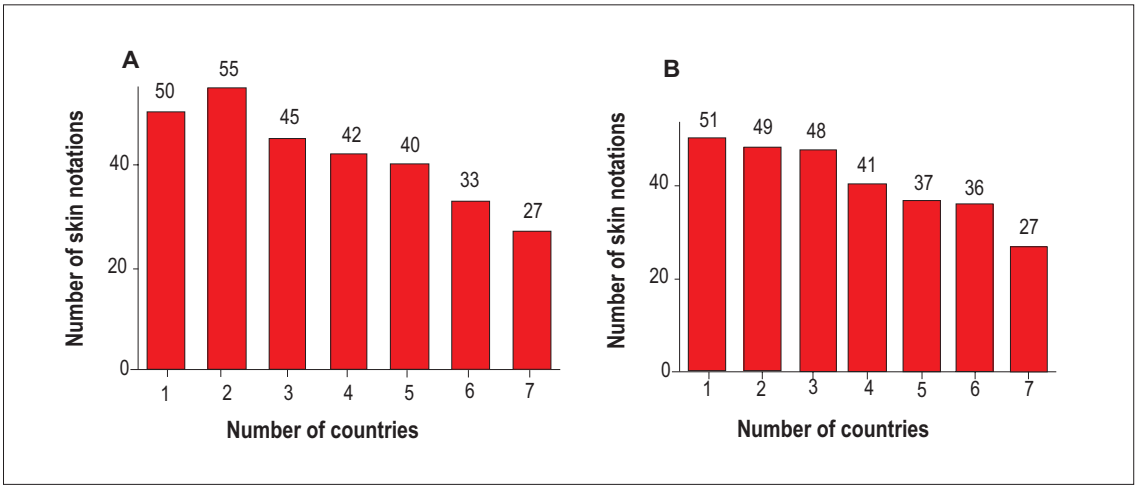
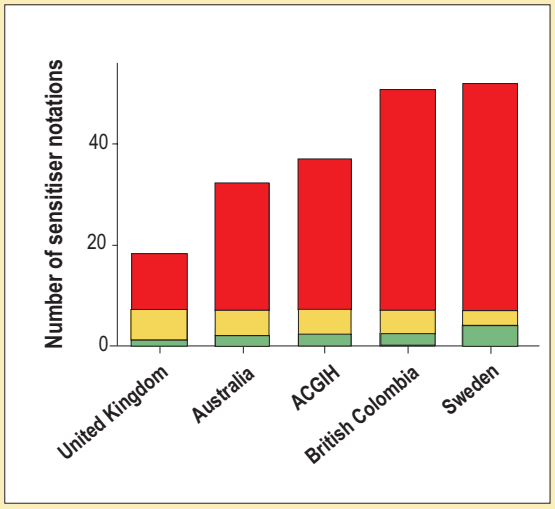


Figure 2. Comparison of the number of substances listed with a skin notation with the number of countries in which they are listed. (A) RHCS and the six other countries (n = 292). (B) MHSR and the six other countries (n = 289)



Key

Green bars – the number of substances with a sensitisation notation listed only in the RHCS and MHSR

Red bars – the number of substances with a sensitisation notation listed only in the other country

Orange bars – the number of substances with a sensitisation notation in both countries, i.e. "overlap"/agreement.

Figure 3. The number of substances with a sensitisation notation in South Africa as compared with other countries

substances with a skin notation appear in all seven of the countries' lists.

Skin notations were also compared with respect to definitions and criteria used to assign them. In the MHSR, a skin notation is only explained by the phrase "danger of cutaneous absorption".[2] The RHCS contains the wording "skin absorption" with further explanation thereof in paragraph 40. This paragraph (adopted from the United Kingdom) states that substances with a skin notation have the ability to penetrate the intact skin upon localised contamination (i.e. splashes on the skin or clothing or in certain cases to high airborne vapour concentrations) and, therefore, become absorbed into the body.[1] However, in the United Kingdom specific reference is also made to skin absorption leading to systemic toxicity. The criteria used for assignment of a skin notation in the United Kingdom are based on available data/experience/predictions which suggest a substantial contribution of the skin exposure route to body burden (compared to the airborne exposure at the OEL) and causing systemic effects. This implies that assessment of airborne exposure concentrations alone may be insufficient in describing exposure and the health effects.[15] In Sweden reference is only made to substances which can easily be absorbed percutaneously.[16] The Finnish notation refers to absorption through the skin causing health effects.[18] Skin notations in Australia, British Colombia (Canada) and the ACGIH refer to substances that contribute significantly to the overall exposure by the cutaneous (skin) route.[14,17,19] British Colombia and the ACGIH explain exposure as being through direct skin contact (solids, liquids) or vapour and includes contact with the mucous membranes of the eyes.[14,19] Additional explanations of direct effects of certain substances (e.g. dermal irritants) on the skin and mucous membranes as well as substances functioning as vehicles or enhancers of penetration (i.e. solvents) are included by Sweden, Australia and the ACGIH.[14,16,17]

Sensitisation notations

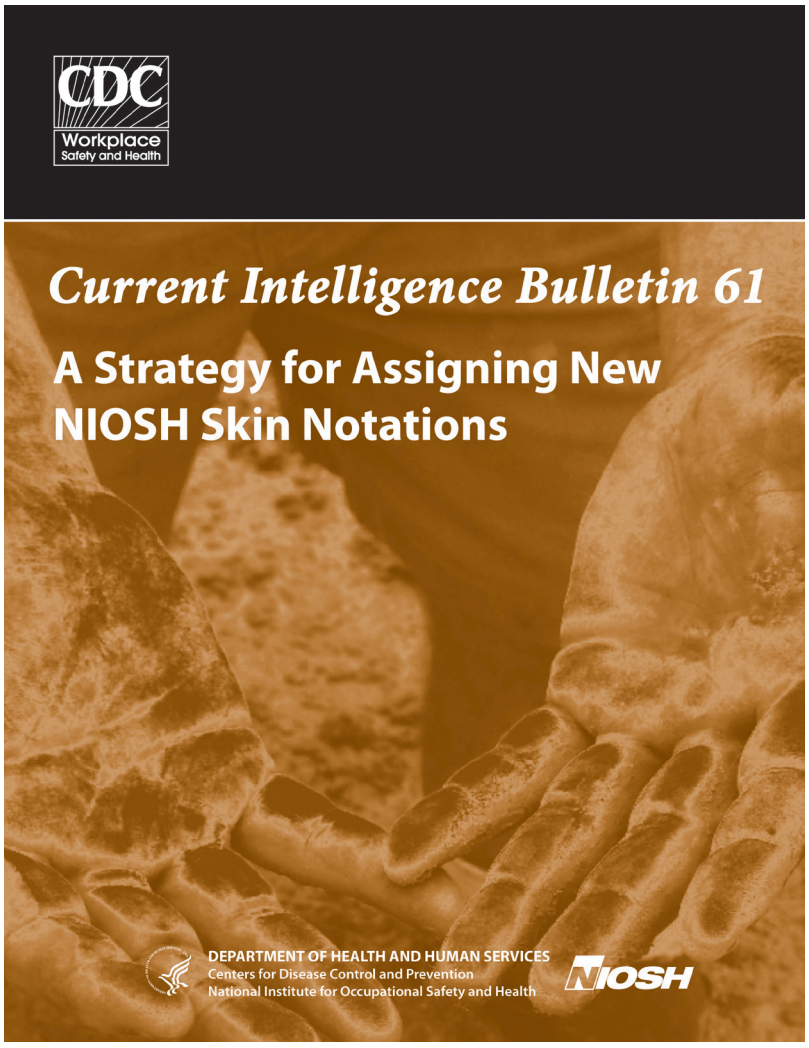
The only difference between the RHCS and MHSR sensitisation lists is that the RHCS lists isocyanates as a group (as –NCO) as well as six individual isocyanate compounds, each with their own sensitisation notation, whereas MHSR have only one notation for isocyanates (as –NCO). Only the RHCS, Sweden and British Colombia listed individual isocyanate compounds with sensitisation notations and it was, therefore, decided to consider isocyanates as a group in this study. It also means that in this study there is no difference between the sensitisation lists of the RHCS and MHSR, with both listing seven substances. A formal sensitisation notation is not listed by Finland, only standard risk phrases relating to the special risks attributed to dangerous substances and preparations. It was, therefore, not included in this data set.

The overlap between the South African lists (RHCS and MHSR) and those of other countries ranges between three and six substances (mean 4.8) with one to four substances only being listed in the South African Regulations (Figure 3). Eleven, 44 and 45 substances listed by the

United Kingdom, British Colombia and Sweden, respectively, do not appear in the RHCS or MHSR.

Figure 4 illustrates that of the 84 substances with a sensitisation notation, 32 (38.1%) are listed by only one country. Surprisingly, only three substances are listed by all six countries, representing 3.6% of all substances listed with a sensitisation notation. These three substances are phthalic anhydride, trimellitic anhydride and the group of isocyanates (-NCO).

According to definitions, the notation of sensitisers by countries can be divided into those only listing respiratory sensitisers causing occupational asthma (i.e. RHCS, United Kingdom) and those listing the substances merely as sensitisers (MHSR, Australia, Sweden, British Colombia and ACGIH). The assigned sensitisation notation in the United Kingdom is accompanied by risk phrases warning against sensitisation through inhalation (R42) and sensitisation through inhalation and skin contact (R42/43). Five substances without a notation, but with a R43 risk phrase (sensitisation through skin contact) are also listed by the United Kingdom.[15] Sensitisation notation by the ACGIH refers to the potential for a substance to produce sensitisation, as confirmed by human or animal data. The notation does not distinguish between the routes of exposure nor to the reactions.[14] British Colombia documentation states that it covers all ACGIH-identified sensitisers, yet when analysed there are significant differences (British Colombia list a total of 49 and ACGIH 35, with 2 only listed by ACGIH and 16 only by British Colombia). In Sweden and Australia, the skin and respiratory organs are named as positions of hypersensitivity reactions.[16,17] Furthermore, apart from providing a list of substances with sensitising properties, Sweden also provides a separate list, containing names of highly sensitising substances, for which permission from authorities must be obtained before being handled.[16]



Discussion

Skin notations

Nielsen and Grandjean compared skin notations of five European countries with that of the ACGIH. They found that agreement ranged between 24.8% (Slovenia) and 61.6% (Denmark) with a mean of 40.4%.[1] Agreement of the RHCS with other countries was slightly higher (42.9%), while that of the MHSR was 45.8%. The low agreement of South African RHCS and MHSR lists with those of Australia, Finland, ACGIH and British Colombia (Canada) is attributed to the number of substances only appearing in the lists of the other countries, ranging between 65 to 109 for RHCS and 65 to 106 for MHSR. One of the main reasons given by Nielsen and Grandjean for the lack of agreement relates to differences in the written criteria used for assigning skin notations.[3] From our results it is clear that there are sometimes subtle differences in the interpretation and intention of the criteria used to assign skin notations between countries. According to definitions and explanatory documentation of countries showing large disagreements with South African notations, it is not that skin notations are incorrectly assigned to for instance skin irritants and corrosive substances. However, the ACGIH assigns skin notations to substances with an acute dermal lethal dose (LD_{50}) < 1000 mg/kg. Furthermore, British Colombia and the ACGIH clearly include contact with mucous membranes of the eyes as skin contact. The lack of proper data on skin permeability/penetration for many substances has also been implicated as a reason for lack of agreement.[3,6] In addition, reasons for assignment or non-assignment are not always accompanied by specific reference to documentation and arguments.[3] This lack of transparency makes it impossible to trace why substances were or were not given a notation but also to establish when last assignments were made. Yearly additions and retractions are only evident for the ACGIH. Unfortunately, neither the

RHCS nor the MHSR provide supporting documents explaining assignment or non-assignment for individual substances. Not only in South Africa, but also in other countries, there is thus an urgent need to develop and implement a strategy which will ensure frequent revision of assignment of skin notations accompanied by accessible supporting documentation.

NIOSH published a new strategy for assigning skin notations in 2009.[13] Based on scientific evidence the existing 142 substances currently listed by NIOSH and other substances will be assigned with multiple (or combined) skin notations distinguishing between effects caused by exposure (Table 1). Substances for which insufficient data associated with skin exposure exist will also be identified. A notation (SK) for a substance not posing a skin health risk (based on current knowledge) will also be assigned.

The skin is also often exposed to mixtures of substances and assessing it will prove as complex as dealing with airborne exposures to mixtures of gases or vapours.[3,11] The NIOSH skin notation criteria do not incorporate a notation for substances known to enhance the skin permeation of other substances. However, such a notation may easily be incorporated in future.

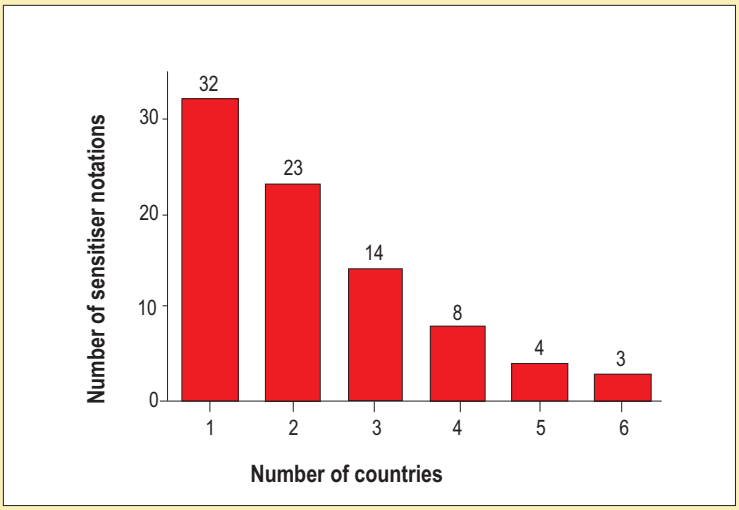


Figure 4. Comparison of the number of substances with a sensitisation notation (n = 84) with the number of countries in which they are listed

". . . only three substances are listed with a sensitisation notation by all six countries."

Sensitisation notations

As already noted, there is no published literature comparing sensitisation notations of different countries. The lack of disagreement for sensitisation notations between countries is quite astounding. This is further accentuated when sensitisers listed by other countries in this study (excluding RHCS and MHSR) are compared. The list of sensitisers listed by all five countries only increased to five substances (6% of all substances listed), adding gluteraldehyde and maleic acid to the existing three substances. If the United Kingdom is also excluded, the list increased to ten substances (12.3% of all substances) for the four countries (adding formaldehyde, methyl acrylate, n-butyl glycidyl ether, phenyl glycidyl ether and turpenes). The lack of human evidence is even more pronounced in skin sensitisation and allergic contact dermatitis[11] which may explain the necessity to rely heavily on predictions and animal data, which in turn lead to varied often subjective interpretation and assignment of notations. The lack of accompanying documentation and, therefore, transparency may also contribute toward this situation.

Alarmingly, the RHCS only acknowledges sensitisation through inhalation. Although not implied by the

Table 1. Skin notations assignment according to NIOSH.[13]

Abbreviation	Explanation
ID$^{(SK)}$	After evaluation, insufficient data exist to assess the skin exposure hazard accurately.
ND	Not evaluated by this strategy and the health hazard associated with skin exposure is unknown.
SK	Skin notation.
SK	Indicating that reviewed data did not identify a health risk associated with skin exposure.
SK:DIR	Potential for direct effects to the skin following contact with a substance.
SK:DIR (COR)	Potential for a substance to be corrosive following skin exposure.
SK:DIR (IRR)	Potential for a substance to be a skin irritant following skin exposure.
SK:SEN	Potential for immune-mediated reactions following exposure.
SK:SYS	Potential for systemic toxicity following skin exposure.
SK:SYS (FATAL)	Highly or extremely toxic substance and may be potentially lethal or life threatening following skin exposure.

definition, the same is also true for the MHSR because of the identical lists of sensitisers.

Conclusions and recommendations

Skin notations in the RHCS and MHSR only had a mean agreement of between 42.9% and 45.8% with those of other countries, while only 3.6% agreement existed for sensitisation notations. It is also clear that there are sometimes subtle differences in the interpretation and intention of the criteria used to assign skin notations between countries. As with many other countries there is a lack of frequent review and updates of these notations, therefore, there is an urgent need to develop and implement a strategy which will ensure frequent revision of assignment of skin notations accompanied by accessible supporting documentation. Adoption of the NIOSH skin criteria for use in South Africa is recommended. It is recommended that all sensitisers, irrespective of the route of exposure, should be acknowledged and incorporated in the RHCS and MHSR and other legislation. The development of multiple sensitisation notation criteria whereby the route of exposure, i.e. respiratory (SEN:RES) and skin (SEN:SK) or a combination thereof (SEN:RES/SK) for inclusion in the RHCS and MHSR is also recommended. This will enable occupational hygienists to distinguish more efficiently between different skin and sensitisation hazards, thereby enabling them to assess and control exposure more appropriately.

Lessons learned

1. **Clearly defined, universal criteria for assignment of skin notations do not exist.**
2. **The absence of a skin notation for a substance does not necessarily imply the absence of a skin hazard.**
3. **Sensitiser notations in the RHCS and MHSR only refer to respiratory sensitisers and not to skin sensitisers.**
4. **The assignment and use of a skin or sensitiser notation in one set of regulations or country is not necessarily the same as for another set of regulations or country.**

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Recently published OH&S resources

A number of very useful resources have recently been published on key occupational health and safety websites. Some of these are described in this article to make our readers aware of them so that they can access and use them.

Linda Grainger, Editor

World Health Organization

Global Plan of Action on Workers' Health

The World Health Assembly endorsed the WHO Global Plan of Action on Workers' Health (GPA) (2008-2017) in 2007. This is a follow up of the 1996 WHO Global Strategy on Occupational Health for All.

The main objectives of the GPA are to:

1. Strengthen the governance and leadership function of national health systems to respond to the specific health needs of working populations
2. Establish basic levels of health protection at all workplaces to decrease inequalities in workers health between and within countries and strengthen the promotion of health at work.
3. Ensure access of all workers to preventive health services and link occupational health to primary health care.
4. Improve the knowledge base for action on protecting and promoting the health of workers and establish linkages between health and work.
5. Stimulate incorporation of actions on workers health into other policies, such as sustainable development, poverty reduction, trade liberalization, environmental protection and employment.

A global workplan was developed by the WHO in collaboration with the WHO Network of Collaborating Centres based on the objectives of the GPA for 2009-2012. This workplan organizes the activities of the Collaborating Centres into 14 priority areas. Links to the detailed plan, the priorities and the work being done by the Collaborating Centres is available at: http://www.who.int/occupational_health/en/.

GOHNET

The latest issue of GOHNET (No 15, Spring 2009) deals with occupational health of health workers. Susan Wilburn (Occupational Health team, Interventions for Healthy Environments, WHO) starts by reminding us that the GPA calls upon member states to develop national occupational health programmes to protect health workers. In support of this, the WHO, together with occupational health of health worker experts in the WHO global network of collaborating centres in occupational health developed a Global Framework for National Occupational Health Programmes for Health Workers to assist member countries to implement their agreements under the GPA. This framework is also consistent with the International Labour Organization Conventions on Occupational Safety and Health (No. C-155), Promotional Framework for Occupational Safety and Health Convention, 2006 (No. C-187) and the Nursing Personnel Convention, 1977 (No. C-149).

The development of the programme will be the responsibility of the Ministry of Health, which must work with other relevant ministries and organizations in the private as well as public sector. They will need to:

"1. Identify a responsible person with authority for occupational health at both the national and workplace levels.
2. Develop a written policy on safety, health and working conditions for health workforce protection at the national and workplace levels.
3. Establish and provide access to Occupational Health Services and allocate sufficient resources/budget to the programme, occupational health professional services, and the procurement of the necessary personal protection equipment and supplies.
4. Create joint labour-management health and safety committees, with appropriate worker and management representation.
5. Provide ongoing (or periodic) education and training that is appropriate to all parties, including occupational health practitioners, senior executives, front-line managers, health and safety committees, front-line workers, and the general public.
6. Identify hazards and hazardous working conditions to prevent and control hazards and manage risks by applying the occupational hygiene hierarchy of controls, which prioritizes elimination or control at the source.
7. Provide immunization against hepatitis B and other vaccine preventable diseases at no cost to the employee and ensure all three doses of the hepatitis B immunization have been received by all workers at risk of blood exposure (including cleaners and waste handlers).
8. Promote exposure and incident reporting, eliminating barriers to reporting and providing a blame-free environment.
9. Promote health worker access to diagnosis, treatment, care and support for HIV, TB and hepatitis B and C.
10. Utilize appropriate information systems, to assist in the collection, tracking, analyzing, reporting and acting upon

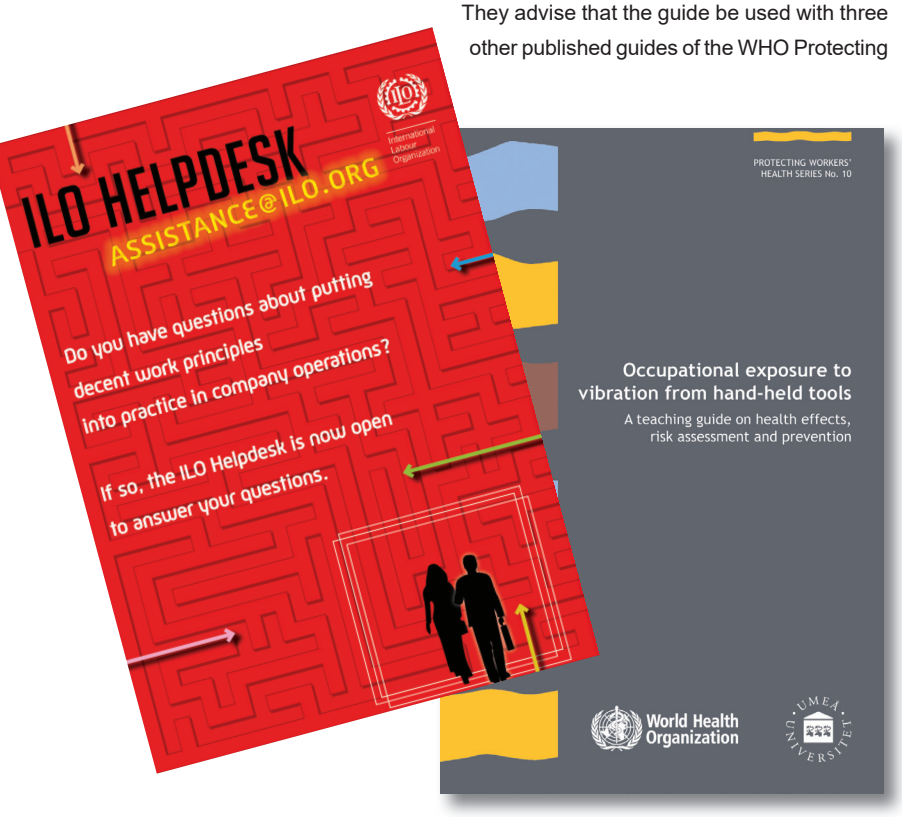
data to promote health and safety of the healthcare workplace and health workforce.

11. Ensure that health workers are provided with entitlement for compensation for work-related disability in accordance with national laws.
12. Promote research on OHS issues of concern to health workers, particularly with respect to combined exposures and applied intervention effectiveness research."

The rest of the issue deals with radiation safety in health care settings, the role of health worker trade unions and professional representatives in negotiating to acquire safer needled devices, policy guidelines on improving health care workers' access to prevention, treatments and care services for HIV and TB (TREAT Policy), core components of infection prevention and control programmes, and health worker safety – ten years of progress through the Safe Injection Global Network (SIGN): from evidence to action. It is available to download at http://www.who.int/occupational_health/publications/newsletter/gohnet_newsletter_17/en/index.html.

Protecting Workers' Health Series No. 10 – Occupational exposure to vibration from hand held tools. A teaching guide on health effects, risk assessment and prevention

Published in 2009, the authors, Burström, Neely, Lundström and Nilsson, have produced an excellent document that aims to promote the translation of policy and knowledge into practice. It provides guidance on key issues including risk assessment, social dialogue and employee participation, key indicators, best practice interventions and corporate social responsibility in the factsheets listed on the website. They advise that the guide be used with three other published guides of the WHO Protecting Workers' Health Series: No. 3: Work Organization and Stress No. 4: Raising Awareness of Psychological Harassment at Work No. 6: Raising Awareness of Stress at Work in Developing Countries: A Modern Hazard in a Traditional Working Environment (links available on the website).



The primary target is employer and worker representatives, but it will also be useful to occupational health professionals and experts and to policy makers. The materials should be especially useful to OH&S practitioners involved in workplace training. To assist with this, Powerpoint teaching materials on topics such as the effects of vibration on body systems, measurement and risk assessments, health and risk factor surveillance, preventive measures and compensation have been provided. The training is designed to address the following objectives:

- To raise awareness of health risks associated with occupational exposure to hand-arm vibration;
- To provide fundamental information on hazards and management practices for health and risk assessment;
- To provide a foundation for the formulation of policies, the development or improvement of legislation, and production of technical and medical guidelines;
- To promote the application of health and risk factor surveillance;
- To encourage the development of good working environments, management practices, and technologies;
- To enable participants to develop their own vibration management plans and training programmes.

The document is available at: http://www.who.int/occupational_health/pwh_guidance_no.10.pdf.

Additional materials on PRIMA-EF are available at: www.prima-ef.org

International Labour Organization

ILO Helpdesk for business on international labour standards

The concept of decent work is widely promoted in OH&S circles, but what does it mean? In the words of Juan Somavia, ILO Director-General, "The primary goal of the ILO today is to promote opportunities for women and men to obtain decent and productive work, in conditions of freedom, equity, security and human dignity." The aspirations of people in their working lives for opportunity and income, rights, voice and recognition, family stability and personal development, and fairness and gender equality sum up decent work. These dimensions of decent work are of great importance as they underpin peace in communities and society. Consequently, the concerns of governments, workers and employers, who together provide the ILO with its unique tripartite identity, are reflected in decent work.

Four strategic objectives capture decent work: fundamental principles and rights at work and international labour standards, employment and income opportunities, social protection and social security, and social dialogue

and tripartism. These objectives are relevant for all workers, including workers of different genders, in formal and informal economies, in paid or self-employment, and in all work settings. Decent work is fundamental to reducing poverty, and is a means for achieving equitable, inclusive and sustainable development. "The ILO works to develop Decent Work-oriented approaches to economic and social policy in partnership with the principal institutions and actors of the multilateral system and the global economy."

(Available at http://www.ilo.org/global/About_the_ILO/Mainpillars/WhatisDecentWork/lang--en/index.htm)

To assist business with meeting the objectives of decent work, the ILO offers a Helpdesk. This free and confidential guidance service can assist managers, workers, or a member of a workers' or an employers' organisation to align their company's day-to-day operations with international labour standards and socially responsible labour practices. It is the entry point for companies to access the whole range of ILO expertise on workers' rights, sustainable enterprise development, conditions of work, social protection, industrial relations, etc. Making use of ILO standards and declarations, conclusions, guidelines, tools and other instruments, the Helpdesk provides prompt responses to queries. Visit their site at: http://www.ilo.org/global/Themes/Decentwork/lang--en/WCMS_120642/index.htm and download their pamphlet at: http://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/publication/wcms_106376.pdf.

ILO Databases

The ILO website provides links to many useful databases (http://www.ilo.org/public/english/support/lib/resource/ilodatabases.htm).

These include the following:

- *CISDOC – Occupational Safety and Health database*
  Contains nearly 50,000 citations of OH&S documents, law and regulations, chemical safety data sheets, training material, journal articles, books and ILO conventions. (http://www.ilo.org/dyn/cisdoc/index_html?p_lang=e)
- *ILOLEX – database of International Labour Standards and recommendations (including ratification information)*
  This is a full-text database of ILO conventions and recommendations, ratification information, comments from the Committee of Experts and the Committee on Freedom of Association, Conference Committee discussions, representations, complaints, General Surveys, and many other related documents. (http://www.ilo.org/ilolex/english/index.htm)
- *LABORDOC*
  Labordoc contains references and full text access to global literature on the world of work. Topics include all aspects of work and sustainable livelihoods and the work-related aspects of economic and social development, human rights and technological change. It consists of books, articles, reports, and journals available at the ILO Library in Geneva and several ILO libraries around the world. (http://labordoc.ilo.org/)
- *NATLEX – database of national labour, social security and related human rights legislation*
  Records in this database contain abstracts of legislation and relevant citation information, indexed by keywords and subject classifications. The full text of the law or a relevant electronic source is linked to the record where possible. (http://www.ilo.org/dyn/natlex/natlex_browse.home?p_lang=en)

Encyclopaedia of Occupational Health and Safety
Fourth edition

The encyclopaedia covers topics including occupational diseases, prevention, health promotional activities; legal, ethical and social policy; hazards, accidents and safety management; chemicals in industry, and toxicological properties. However, it was published in 1998 and a 5th edition should soon become available. (http://www.ilo.org/safework_bookshelf/english?d&nd=170000102&nh=0)

Call for papers

The September/October 2010 issue will be devoted to occupational dermatology. We plan to include original research, review, case study, and back to basics articles in this issue. Of particular interest are recent advances in occupational dermatology clinical practice, dermal exposure risk assessment and control, the burden of occupationally-related dermatology conditions, and compensation for skin diseases related to occupational exposure. We therefore invite you to submit papers for consideration for publication in this issue. The authors' guidelines are available on the website, www.occhealth.co.za. All papers are peer-reviewed before publication.

Should you be interested in submitting a paper, please indicate your interest by e-mailing the Editor at grainger@telkomsa.net. Please provide some basic details about what you envisage would be included in the paper. I would appreciate receiving this information as soon as possible. The actual final submission date for papers is 1 August 2010.

Chemicals and detoxification

Dr Murray Coombs – SASOM Chairman Scientific Committee on Biological Monitoring, E-mail: mcoombs@iafrica.com
Volker Schillack – Ampath Esoteric Sciences, E-mail: schillackv@ampath.co.za

Introduction

There is an area of knowledge/interest that lies within medicine, pharmacology, microbiology, biochemistry, and organic chemistry called "xenobiochemistry" (Greek xenos: strange). The human body is continually exposed to a wide range of substances which are not natural constituents of the body, but do eventually land up in the human circulatory system where they have to be metabolised/detoxified. This happens through a process of microsomal oxidations which primarily involve the liver. The ability to understand some of the major hepatic detoxification reactions has become a valuable clinical tool in determining whether the employee/patient is able to metabolise/detoxify such strange/hazardous substances. The relationship between natural substances (nutrients) and xeno/strange substance or pollutants and the body's ability to modify such nutrients and pollutants into non-toxic substances that the body can use or discard has fascinated scientists for centuries. This change of "bad into good" also exists within alchemy, a branch of pseudoscience and mysticism:

"Transmutation" is the key word characterizing alchemy, and it may be understood in several ways: in the changes that are called chemical, in physiological changes such as passing from sickness to health, in a hoped-for transformation from old age to youth, or even in passing from an earthly to a supernatural existence" (Britannica 2007).

The liver – our main organ of detoxification

The liver functions in the body as the alchemist's "Philosopher's stone", magically some would say transforming substances to detoxify or balance levels.

Also, we know from numerous literature that the multiple impacts of chemicals and toxins on nutrient status can create a deficiency state. Thus, a patient's response to drugs and environmental toxins depends on their nutrient status, in particular those necessary for the operation of central energy pathways. Dieting and other lifestyle habits also have a direct influence on detoxification pathways, for instance low protein intake causes increased mortality of laboratory animals from exposure to pesticides, chlorinated hydrocarbons and organophosphates. Diabetic patients experience an increase in toxicity to CCl_4 (carbon tetra chloride) through the reduction of detoxification pathway enzymes, lowered levels of glutathione and increased ascorbic acid utilization. Nevertheless, clinical effect will vary depending on the level of CCl_4 and the presence of diabetes and the body's status of glutathione and vitamin C.

We know the principal site of metabolism is the liver, but the kidneys, lungs, skin, GI tract and other tissues play an important role in the metabolism of hazardous and nutritional compounds. Very often the drug or pollutant, when undergoing the first phase (pre-systemic or first-pass effect), is changed to an inactive or more active, and in some cases to a metabolite that may be more toxic than the parent compound.

Examples of detoxification for sulphur compounds are shown in Figure 1.

Additional detoxification takes place through our immune system. When a foreign organism enters the body, the immune system produces antibodies to interact with and destroy it.

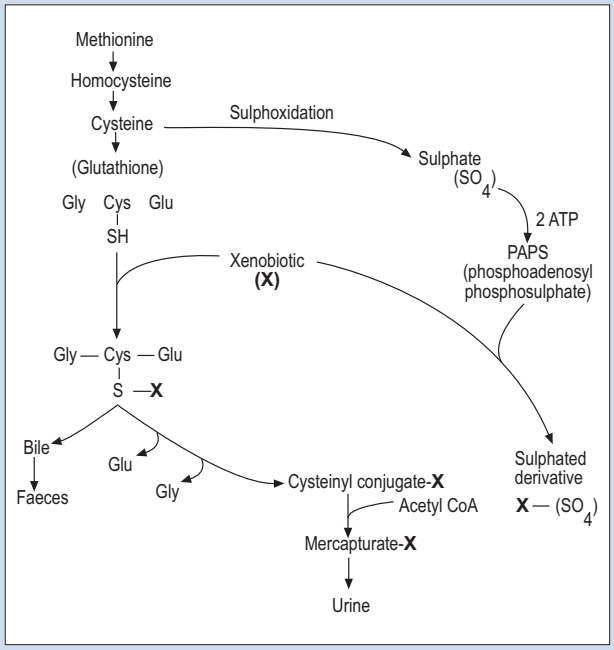


Figure 1.The sulphur compounds in detoxification

However, small molecules do not stimulate antibody production. So how has the human body evolved to protect itself against these low molecular weight environmental pollutants? The principal mechanism to protect the human relies on non-specific enzymes that transform the pollutant or drug (often non-polar) into a more polar substance which can then be excreted by the normal bodily processes (see Figure 2). Thus, knowing the status of the glutathione pathway alone is a powerful tool in predicting the metabolic reaction involved in producing substances that may be more harmful to the patient. Figure 1 demonstrates the different variations and interaction sites a substance undergoes through sulphation.

Figure 2 illustrates the metabolic pathway of toluene. Observe the by-product o-cresol formed for first phase hydrolysis, generally more toxic than the parent compound toluene.

How good is the liver in protecting us?

Hepatic detoxification capacity

The liver consists of six different types of cells organised into microscopic array called lobules and has an enormous capacity to detoxify as each cell is capable of performing hundreds of different biochemical reactions. However it is evident that with any history of hepatic inflammatory disorder the overall organ reserve is lowered and the hepatic function may become globally depressed. Hepatic inflammatory disorders may be the result of chronic alcohol abuse, infection caused by viruses, bacteria, or parasites (hepatitis, tuberculosis and amoebic liver disease, respectively), drugs (prescription and abused), as well as chemicals and toxins. Figure 3 illustrates enzyme reactions involved in acute hepatitis.

Detoxification process

Throughout the process of detoxification the lobules generally respond to toxins through oxidation (Phase I) and conjugation

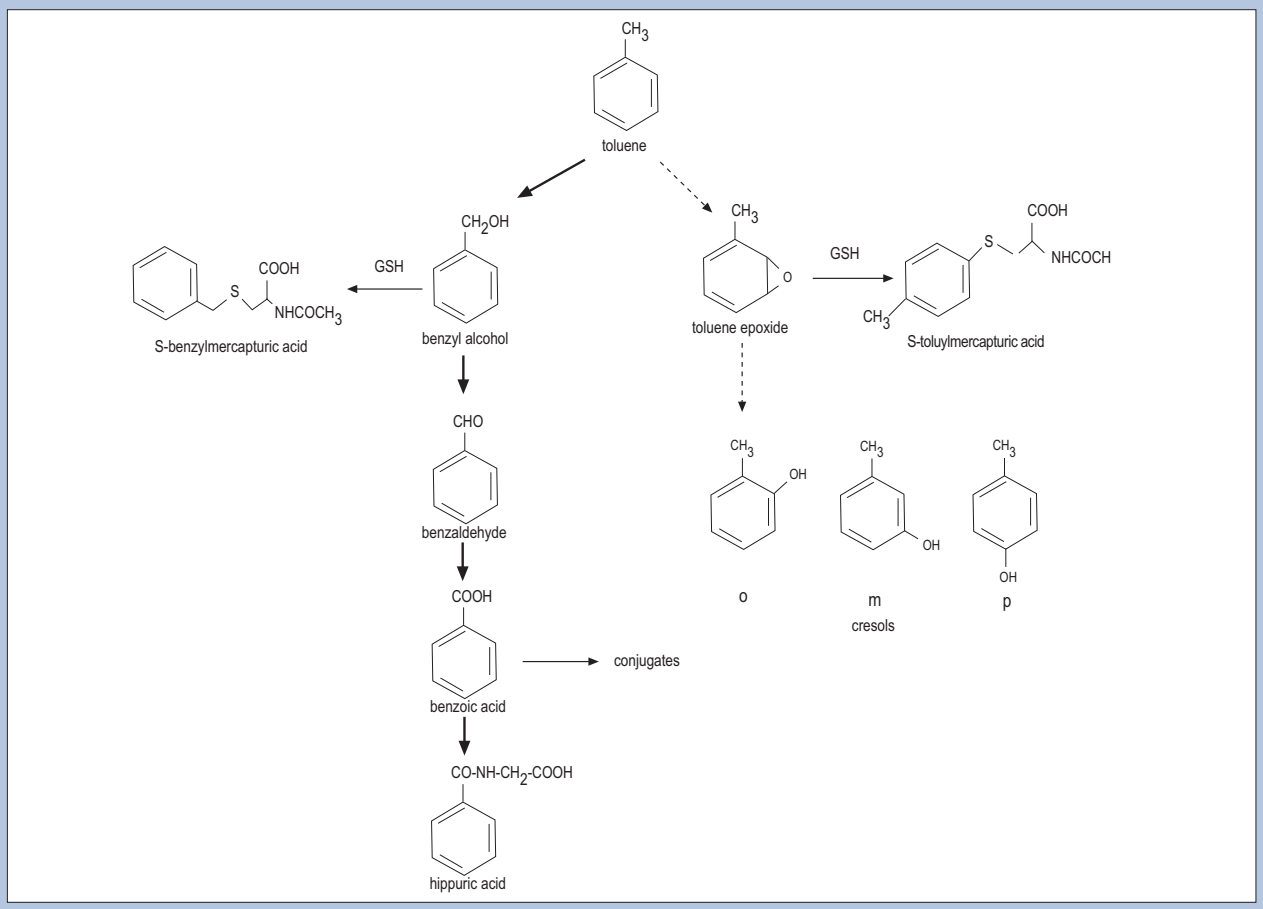


Figure 2. The metabolic pathway of toluene

(Phase II) of the chemical substance. The degree of detoxification (acute or chronic and toxicity of the substance) will result in liver enzyme activity above normal values.

Phase I – Clearance high

The first part of the detoxification step is the activation of the cytochrome P450 enzymes, which is the oxidation or hydroxylation of the substance for further substitution reaction (conjugation agents). The liver generally handles such a vast amount of toxins and natural components (see Table 1) that the detoxifying capacity is limited or determined by the patient general health status. Detoxifying enzymes are generally very slow compared to the other enzymes and the Phase I clearance rates determine the activity of the microsomal P450 enzymes. High clearance rates

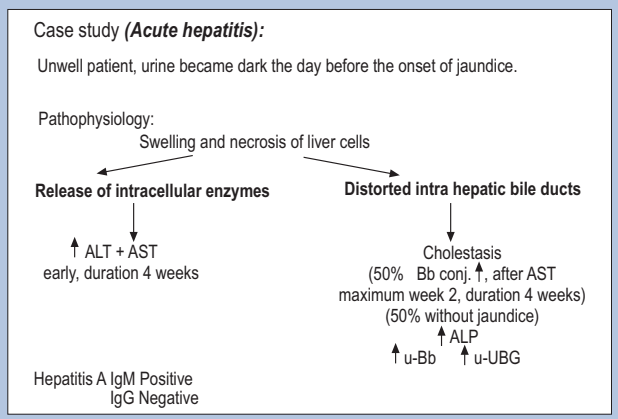


Figure 3. Enzyme reactions involved in acute hepatitis

Table 1. Detoxification functions of specific nutrients

Nutrient	Effects
Vitamin C	Increased mobilisation, toxin metal binding and antioxidant protection
B-complex vitamins	Hepatic enzyme cofactors
Lipoic acid	Hepatic protection & antioxidant regeneration
N-Acetylcysteine (NAC)	Glutathion formation and direct complexation
Cysteine	Increased glutathione and sulphate production
Methionine	Methyl donor and sulphur supply
S-Adenosylmethionine (SAM)	Active form of methionine
Glycine	Hepatic conjugation
Free-form essential amino acid mixture	Mitochondrial energy production, methyl donors, and organic sulphur
Sulphate	Hepatic conjugation
Calcium	Lead protection
Magnesium	Multiple hepatic and other effects
Selenium	Glutathione regeneration and mercury protection
Manganese	Glutathione regeneration
Copper	Glutathione regeneration

signify the importance to reduce the exposure to environmental toxins, food contaminants and occupational toxins. High clearance rates also signify that the P450 enzyme system's potential to produce free radicals (chemically active cancer causing compounds) is a concern and if the patient's nutritional intake (of anti-oxidant nutrients) will to a certain extent determine efficacy of the detoxification process.

Phase I – Clearance low

Low clearance indicates that the processing and degradation of substances is slower than normal and indicative of low liver function. These substances are generally not soluble (non-polar) and accumulate within the fatty or membrane rich tissue. This is typically seen in the central nervous system and in rapid ageing of neuromuscular function with degenerative manifestation.

Phase II – Conjugation pathways

In Phase II (conjugation), additional polar groups that confer greater solubility are substituted so that the substance component can easily be transported via the kidney and excreted in the urine. Phase I enzymes include cytochrome P450 mixed-function oxidase, peroxidase, hydroxylase and flavin oxygenase. Phase II reactions include glucoronidation, acetylation and glutathione conjugation.

The potential for drugs and medication to influence biological monitoring through induction or inhibition of hepatic metabolism/detoxification, will thus depend on how effective Phase I and II are in the detoxification of said substances. Overall hepatic elimination and biological levels of metabolism depend on metabolic activity and in some cases elimination of chemicals with low clearance is limited by metabolic capacity (how many enzymes, co-factors, etc. are available), independent of exposure level and hepatic blood flow.

Figure 4 demonstrates metabolic pathway interaction after co-ingestion of over-the-counter pharmaceuticals and caffeine.

WHAT DOES THIS MEAN FOR BIOLOGICAL MONITORING IN THE WORKPLACE?

What percentage of workers in the workplace may be receiving drugs or medication? A number of these drugs will interact with co-exposure to workplace chemicals in a way that will affect biological monitoring levels of the chemicals or their determinants/metabolites, thus confounding exposure assessments or toxicological inferences. Those of us that are responsible for biological monitoring should be aware and take notice of the potential for these interactions. The possibility of drugs and medication influencing the results should always be considered when aberrant or unexpected results are found during BM programmes, in particular where these deviate within a certain workgroup, shift, or known environment and the exposure/OEL/BM/BEI relationships are not met.

Knowledge of these interactions is paramount for good occupational health practice. Table 2 gives some examples of such interactions between chemicals, natural substances and pharmaceuticals.

In addition to disease (and the treatment thereof), physiological, pathological and genetic variance/changes (both minor and major), deficiencies and other imbalances in the bodily system, all complicate the natural balance of the body and allow for individual variances (metabolic rates, nutrient intake, enzymes, substance levels, etc.) at a moment in time and over time. All such have to be taken into consideration if we wish

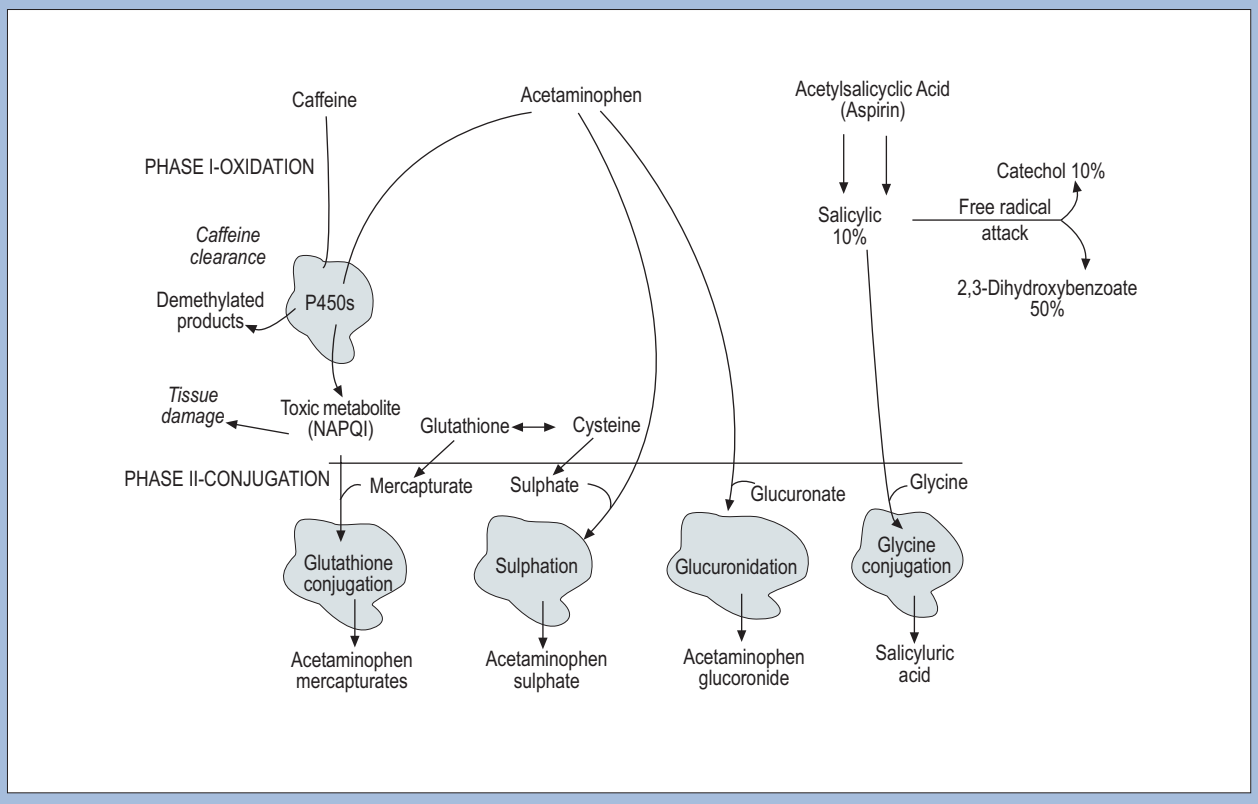


Figure 4. Metabolic pathway interaction after co-ingestion of over the counter pharmaceuticals and caffeine

Table 2. Conjugation pathways for specific compounds

Pathway	Xenobiotics	Drugs	Natural compounds
Glutathione conjugation	Styrene, Acrolein, Ethylene oxide, Benzo pyrenes, Methylparathion, Chlorobenzene, Anthracene, Toxic metals, Petroleum distillates, Naphthalene	Acetaminophen, Penicillin, Ethacrynic acid, Tetracycline	Bacterial toxins, Aflatoxin, Lipid peroxides, Ethyl alcohol, Quercitin, N-Acetylcysteine, Prostaglandins, Bacterial toxins, Bilirubin, Leukotreine A4
Sulphation	Aniline, Pentachbrophenal, Terpenes, Amines, Hydroxylamines, Phenols	Acetaminophen, Methyldopa, Minoxidil, Metaraminol, Phenylephrine	DHEA, Quercitin, Bile acids, Safrole, Tyramine,Thyroxine, Estrogens, Cortisol, Catecholamines, Melatonin, 3-Hydroxy coumarin, 25-Hydroxy vitamin D, Ethyl alcohol, CCK, Cerebrosides
Glycine conjugation	Naphthylacetic acid, Alphatic amines	Salicylates, Nicotinic acid, Chlorpheniramine, Brompheniramine	Bile acids, Cinnamic acids, PABA, Plant acids, Benzoic acid, Phenylacetic acid
Taurine conjugation	Propionic acid, Caprylic acid		Bile acids, Stearic acid, Palmitic acid, Myristic acid, Lauric acid, Decanoic acid, Buttyric acid
Glucuronidation	Aniline, Carbamates, Phenols, Thiophenol, Butanol, N-Hydroxy-2-naphthylamine	Salicylates, Acetaminophen, Morphine, Meprobamate, Benzodiazephines, Clofibric acid, Naproxen, Digoxin, Phenylbutazone, Valproic acid, Steroids, Lorazepam, Ciramodol, Propranolol, Oxazepam	Bilirubin, Estrogens, Melatonin, Bile acids, Vitamin E, Vitamin A, Vitamin K, Vitamin D, Steroid hormones
Acetylation	2-Aminofluoride, Analine	Clonazepam, Dapsone, Mescaline, Isoniazid, Hydralazine, Procainamide, Benzidine, Sulphonamides, Promizole	Serotonin, PABA, Histamine, Tryptamine, Caffeine, Choline, Tyramine, Coenzyme A
Methylation	Paraquat, Beta carbolines, Isoquinolines, Mercury, Lead, Arsenic, Thallium, Tin, Pyridine	Thiouracil, Isoetharine, Rimiterol, Doubutamine, Butanephrine, Eluophed, Morphine, Levaphanol, Nalorphine	Histamine, Epinephrine, Dopamine, Nor-epinephrine, L-dopa, Apo-morphine, Hydroxyestradiols

to scientifically analyse workplace exposures on a collective and (more importantly) on an individual basis. More complex metabolic pathways for substances not foreign to the body (chrome and hexavalent chrome, manganese exposure with iron deficiency) needs even more pronounced analysis and research to ensure the prevention of occupationally-related exposures and the resultant disease.

Conclusion

For the past century there has been an enormous increase in the number and type of foreign compounds ingested by the general population, both environmentally and as supplements. Indeed, many substances are only the products of human industry and are never found in nature. This provides for an ever increasing complexity of exposure and biological sample analysis.

Lifestyle as always remains a factor in health surveillance of chemical-exposed groups, knowledge of the metabolic interactions of such exposures from lifestyle, disease and treatment, work and community will allow for appropriate and correct preventive responses.

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Dear colleagues

SAIOH is proud to announce that:

International Occupational Hygiene Training and Qualifications
are now available through the Occupational Hygiene Training Association (OHTA)
www.OHLearning.com

Recent decades have seen a major change in the pattern of industrialisation across the world. With the expansion of the industrial base comes a change in geographical patterns of demand for occupational hygiene and occupational hygienists. Now there is a means of delivering quality training where needed with a scheme of internationally recognised qualifications available through the Occupational Hygiene Training Association (OHTA). OHTA is a truly multinational project to improve worker health under the guidance of the International Occupational Hygiene Association (IOHA) and its member organisations. SAIOH is proud to be associated with this work as a participating occupational hygiene association. Details can be found online at OHLearning.com where training materials can be downloaded free of charge and links can be found to approved training providers and sponsors.

The scheme provides a means of growing occupational hygiene skills using a modular system of training and qualifications and has been developed through extensive consultation over the last four years. The basis is a system of standard training packages with student assessment that can be accessed free of charge anywhere in the world from OHLearning.com. All materials have been peer reviewed and trialed before release. The concept is based on standardised, modular training and student assessment to a consistent format. It focuses initially on the development of basic and practical occupational hygiene skills at the technical level to identify, assess and control risks to health in the working environment.

Training materials have been developed through a rigorous process of authoring, peer review and testing. This quality approach and standardisation provides assurance on the content of training wherever it is delivered. Standardised packages mean that materials can be translated into languages other than English. This will enable use anywhere in the world while retaining the same core technical standards of teaching materials and student assessment processes. The outcome is a scheme that reduces costs, increases potential for local development, and provides a means to train large numbers of individuals in a cost effective way. The result is a standardised system of intermediate level qualifications that can be supplemented with higher level modules or other training to the standard required for professional qualification under the IOHA National Accreditation Recognition Scheme.

Modules available	Level
W201 – Basic Principles in Occupational Hygiene	Foundation
W501 – Measurement of Hazardous Substances	Intermediate
W502 – Thermal Environment	Intermediate
W503 – Noise	Intermediate
W504 – Asbestos	Intermediate
W505 – Control	Intermediate
W506 – Ergonomics	Intermediate
W507 – Health Effects of Hazardous Substances	Intermediate

In addition to these intermediate level courses there is also a foundation level 'Principles' module. This provides a general introduction to occupational hygiene and is suitable as a starter course for those preparing to study the modules or for other individuals with an interest in occupational hygiene. Additional study at postgraduate level can be used to build the knowledge and skills required for professional accreditation under one of the IOHA National Accreditation Recognition (NAR) schemes. See Figure 1.

The modular courses available so far are listed above. They cover a range of occupational hygiene topics. By using a package of courses, skills can be developed to suit the risk profile and priorities of the organisation funding the training (see table).

Although anyone can download materials free of charge, students are encouraged to attend training courses delivered by OHTA approved training providers (ATPs) and to work through participating national occupational hygiene societies. ATPs are organisations with a proven track record in training and a qualified occupational hygienist as course director. ATPs and their OHTA courses are listed on OHLearning.com and offer awards which bear the IOHA logo and phrase 'Supported by IOHA'.

Southern African Institute for Occupational Hygiene
Melinda Venter, SAIOH President

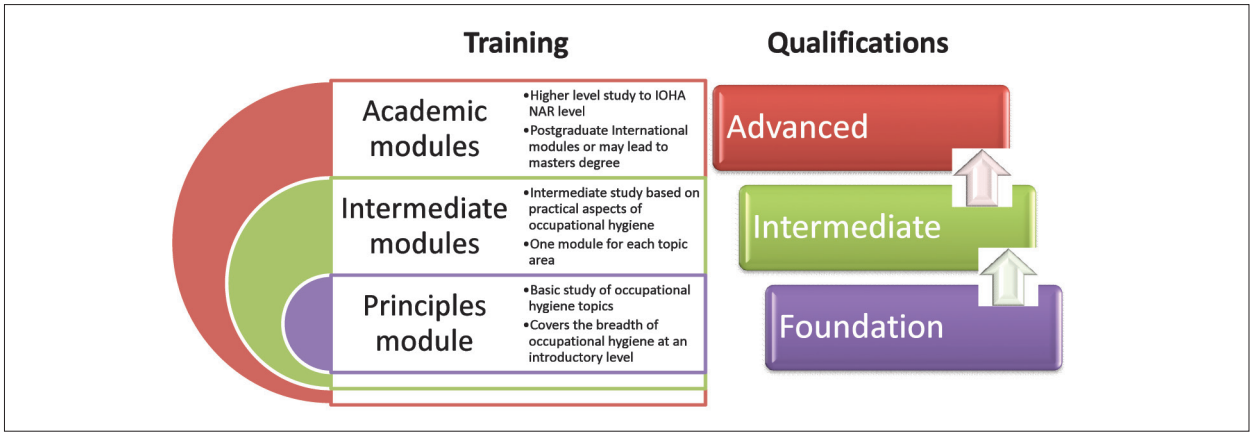

Figure 1. Occupational Hygiene Training levels

Managing the occupational health service

SASOHN 5th Academic Day, May 2010

2010 – what a special year! Not only will South Africa be hosting thousands of visitors for the Soccer World Cup but it is the International Year of the Nurse, SASOHN celebrates its 30th birthday and 12 May is Nurses' Day. I am not sure how long an event has to run before it is called a tradition but SASOHN has well and truly established a tradition in just five years. The 5th successive SASOHN Academic Day has been a resounding success. This year Johannesburg, Durban and Port Elizabeth have hosted the event spreading professional development to more than 250 practitioners. The topic was chosen to align with the International Year of the Nurse and to address issues which are often considered "soft" issues in the clinic. Despite this, each has its own importance which should not be overlooked.

Dr Sharon Vasuthevan, President of the Nursing Educators Association, spoke on professionalism of the nurse, particularly the occupational health nursing practitioner (OHNP). It is often said that nurses are losing their professionalism but as Sharon rightly questions – whose fault is that? As professionals we are responsible for our own levels of professionalism and should ask ourselves how we are contributing to the development and maintenance of our professional status. She also discussed the proposed new nursing categories that will be used to train and register nurses. One will be the advanced practitioner and it is the responsibility of those within the specialisation to ensure that they define it and become involved in writing the scope of practice. With respect to occupational health (OH) nursing as a specialisation, without the OHNPs' involvement, the function of the advanced practitioner will not be developed and may well lose its recognition.

Andre Diederichs tackled a topic that OHNPs seem to shy away from – talking business. He used comparisons between industry and nature – thought provoking and relevant analogies. Each of us as professionals need to understand the business process to ensure that we develop a sustainable and relevant service. This is done either by being the cheapest or by being unique, but it is the latter that maximises the opportunity for sustainability. He described how OHNPs must increase their intrinsic value to increase their exchange value within an organisation, which will assist in ensuring that they are still there in years to come.

Jess Bird (Chairman) and Rhona Newman were at the Port Natal Academic Day

Brenda Tait is an OHNP who has now proudly joined the ranks of "first time" speaker. She eloquently explained how her organisation has strived to introduce and sustain quality within their respiratory surveillance and conservation programme. They embraced the concept of ensuring service delivery quality to prevent occupational diseases. Programme audits found it to be sustainable and effective and employees are active participants in the programme.

Marius Fourie, an Eastern Cape human resources consultant, spoke on managing and understanding absenteeism in the workplace. He emphasized that needs to be managed by a team and not an individual or a department, explaining that unsanctioned absence was not a medical issue but rather an event and concern that had to be addressed by human resources or management. The reason for any absence must be established as there may be a number of causes which should be understood before it can be managed.

An area the OHNP may steer clear of is that of making ethical decisions as knowing what is right and what is wrong is often not an easy concept. Dr Frank Fox explained how practitioners have a responsibility to both the employer and the employee and can find themselves in a situation where they are caught between the two. It should be remembered that the "patient" – in this case the worker – is employed in an environment that may cause ill health and harm. If the primary focus is not the patient's wellbeing then sub-optimal health care will be the outcome.

Marketing of the OH service was addressed by Dr Murray Coombs. A reality check for the audience was the reminder that "we cannot assume that people know or want what we sell, or that they are prepared to find out". Most companies do not want what we offer but they need it and it is our responsibility as professionals to market this to the clients. As service providers, in one form or another, we must change our focus and understand that it is not so much about what we do but about what the client needs. Murray picked up on the concept that Andre had raised about offering something that is unique and thus increasing one's market worth.

The day concluded with Leagh Clinning explaining how important it is that the OHNP understands how to work with money in a business setting. It is imperative, and never more so than in hard financial times, that the OHNP has a grip on the finances within the unit. When the purse strings are pulled in it is often the OH service that feels it first through the reduction in work hours and/or closing of facilities. This often happens because practitioners have not marketed their worth to the relevant stakeholders. The practitioner, as a professional, needs to provide and ensure a quality service at an affordable and realistic price.

The common thread that ran through the presentations was the fact that we need to make it happen. OHNPs need to be forward thinking and make it happen because nothing is impossible.

SASOHN extends its sincere thanks to all the exhibitors and to the three sponsors OCSA, Old Mutual and Elixir for generously sponsoring all travel costs for their speakers to all three workshops. To the delegates – our thanks for attending; and to all nurses, in particular our members – a Happy Nurses Day, and enjoy the rest of the International Year of the Nurse.

Karen Michell, SASOHN Education Representative

SASOM Annual Congress

CLINICAL CONDITIONS IN OCCUPATIONAL HEALTH

All journal readers and their colleagues are cordially invited to the SASOM Annual Congress to be hosted at the Birchwood Hotel in Boksburg on 29 and 30 July 2010. While the SASOM National Office has received many registrations to date, it is gratifying to note that several of these come from countries throughout Africa.

The exciting programme is set out below:

29 JULY	**DAY 1 THURSDAY**	
07:30 - 08:00	*Registration*	*Mrs Jenny Acutt*
08:00 - 08:15	*Opening*	*Prof Daan Kocks*
	Session 1 Chair: Dr André Kotze	
08:15 - 08:45	Your voice and your work – common conditions	Dr JW Callaghan
08:45 - 09:15	Speech – learning and rehabilitation	Ms Rialette Gous
09:15 - 09:45	Arc eyes, conjunctivitis and foreign bodies in the eye	Prof Trevor Carmichael
09:45 - 10:30	Laughing therapy	Mrs Janine Grobler
10:30 - 11:00	**Tea, Posters and Exhibitions**	
	Session 2 Chair: Dr Lettie La Grange	
11:00 - 11:30	Contact dermatitis	Dr Hilary Carman
11:30 - 12:00	Fungus of the skin	Dr Hilary Carman
12:00 - 12:30	Cardiac conditions in the work place	Prof James Ker
12:30 - 13:00	Diabetes mellitus (Insulin tablets, etc)	Prof James Ker
13:00 - 13:40	**Lunch, Posters and Exhibitions**	
	Session 3 Chair: Prof Mary Ross	
13:40 - 14:50	Physically disabled – Practical considerations (National Council for Persons with Physical Disabilities in SA)	Mr Johan Viljoen National Director
14:50 - 15:30	Chiropractic – the value and practice	Dr Reg Engelbrecht
15:30 - 16:00	Low back pain	Mrs Tania Buys
	Posters and Exhibitions	
16:15 - 17:30	SASOM meeting with officials from the African region	
19:00	Banquet in hotel	
30 JULY	**DAY 2 FRIDAY**	
08:00 - 08:30	*Registration*	*Mrs Jenny Acutt*
	Session 4 Chair: Dr Charlmé Blignaut	
08:15 - 08:45	Shortness of breath	Prof Guy Richards
08:45 - 09:15	Spirometry – interpretation and management	Mr Christo vd Westhuizen
09:15 - 09:45	Ethics in occupational health	Dr Frank Fox
09:45 - 10:30	Laughing therapy	Mrs Janine Grobler
10:30 - 11:00	**Tea, Posters and Exhibitions**	
	Session 5 Chair: Dr Kevin Rainier	
11:00 - 11:50	Testing my urine? – legal dilemmas	Mrs Fransa Owens
11:50 - 12:20	Renal failure and dialysis at work	Dr Heleen Bierman
12:20 - 12:50	Music therapy	Mrs Karen de Kock
12:50 - 13:20	HIV – what's new?	Dr Lynne Webber
13:20 - 14:00	**Lunch, Posters and Exhibitions**	
	Session 6 Chair: Dr Marina Botha	
14:00 - 14:30	Hepatitis	Dr Lynne Webber
14:30 - 15:00	Occupational health – clinical conditions in Egypt	Prof Abdel-Aziz Kamal
15:00 - 15:30	Depression / Post traumatic stress disorder	Dr Vasco Ferreira
15:30 - 16:00	Balance, coordination, dizziness and cerebellum disorders	Dr Wiebren Duim
16:00 - 16:10	Closure	Prof Daan Kocks

Sixteen Continuing Education Units have been applied for. CEU and Attendance certificates will be available for all delegates at the end of the programme.

For more information contact Jenny Acutt in the SASOM National Office. E-mail info@sasom.org or Tel/fax: +27 (0)12 803 7418. Information is also on the SASOM website: www.sasom.org

Mine Medical Professionals' Association

On health leadership

Health, along with safety is a key driver of productivity in the mining industry. Currently, health in the mining industry faces huge challenges: there is a very real, high burden of disease; legislation with the MHSC milestones and targets, the National Health Insurance; amendments to the punitive MHSA; looming court cases; questions raised in Parliament; and civil society demanding more and better quality health services. All of these demand that we as mine medical professionals exercise a certain degree of health leadership. This means using every opportunity to create awareness of the health priorities in the mining industry, putting HEALTH on every agenda of every meeting, from the board room to the coal face, and that we display our commitment as leading advocates of all health-related issues in the industry. We have a duty to raise the "profile of medicine in mining" at every opportunity. It is not acceptable that leadership at major mining houses focus only on safety and are not aware that TB is the main occupational disease in a silica dust environment or that tobacco smoking greatly increases one's risk of acquiring TB and dying from it. It is also unacceptable that we as medical professionals do not spend even one minute counselling a patient to quit smoking knowing that this is the cheapest, most effective, preventative intervention in medicine. It is our duty as mine medical professionals to raise this awareness, by purposefully raising the consciousness of individuals such that HEALTH becomes an inherent way of life and of thinking, and ultimately a new culture of health AND safety.

Are we there yet? Is the industry mature enough to embrace this? Or are we still focussed on the blood and guts of accidents that hit us in the face, not realising that health too is a major proponent for safe behaviour at work, at home, surely of life in general?

If we do not understand this, we as the medical professionals face the risk of being accused of not caring: CARE, as a fundamental basic value that any medical professional should espouse to.

Do we care? Do we care enough when we know that prevention is better than cure? Or are we too busy curing? Does caring then require health leadership or just some common sense? A combination of both perhaps? A healthy dose of common sense when faced with a patient at your side and an overdose of leadership when it comes to investing in health promotion at the workplace. Health leadership literally means walking the talk; investing efforts and resources where they will have the greatest impact. By exhibiting health leadership we contribute directly to the pool of knowledge that is required for business to make sound business decisions; business decisions across the value chain from prevention (of exposures) through to treatment, care and support (of occupational and other medical conditions). What greater investment can business make in HIV prevention, TB prevention and occupational disease prevention? What delivery to the coal face – healthy, productive, aware individuals who make the right healthy and safe decisions?

The old adage PREVENTION IS BETTER THAN CURE rings true and resonates stronger than ever in the dynamic and challenging times in which we find ourselves. Now more than ever, mining industry needs us as medical professionals to deliver on our goals, with the patient as our primary responsibility. MMPA's mission is to deliver that productive, healthy individual, to adopt best practice and this calls for health leadership. Each and every one of us has an obligation and a responsibility to lead and provide direction day by day; we should be privileged that we have this opportunity to serve on a daily basis and act accordingly.

Very often the solutions are known, but it requires good leadership to grasp what is working and to work with the team to enhance it and develop it into a best practice that is owned by that team. The good leader will develop the strategy, but the great leader will shape that into a framework of achievable tasks that the team can identify with. The great leader too, will inspire that team to progress relentlessly, regardless of the environmental dynamics. To embrace the dynamic changing climate, we have to network, partner and synergise, and thus it becomes imperative for us as mine medical professionals to consciously expand the impact we make on our workforce, our patients and the communities we serve. We need to commit ourselves to sharing and identifying those pockets of excellence for the greater good of the industry so we remain sustainable. One way to do this is to become a member of the MMPA because it is committed to these ideals and requires a solid member base to increase and enhance the contribution it makes to the industry at large.

We are fortunate that amongst the ranks of the MMPA we have a cache of great leaders who have done the industry and the profession proud. The MMPA is proud to have awarded some of these great leaders with medals during the 13th MMPA AGM at Gold Reef City on 21st May 2010. This list below is by no means exhaustive – MMPA acknowledges that there are many unsung heroes and plans on awarding these medals at periodic intervals.

1. Prof J Murray – Gold
2. Prof MH Ross – Gold
3. Dr VG Govender – Silver
4. Dr DJ Emby – Silver
5. Dr DB de Villiers – Silver
6. Dr D Kritzinger – Silver
7. Dr EW Geddes – Silver

Congratulations to all the recipients and may you continue to shine that light of health leadership in the mining industry so that we can be the change we want to see.

Dr Vanessa Govender,
Past President MMPA

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