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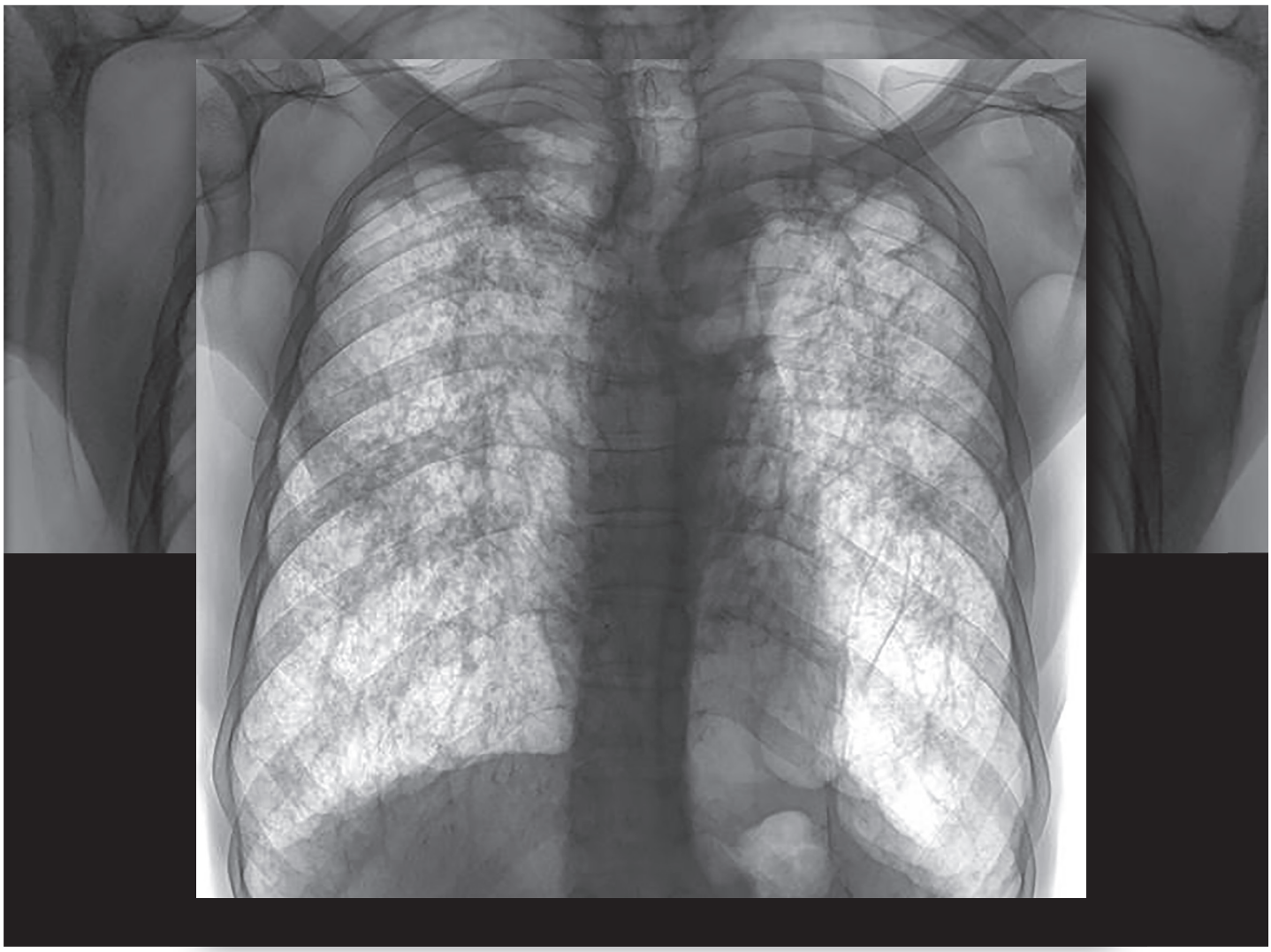

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- The South African Society of Occupational Medicine
- Southern African Institute for Occupational Hygiene
- South African Society of Occupational Health Nursing Practitioners
- Mine Medical Professionals Association

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From the Editor . . .

Gill Nelson,
Editor-in-Chief

X-rays were discovered in 1895, by German physicist, Wilhelm Conrad Rontgen (hence the terms roentgenology, roentgenologist, etc.) who was awarded the first Nobel Prize in physics for his discovery, in 1901. In the same year at the British Congress on Tuberculosis and Prevention of Consumption, empirical claims were made about the superiority of X-rays over other methods of diagnosing tuberculosis.[1] The science of the radiograph has developed considerably over the decades and, almost 125 years later, X-rays are still used to diagnose many respiratory diseases, including tuberculosis.

In this issue, we publish two papers showing such developments. In the first, a back to basics paper, Rodney Ehrlich and colleagues discuss the differences between analogue and digital X-ray readings for two common occupational diseases: silicosis and pulmonary tuberculosis. Jim teWater-Naude describes a practical approach to reading an X-ray in the second paper.

X-rays can assist in the diagnosis of mesothelioma, together with a series of other diagnostic methods, as they can detect pleural effusion, an early sign of mesothelioma. However, in most cases, by the time that the cancer is detected radiologically, it is at an advanced stage and no curative treatment is available. Many people think that, because asbestos is banned in most countries, including South Africa, we no longer need to be concerned about exposure and the subsequent dire health effects. The recent death of Jock McCulloch, well known for his writings on the history of occupational diseases, from mesothelioma, reminds us that the danger has not passed. Asbestos occurs in old buildings, in the brake linings of old vehicles and across the thousands of hectares of land in which asbestos deposits naturally occur and were mined for most of the previous century. The tribute to Jock is testament to his valuable contribution, not only to asbestos research, but to the many people whose lives he touched. His death is a big loss, and he will be remembered always. Look out for his final book about the history of tuberculosis in the mining industry: the third of his books on disease in the mining industry, which he was writing in the last months of his life.

There are no similar diagnostic methods for musculoskeletal disorders, the subject of the third paper in this issue, which are most often diagnosed by self-reported pain. The paper by Eggers et al., describing the results of a study in primary school teachers, has implications across all spectra of the education system – from primary to tertiary educators. In line with their findings, the Canadian Workers Health and Safety Centre Federation of Ontario has developed an informative leaflet on the health effects of prolonged standing.[2] Similarly, the European Agency for Safety and Health at Work has a checklist for preventing bad working postures.[3] Many such educational documents are available, and the issues of musculoskeletal disorders and related pain are increasingly being incorporated into workplace wellbeing programmes. Perhaps this is due to awareness generated from the Global Burden of Disease (GBD) Study (conducted in 2010 and published in several papers in the Annals of the Rheumatic Diseases in 2014). In that study, it was estimated that "all musculoskeletal disorders combined caused 21.3% of the total years lived with disability (YLDs) globally…" and "… accounted for 6.7% of the total global disability-adjusted life years (DALYs), which was the fourth greatest burden on the health of the world's population".[4]

As always, we feature the four societies' contributions. SASOM and SAIOH report on their exciting developments; Dr Penny Orton from SASHON makes us envious with her description of her travels to Croatia to attend the ICOH Scientific Committee on Education and Training in Occupational Health Symposium; and Dr Lindi Mokwena, on behalf of the MMPA, reminds us all about occupational lung disease compensation under the Occupational Diseases in Mines and Works Act (ODMWA).

The 32nd International Congress on Occupational Health (ICOH 2018) is taking place in Dublin, Ireland from 29 April to 4 May 2018. I hope to see many of you there.

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Lessons learnt from an unexpected cause of persistent post-operative pyrexia

All those who work within the field of medicine will have experienced lesions that have influenced the way that they practice. I would like to share one such episode. Although the events that are described occurred a number of years ago, the lesson learnt is as relevant now as it was then.

An otherwise fit-looking male in his forties presented to Casualty with an acute abdomen.

He had a history of dyspepsia that he had been self-medicating with antacids. He worked underground in a gold mine. He had not left the gold belt of the far West Rand and North West province in the past 18 months. At laparotomy, a perforated peptic ulcer was found. This was over-sown and a thorough peritoneal lavage was carried out. He was transferred to the ICU where he developed an intermittent high-spiking temperature. Intravenous treatment with a third generation Cephalosporin was commenced. Despite this, his temperature continued to spike with no sign of a response to the treatment. Thirty-six hours after the initial laparotomy, he was taken back to theatre with a provisional diagnosis of post-perforation sepsis, and a re-look laparotomy was performed. No evidence of abscess formation or sepsis was found. A repeat peritoneal lavage was carried out, the abdomen closed, and the patient returned to the ICU where a triple antibiotic regimen was commenced.

Despite the negative second laparotomy and the 'big gun' antibiotic treatment, his high-spiking temperature continued, unabated. Twenty-four hours later, a sonar examination of the abdomen was performed in the ICU. No intra-abdominal fluid collections were found and no cause for the unremitting temperature was identified. The radiologist did, however, report that the spleen was enlarged.

In view of the known association between splenic enlargement and malaria, the remote possibility of malaria was considered, and a blood specimen sent as 'rule out malaria' to the laboratory. A short while later a telephonic report was received that abundant malarial parasites had been observed. The patient was treated for malaria and eventually made a full recovery. Had the diagnosis of malaria been delayed for as little as a further twenty-four hours, the outcome, despite treatment, might well have been fatal. Repeat questioning confirmed that he had not left the malaria-free area where he lived and worked for the past 18 months.

The gold mine employed a large number of workers from Mozambique. It was subsequently postulated that a malaria-carrying mosquito had travelled from a malaria area in Mozambique to the mine in a taxi, and was the source of his infection.

Unusual malaria cases, affecting persons with no recent history of travel to malaria transmission areas are uncommon, but the phenomenon is well-documented. It is generally attributed to the malaria vector, *Anopheles* mosquitoes, being accidentally transported by vehicles from malaria areas. This form of disease is called Odyssean malaria; also known as airport, suitcase, minibus, or taxi-rank malaria.

As recently as October 2017, six cases were reported to the National Institute for Communicable Diseases (NICD). Four of these occurred in Kilner Park, Pretoria; and two in Kempton Park, Ekurhuleni. Unfortunately, one patient from Kempton Park demised.[1]

In occupational and preventive medicine, much emphasis is placed on identifying cause and related effect. For example, exposure to excessive noise predisposes to hearing loss; exposure to dust containing respirable quartz crystals predisposes to silicosis. Establishment of these associations is critical so that exposure to the causative agent can be mitigated.

The establishment of true cause and effect requires in-depth analysis and research, as co-incidental unrelated associations are common. This is particularly problematic where there is a chronological arrangement of events, so that an occurrence is attributed to whatever event preceded it. This has been termed *post hoc, ergo propter hoc*: 'After it, therefore because of it.' The case described provides a good example of a fallacious assumption of cause and effect. There are many examples of chronological events that are patently ridiculous. The stars grow dim as dawn approaches; therefore, the dimming of the stars causes the sun to rise.

In clinical medicine, the approach to problems tends to follow the doctrine contained in what is referred to as 'Occam's Razor'. This alludes to the scientific principle that *for any given set of explanations for an event occurring, it is most likely that the simplest one is the correct one*. While this is true in most instances; as is the case with chronological events, there are many exceptions, the case of the man with the perforated peptic ulcer and unremitting spiking fever, as described above, being one.

The 'take home' lesson from this episode is that malaria should be considered in the differential diagnosis of any unremitting pyrexia, *and that it is not necessary for a person to have travelled to a malaria area, in order to contract malaria.*

Dr Don Emby
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Upcoming events

LOCAL EVENTS

DATE	EVENT	PLACE	MORE INFORMATION
13 Apr 2018	SASOHN West Rand Annual Workshop	Constantia Kloof, Johannesburg, Gauteng	E-mail: ad@sbakels.co.za Website: www.sasohn.co.za/home.php
21 Apr 2018	MMPA Symposium	Aspen, Woodmead, Johannesburg, Gauteng	E-mail: mbalenhleb@mpas.org.za
23-24 Apr 2018	1st Annual African Meeting of Alcohol Toxicology	National Institute for Occupational Health (NIOH), Johannesburg, Gauteng	E-mail: ildi.wainer@wits.ac.za
10 May 2018	SASOHN Johannesburg 13th Academic Day	The Aviator Hotel, Kempton Park, Johannesburg, Gauteng	E-mail: office@sasohn.co.za Website: www.sasohn.co.za/home.php
22-24 May 2018	A-OSH Expo 2018	Gallagher Convention Centre, Midrand, Johannesburg	Website: www.aosh.co.za E-mail: info@aosh.co.za
24 May 2018	SASOHN KZN Coastal 13th Academic Day	The Karridene Hotel, Amanzimtoti, KwaZulu-Natal	E-mail: office@sasohn.co.za Website: www.sasohn.co.za/home.php
29-31 May 2018	Africa Health Exhibition 2018	Gallagher Convention Centre, Midrand, Johannesburg, Gauteng	E-mail: africahealth@informa.com Website: www.africahealthexhibition.com/
22-23 Jun 2018	SASOM Annual Congress	Protea Hotel by Marriott, OR Tambo International Airport, Johannesburg, Gauteng	E-mail: info@sasom.org Website: www.sasom.org/
12-15 Sep 2018	KwaZulu-Natal Industrial Technology Exhibition (KITE)	Cape Sun Hotel, Cape Town	E-mail: admin@sastm.org.za Website: www.sastm.org.za/
23-26 Oct 2018	SAIOH Annual Conference	Champagne Sports Resort, Central Drakensberg, KwaZulu-Natal	E-mail: info@saioh.co.za Website: www.saioh.co.za/page/SAIOHConference18
31 Oct-2 Nov 2018	SASOHN Annual Conference	Stellenbosch, Western Cape	E-mail: office@sasohn.co.za Website: www.sasohn.co.za/home.php

HEALTH AWARENESS DAYS, WEEKS AND MONTHS

MARCH
TB Awareness Month
3 World Hearing Day
8 International Women's Day
8 World Kidney Day
11-17 World Glaucoma Week
12-18 World Salt Awareness Week
20 World Head Injury Awareness Day
21 Human Rights Day
24 World TB Day

APRIL
Health Awareness Month
7 World Health Day
24-30 African Vaccination Week
25 World Malaria Day

INTERNATIONAL EVENTS

DATE	PLACE	EVENT	MORE INFORMATION
16-19 Apr 2018	Stratford-upon-Avon, United Kingdom	BOHS Annual Conference - OH2018	E-mail: conferences@bohs.org Website: www.oh-2018.com/
29 Apr-4 May 2018	Dublin, Ireland	32nd International Congress on Occupational Health - ICOH 2018	E-mail: icoh2018@conferencepartners.ie Website: icoh2018.org/wp/
2-5 May 2018	Ottawa, Canada	14th International Conference of the International Mesothelioma Interest Group (iMig)	E-mail: imig2018@icsevents.com Website: www.imig2018.org/
24-25 May 2018	Valencia, Spain	2nd International Conference on Women Health and Breast Cancer	E-mail: womens_health@scientificfederation.com Website: scientificfederation.com/women-health-2018/
29-31 May 2018	Bari, Italy	DUST2018: 3rd International Conference on Atmospheric Dust	E-mail: tesoreria@aipea.it Website: www.dust2018.org/
25-26 Jun 2018	Kuala Lumpur, Malaysia	4th World Congress on Nursing & Healthcare (WCNH 2018)	E-mail: wcnh-2018@scientificfederation.com Website: scientificfederation.com/nursing-2018/
10-12 Sep 2018	Hanoi, Vietnam	5th International Conference on Occupational and Environmental Health (ICOEH5)	E-mail: icoeh52018@gmail.com Website: icoeh5.nioeh.org.vn/
12-13 Sep 2018	Leuven, Belgium	Employability in the 21st Century - 2nd International Conference on Sustainable Employability	E-mail: philippe.kiss@securex.be Website: www.employability21.com
24-26 Sep 2018	Washington DC, USA	11th International Occupational Hygiene Association (IOHA) International Scientific Conference	E-mail: ebreece@aiha.org Website: https://www.aiha.org/events/IOHA2018/
24-26 Sep 2018	Manchester, UK	X2108: 9th International Conference on the Science of Exposure Assessment	E-mail: kate.jones@hsl.gsi.gov.uk Website: www.rsc.org/events/detail/29724/x2018-9th-international-conference-on-the-science-of-exposure-assessment

Jock McCulloch (1945-2018)

Professor, International Development Program, School of Social Science and Planning, RMIT University, Melbourne, Australia

Compiled by: Gill Nelson, Editor-in-Chief, Occupational Health Southern Africa

On 18 January 2018, one of the Greats of occupational health, Jock McCulloch, passed away from mesothelioma in Melbourne, a mere nine months after being diagnosed with the deadly cancer. Pavla Miller, his partner of 30 years, broke the news to his friends and colleagues who immediately responded with deep sadness at the loss of this remarkable man who had dedicated much of his life to researching asbestos issues in South Africa. "His exposure to blue asbestos was probably in South Africa during the mid-1990s, when he was researching a book on the history of mining," said Pavla. "Until late November, Jock was able to work on his manuscript on gold mining, migrant labour and corruption of scientific knowledge in southern Africa..." Pavla worked with Jock on his last book, as yet unpublished, which she describes as "another lasting testament to his remarkable contribution to historical scholarship and the fight of workers and communities for justice".

"It is very hard accepting that Jock is gone. Although I had known about his illness, I thought there would be more time. We had been working on a piece together and I had let some follow-ups lapse – now, it is too late. Nevertheless, I used some of what Jock and I discussed as the basis for a tribute ... The link for the article entitled In Memory of Jock McCulloch is: http://ibasecretariat.org/lka-in-memory-of-jock-mcculloc.php."

Laurie Kazan-Allen, International Ban Asbestos Secretariat

"I am so sorry to hear that Jock has died from mesothelioma… It's just so hard to believe. Jock was one of a handful of people who have deeply investigated and analyzed the history of the asbestos pandemic, now estimated to cause 280 000 deaths a year. His thoroughness and persistence in seeking to understand this history in every way left behind an extraordinary volume of published work."

Barry Castleman, Asbestos Disease Awareness Organization (ADAO) Science Advisory Board Member

"Jock was a sincere advocate for all those affected by the ravages of asbestos. His work will long stand in the struggle for achieving an asbestos-free world. He will be missed as we mourn his passing, but his memory will remain in our thoughts among all who admired his life's work."

Dr Richard Lemen, Assistant Surgeon General, US Public Health Service (retired)

"In Jock's final years he was a generous colleague. One of his final acts of generosity was to share with us his enormous collection of materials on silicosis and asbestosis in South Africa and Australia. ... It is with great irony and sadness that today is the day that we are launching a website with his collection included. For those of you who want to see a small piece of Jock's extraordinary contribution to scholarship you might want to check out https://www.toxicdocs.org/blog/remembering-jock-mcculloch/. His legacy lives in the research and advocacy that was so integral to him and that is obvious in the primary materials he collected ... What a wonderful, decent man he was. All of us here at Columbia remember his warmth, dedication, scholarship and companionship."

David Rosner, Columbia University

"I am moved to tears as I remember Jock and his magnificent contribution to the cause of justice and fairness in South Africa ... I always respected his drive, courage and fairness as a crusader for the rights of asbestos workers and communities ... please convey ... a message of love and support from the trustees and staff of the Kgalagadi Relief Trust, which in many ways owes its existence to the pioneering work of health and safety warriors like Jock."

Brian Gibson, Chairman, Kgalagadi Relief Trust

"This is such terribly sad and devastating news about Jock's passing. The news of Jock's passing is devastating - to his family, to international colleagues and, importantly, to the many workers and communities exposed to industrial hazards on whose behalf he worked so valiantly."

Lundy Braun, Brown University

Jock McCulloch

"Jock McCulloch will be remembered widely, and for many decades, as the author or co-author of many important books about asbestos mining and milling, and gold mining, in southern Africa. I have three of them and have read them with care and great interest as part of the historical foundation for the legal proceedings in connection with the neglect of dust control in this country. The work that went into them was truly impressive. I was close to a good deal of it. They contain an exhaustive account of the 20th century epidemics of asbestos- and silica-related diseases in South African mines – mandatory reading for those who care about the health and welfare of men who work in mines. The publication of his nearly completed book about migrant workers in the mines is expected to provide a new stimulus for us all. The broad outlines of the diseases and accidents associated with the coal mines in South Wales are well known to many but much of the detail is not. Until relatively recently, the same was true of asbestos and gold mining in South Africa.

Scientists working in the relevant fields will remember Jock as an important ally in opening up the hidden disasters around the mining and milling of asbestos, and the failure of dust control in the gold mines. Those of us who worked in jobs which were, to a greater or lesser degree, 'ruled' by individuals or groups that were not really interested in the fate of workers in the very dusty asbestos mills or at the silica-rich rock face, will regret his passing. His role in exploring the stored material at the National Institute for Occupational Health (NIOH), which proved to be a gold mine in its own right, cannot be overstated.

About 1996 I received an email from Jock, of whom I had never heard. His asked if he could have access to the material held by the National Centre for Occupational Health (now the NIOH). The answer was of course, "at any time". The NCOH data was already being used to prepare the case against Cape Asbestos, and the same access was granted to the legal team defending Cape Asbestos. Jock and I began what became one of the longest conversations in my career with anyone outside South Africa. I never ceased to wonder at the energy and determination that went with his expertise and capacity for hard work over long periods of time. We spent many hours discussing mining in this country and the resources of the NIOH.

My personal history had primed me, at an early age, for Jock's research proposal. On the mantlepiece in our lounge in Kensington, Johannesburg, stood a piece of rock from a mine in the Northern Cape. It consisted of country rock, separating seams of bright blue fibre. My mother told me that my father (a mining engineer) had come back from a trip to the Northern Cape in the 1930s, picking at this piece of rock. When asked what he was doing, he replied that "this is what is killing the miners".

Jock's academic base (RMIT) provided his background in history, sociology, politics and ideology, and he brought this refreshing mixture with him to South Africa. For anyone who seeks insight into the demise of the asbestos industry in South Africa *Asbestos Blues: Labour, capital, physicians and the state* is an unbeatable primer. It is a product of the first years of Jock's research in this country, begun in the latter half of the 1990s and published in 2002. It is divided into 10 chapters, covering a wide field, followed by an index to more than 70 books, theses and monographs, a list of more than 50 references, and a comprehensive index to the text. I have found it a reference work of great value.

In the conclusion to *Abestos Blues*, Jock sets out the development of knowledge about the dangers of fibre-containing dust, the repeated failures to publish the truth, and the legacy that the industry would leave to the country and the world. Read Chapter 10 first – seven pages of carefully arranged facts that are an indictment of the industry and South Africa.

Jock McCulloch was not a loner. The second book on my shelf is written with Geoffrey Tweedale, a long-time colleague, titled *Defending the Indefensible*: *The global asbestos industry and its fight for survival.* It is packed with information and stories that might upset the reader. Read the seven pages at the end of the book headed 'sources and acknowledgements'; they will whet your appetite for some stirring stuff.

I am fortunate in that I have been exposed, throughout my life, to women and men of exceptional quality. Jock is one of those. I think it was he who told me that the success of the case against Cape Asbestos would open the path to the gold mining industry, and so it proved. The third book on my shelf is *South Africa's Gold Mines and the Politics of Silicosis*. It opens with the following paragraph, paraphrased from an address by the then President of the Chamber of Mines, KW Maxwell, at the Chamber's 100th Annual General Meeting in 1990 on the eve of majority rule: "Per capita disposable income was falling and more than five million South Africans were unemployed. Half of the adult population was illiterate and half of the country's children were not attending school. South Africa had just 60 000 students in technical and higher education. With half the population, Australia had over 800 000". Against this sombre background, an account of the development, and the current situation in South Africa's gold mines, was evidently not going to be a simple task.

"South Africa's modern history lies at the convergence of two colonial systems, the British and the Dutch. Its transformation from a rural society to an industrial state at the end of the 19th century was accelerated by the discovery of diamonds near Kimberley in 1867 and gold at Johannesburg in 1886. It is a story of late colonial conquest, mineral wealth and the persistence of racial ideologies which came to be embodied in apartheid." By the time this book was published, the major gold mining companies in South Africa were faced with massive class actions by former mine workers. The history set out in this book may help South Africans who find it difficult to approve the resort to the courts in order to remedy the neglect of damaging occupational exposure for so many workers over such a long period of time. It is not an easy read so, once again, I suggest that the concluding seven pages be read first.

There is every reason for those of us who work, or worked, at the NIOH, to remember Jock McCulloch with respect and affection, and as a disciplined and honest researcher. By reading his books we can reinforce our efforts to improve working conditions in this mineral-rich country."

Tony Davies

Former Director of the (now) National Institute for Occupational Health (NIOH), and Wits Emeritus Professor

Jock McCulloch:
scholar, teacher, loyal friend, and a man of fierce determination and deep concern for social justice

"It was with great sadness that I received the news of Jock's death. I can't remember exactly when I first met him but it was Professor Tony Davies who brought Jock to the museum when he was in South Africa on a research trip. Both Tony and Jock taught me an inestimable amount about miners' lung disease and specifically asbestos-related disease.

Through the years I corresponded with Jock who assisted with enquiries received from researchers, critiquing and adding to the texts of exhibitions I edited for the Adler Museum (researched by Emeritus Professor Tony Cantrell and Jemima Cantrell), and researched for the National Institute for Occupational Health (NIOH), and with reviewing articles submitted for publication in the Adler Museum Bulletin. Incidentally, the Adler Museum exhibition included two fine photographs taken by Jock during the course of his research in South Africa.

From time to time, Jock sought information from the archives of the Adler Museum for his research. Our last exchange was in 2017 regarding an article he was writing on AJ Orenstein which, as one would assume, showed him in a most unfavourable light. He was keen to change the name of the eponymous lecture (AJ Orenstein Memorial Lecture) arranged annually by the Adler Museum. He himself had delivered this lecture in 2013, entitled 'Dust, Disease and Politics on South Africa's Gold Mines.' It was a truly riveting lecture, and was subsequently published in the June 2013 issue of the Adler Museum Bulletin (Vol. 39 [1]).

Jock knew that I had been at the Johannesburg Art Gallery for 25 years before joining the Adler Museum and he shared with me photographs of artworks he had acquired or had enjoyed seeing. Fine art was an area that he had studied and with which he constantly engaged. We also exchanged views about the state of cricket in the world, 'bet' on who would win the Ashes and other series, and enjoyed swopping unusual collective nouns!

I feel sad that Jock is no longer on this earth. I will miss his sharp mind, his compassion and his brilliant sense of humour a lot. I feel privileged to have known him."

Rochelle Keene, Former Curator, Adler Museum of Medicine (2004 – 2015),
Faculty of Health Sciences, University of the Witwatersrand, Johannesburg

"We ... are so sorry to read the news of Jock ... (he) was held in high esteem by our organisation and he was certainly a gifted person. The world has lost a truly wonderful human being he will be sadly missed by all ... "

Vicki Hamilton, CEO/Secretary,
Asbestos Council of Victoria

"Meeting Jock in 2014 was a deeply moving experience for me. As a mesothelioma widow, I greatly appreciated his passion, insight, and talent as an author and educator. His vast work such as *Defending the Indefensible: The global asbestos industry and Its fight for survival; Asbestos Blues: Labour, capital, physicians & the state in South Africa; and Asbestos: Its Human Cost,* have been monumentally important to me and the global fight to ban asbestos. He was strong when we talked in June about him being recognised with the 2018 ADAO Dr Irving Selikoff Lifetime Achievement Award for his outstanding contributions for truth and justice."

Linda Reinstein, President/CEO, Asbestos Disease Awareness Organization (ADAO)

My own memories of Jock are of a kind and caring man, deeply committed to the 'cause' of asbestos and the immense suffering that so many people experienced after being exposed to the deadly fibre. I can imagine him walking across the veld of the Northern Cape asbestos fields, witnessing the scarred landscape and the ubiquitous scatterings of grey tufts of crocidolite. It is something that I and many others who worked at the National Institute for Occupational Health (NIOH) and affiliated organisations also, naively, did. Sadly, some, like Jock, subsequently developed mesothelioma. The legacies of Dr Derick Rendall, Dr GK Sluis-Cremer, Dr Jack Abramowitz, Mr Joas Kubayi, and others, live on in their valuable contributions to asbestos-related research. May they all rest in peace.

Gill Nelson,
Editor-in-Chief, Occupational Health Southern Africa

Digital radiological surveillance of silicosis and related tuberculosis in the South African mining industry: practical and technical considerations

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ABSTRACT

The switch from analogue to digital radiography formats for surveillance for silicosis and tuberculosis in the South African mining industry raised the question of equivalence of formats for this purpose. As a result, the South African Mine Health and Safety Council (MHSC) sponsored a study, recently published, on the equivalence of digital and analogue radiography in this setting. This commentary aims to provide a summary of the study findings, accompanied by an overview of the practical considerations that arise in the use of digital radiographic surveillance in the South African mining industry. Through a clear understanding of the objectives of surveillance, use of quality and reference standards for hardware and software, and interpretation of digital images, avoidance of common pitfalls, and use of all the clinical and occupational health information on each miner, the contribution of surveillance to identification and control of silicosis and tuberculosis in the mining industry can be maximised.

Keywords: **radiology, surveillance, mining, silicosis, tuberculosis**

INTRODUCTION

This paper is directed at medical practitioners and other professionals with responsibility for, or an interest in, mass radiography in the mining industry and, more generally, in silica dust generating industries in South Africa and elsewhere. Given the widespread changeover from analogue to digital radiography in recent years, we draw attention to a recent study comparing analogue and digital radiography in the detection of silicosis and pulmonary tuberculosis.[1] The publication of this study provides an opportunity to consider, in more detail, a number of technical and practical issues in radiographic surveillance of miners in the South African mining industry, and to make recommendations to enhance the efficiency and effectiveness of the system.

Radiological medical surveillance

The main target conditions of mass radiography in the South African mining industry are silicosis and pulmonary tuberculosis. Both occur at high rates as a result of exposure to respirable silica with its known association with tuberculosis,[2] as well as high tuberculosis infection rates in congregate settings and high prevalences of HIV infection.[3,4]

The Witwatersrand gold mining industry was one of the first to introduce mass radiography at the beginning of the 20th century.[6] Mass miniature radiography (MMR), which became widely used in the 1960s, was originally developed for the South African mining industry.[7] However, racially-based practice pervaded the system: white miners were examined with full size films, while MMR was restricted to miners in job groups four to eight (mainly black miners) (Paulette Brink, personal communication, 5 March 2018). This persisted until the early 2000s, when full size analogue radiography was introduced for all miners.[6]

Underground miners subject to radiological surveillance undergo two such examinations annually. With approximately 366 000 miners employed in the gold, coal and platinum sectors in 2016,[8] and even given that not all would be required to undergo radiographic examination, the implied volume of radiography is enormous. The cost of any inefficiency or ineffectiveness inherent in practice would be high.

To be able to evaluate this system, it is necessary to understand its purpose and the fact that radiological medical surveillance fulfils two functions, more precisely characterised as active screening and disease surveillance.

Medical surveillance is the general term used in occupational health to describe the regular examination of workers for pre-clinical or clinical abnormalities. Active screening is directed at the individual worker. Its aim is to detect disease – in this case, silicosis or pulmonary tuberculosis – at a stage prior to that at which the individual would present for care as a result of symptoms or ill-health. The rationale for screening is that early clinical action, such as treatment, or occupational management, such as risk counselling, job change or compensation, will limit the impact of the disease on that individual.

Disease surveillance is directed at the population. Its aim is to measure the number of cases of the disease in the target population, which can be expressed as prevalence or annual incidence. The rationale for surveillance is that such information is needed for disease prevention and control, and for health programme planning. Both of these functions are important in the mining industry.

Legal background

Both the Mine Health and Safety Act (MHSA) of 1996 as amended and its related guidance notes, and the Occupational Diseases in Mines and Works Act (ODMWA) of 1973 as amended, mandate medical surveillance

of miners.[9,10] The MHSA imposes duties on the Inspectorate of Mine Health and Safety, Department of Mineral Resources, as well as on the manager of each mine and the occupational medical practitioner employed by the mining company, to ensure that medical surveillance occurs. In terms of the ODMWA, the Director of the Medical Bureau for Occupational Diseases (MBOD) is empowered to inspect the equipment and outcomes of any medical examinations. Where a medical practitioner considers or suspects that a miner or ex-miner is suffering from a compensable disease, he or she is required to report the findings to the Director.

Clinico-radiological features of silicosis and pulmonary tuberculosis

Practitioners with responsibility for mining radiology need to be familiar with the common radiologic presentation of silicosis. In particular, it is essential to distinguish the early radiological features of silicosis from those of a normal chest, or of tuberculosis, and the signs of active tuberculosis from those of 'healed' disease.[11,12] This task is made considerably easier by high-quality imaging and the use of reference standards (both discussed later in this paper), and the converse holds for a poor-quality imaging which might make the distinction impossible.

The most common form of silicosis seen today in the mining industry is chronic uncomplicated silicosis, characterised by bilateral, more or less symmetrical, rounded nodulation with upper lobe predominance. When extensive, the whole lung may be affected, a pattern which needs to be distinguished from miliary tuberculosis, especially if the nodules are small. Complicated silicosis may also be characterised by regular or irregular masses exceeding 1 cm in the long axis, most commonly, and originating in the upper zones – labelled progressive massive fibrosis. In such cases, the association with surrounding nodules may be apparent, or lung destruction with surrounding emphysema may incorporate and obscure the nodules in the adjacent lung. Eggshell calcification of hilar or mediastinal nodes, while not pathognomonic, is an uncommon but distinctive marker of longstanding silicosis.

Pulmonary tuberculosis has a wider range of appearances than silicosis and may be due to previous 'healed' tuberculosis or to active tuberculosis requiring immediate action. Appearances include cavitation, adenopathy, masses, asymmetrical nodules, often clumped and heterogeneous in size, linear fibrosis, fibrocystic disease, bronchiectasis, pleural thickening or effusion, hilar distortion with 'compensatory' emphysema, or lung collapse. Symmetrical bronchopneumonic or miliary patterns may also occur.

ANALOGUE VS DIGITAL RADIOGRAPHY – THE STUDY

Background

The most widely used system for categorising the abnormalities seen on chest radiographs due to the inhalation of fibrogenic dusts is the International Labour Organization (ILO) classification.[13] While the ILO system was developed using analogue film radiographs, in recent years a number of validation studies have shown that interpretations of soft copy digital radiographs (i.e. digital radiographic images displayed on a radiology-quality high resolution computer workstation) are equivalent to those for film radiographs (analogue) for classifying parenchymal and pleural abnormalities due to pneumoconiosis.[14-19]

Largely on the basis of these reports, the ILO and the United States National Institute for Occupational Safety and Health (NIOSH) have promulgated guidelines for use of digital radiographs for such purposes.[13, 22] However, all the validation studies were conducted in the United States, western Europe or Japan, regions in which the incidence of pulmonary tuberculosis is low. Because there were few, if any, subjects with tuberculosis in these studies, it was not possible to assess whether digital radiographs were equivalent to film radiographs for identifying radiographic changes suspected to be related to tuberculosis, or combined silicosis and tuberculosis.

Digital radiographic equipment was installed in the health services of the larger mines in South Africa in the early 2000s. Although analogue film chest radiography continues to be used in the health facilities in remote rural areas of South Africa and surrounding countries where the majority of migrant ex-miners live, there is increasing adoption of digital radiographic technology in some of these areas in South Africa and Lesotho. In 2007 the South African Mine Health and Safety Council (MHSC), composed of representatives from labour, management and government, requested evidence on the equivalence of the two formats in the detection of silicosis and tuberculosis.

Methods

A sample of 132 active gold miners with a range of radiographic findings of both silicosis and tuberculosis, from 'normal' to 'severe' for each outcome, and combinations of the two, were recruited. Previously-taken periodic surveillance radiographs were reviewed to identify potential study subjects from among active workers at a single mine, who were then invited to participate. Each miner completed a questionnaire and underwent a digital chest radiograph as part of routine periodic health screening at the mine. The digital image was then printed as a hard copy. In addition, a film chest radiograph was obtained for study purposes on the same day.

The main objective of the study was to measure the intra-reader agreement (reliability) between the three formats – soft copy digital, hard copy digital, and traditional film images – for silicosis and/or tuberculosis, as well as the prevalences obtained with each of the three formats. Measurement of agreement between readers (inter-reader agreement) was a secondary objective.

For each image format, the radiographic and printing protocol was that in effect at the mine at the time (2012). Owing to circumstances outside the researchers' control, hard copy images were printed at two thirds of the size of the other two formats, a size that is common practice in hard-copy digital printing and deemed acceptable in the ILO guidelines.

De-identified images were interpreted independently and in random order by four expert readers, two from South Africa and two from the United States. Readers classified images according to the 2011 revision of the ILO classification system and NIOSH guidelines.[13, 22] Criteria for marking the symbol 'tb' were based on the instructional language in the ILO guidelines, viz. "The symbol *tb* should be used for either suspect active or suspect inactive tuberculosis. The symbol '*tb*' should not be used for the calcified granuloma of tuberculosis or other granulomatous process, e.g. histoplasmosis. Such appearance should be recorded as *cg*."

The primary focus of the study was to assess intra-reader agreement (same reader, same miner, different image formats) among pair-wise comparisons of the three radiographic formats. For each pair of formats, the kappa statistic was calculated as a measure of intra-rater agreement.[23] The kappa statistic is used to measure agreement between two raters on an outcome after adjusting for the proportion of agreement due to chance. Kappa values can range from -1 (perfect disagreement) to +1 (perfect agreement), with kappa = 0 representing no agreement beyond chance. Values of kappa

>0.75 are considered to indicate 'excellent' agreement, values 0.40 to 0.75, 'fair to good', and values < 0.40, 'poor'.[24]

The kappas were pooled across the four readers. We considered only the dichotomous outcomes, e.g. silicosis read as profusion >=1/0 vs <1/0, or tuberculosis as present vs absent, using the ILO system. Assessment of inter-reader agreement (different readers, same miner, same image and format) was a secondary goal of the study. Full methods are described in Franzblau et al., 2018.[1]

Main findings of the research

Digital soft copy and traditional film images showed consistent prevalence of findings for tuberculosis and silicosis. By contrast, digital hard copy (printed) images yielded higher prevalences.

Intra-reader agreement of film versus digital soft copy was *fair to good* for the detection of tuberculosis, while three of the four readers showed *fair to good* agreement for parenchymal abnormalities consistent with silicosis.

Inter-reader agreement for film and digital soft copy readings was *fair to good* for tuberculosis. Agreement on parenchymal abnormalities (silicosis) was *fair to good* for film, but *poor* for digital soft copy. This latter finding was due to one reader reporting parenchymal abnormalities much more frequently than the other readers.

Previous studies of equivalence, whether intra- or inter-reader, have found agreement in the fair to good ranges of kappa.[14-19] Using this standard, we concluded that the study demonstrated reasonable equivalence of soft copy digital chest images in comparison to traditional film for conducting radiological surveillance in working populations that might be exposed to both silica dust and tuberculosis. We concluded that use of hard copy digital should be discouraged because this method might overstate prevalence.

RECOMMENDATIONS ON DIGITAL SURVEILLANCE FOR SILICOSIS AND TUBERCULOSIS

In this section we set out the standards that we believe should be followed in digital radiographic surveillance, with special reference to internationally recommended standards.

Radiographic process and quality standards

While only qualified radiographers are legally permitted to carry out radiography, the Health Professions Council of South Africa (HPCSA) does allow supplementary diagnostic radiographers to operate under the supervision of a radiographer to carry out chest radiography on the mines.

The recommended technique for performing chest radiography has been well-described by the American College of Radiology (ACR).[25] A high kilovoltage peak (kVp) technique (100-120 kVp) is recommended for chest radiography to reduce contrast between bone and soft tissue, making 'grey' lung parenchyma more visible. Increasing the mAs (tube current) does not improve the quality of the image while increasing patient dose.

Digital postero-anterior chest radiographs should conform to the same positioning standards as analogue positioning, ensuring that the entire lungs and pleural reflections are visible. The dynamic range of digital chest radiography is considerably larger than that of film-screen images, permitting a wider range of diagnostically acceptable exposures. An overall advantage of digital radiography is the ability to produce lower dose diagnostically acceptable images. However, it is also possible to produce images at low exposure settings with acceptable contrast but excessive quantum noise, which might simulate small opacities.

The converse is also true: exposures can be progressively increased, resulting in very low noise and high-quality images, but at the expense of excessive patient dose. This is possible because the brightness and contrast of the image are uncoupled from the exposure. When this occurs systematically, it is known as 'dose drift' or 'dose creep'. Vendor-specific exposure indicators have been developed to allow each facility to monitor exposure factors by the technologist and mitigate dose drift.[26]

Monitors, workstations and use of screen software

The desired reading environment is described in the 2011 ILO booklet.[13] The room should be evenly lit with low ambient light, no direct sunlight, no glare, and clean viewing surfaces, and be clean, quiet and free from distractions.

The NIOSH and ILO guidelines also provide standards for monitors.[13,22] The technical specifications should be adhered to but, where the mega-pixel number is higher than five and the pixel pitch (the dark space between two pixels) is <0.2 mm, the other specifications will usually also be met. A quality control system is recommended to evaluate monitors and to ensure they continue to perform adequately. For this purpose, quality control software is available that ensures daily testing of monitors for reading fidelity.

The digital acquisition of an image involves the conversion of photons to an electronic signal, using a detector. The image is preprocessed with vendor-specific algorithms, producing an image histogram. Post-processing algorithms can then be applied by the technologist to the image for the purpose of creating an image that most efficiently displays the anatomic information of the radiograph, both contrast and spatial resolution. Post-processing spatial frequency algorithms that create edge enhancement should be specifically avoided as they can artificially accentuate normal parenchymal markings and simulate small opacities. Grid suppression or anti-aliasing software should be activated; failure to do so may result in artefactual parallel lines on the image.

Finally, if a very high-energy technique is used, the digital equivalent of overexposure, known as detector saturation, occurs. The over-exposed region registers as black on the monitor, and no window-and-level adjustment will display anatomic information. Detector saturation could suppress or obscure small, or even large, opacities of pneumoconiosis.

Viewing image with ILO reference standards

Historically, the ILO has provided a set of 22 standard (film) radiographic images for side-by-side comparison and classification of film chest radiographs for findings related to inhalation of pneumoconiotic dusts.[21] In 2011, the ILO produced a set of digitised standard radiographic images for side-by-side comparison and classification of soft-copy digital chest radiographs, for findings related to inhalation of pneumoconiotic dusts.[21] NIOSH has also issued a guideline document that builds on that of the ILO and is intended to provide 'technical and operational guidance for radiographic facilities and physician readers who obtain digital chest radiographs for the evaluation of pneumoconiosis'.[22]

A key element of application of the ILO system for interpretation of radiographic images is the requirement for side-by-side comparison of a patient's image with the ILO standard images. Historically, when using traditional film images, this was not difficult since both images could be displayed on adjacent viewing boxes. However, the clinical Picture Archiving

and Communication System (PACS) is designed not to permit display of the images of two different patients side-by-side, to avoid inadvertent interpretation of the incorrect patient radiograph. While this failsafe is important in clinical radiology, it is problematic when interpreting radiographs for pneumoconiosis where the specified expectation is that the examinee images will be compared with the ILO standard radiographs in the same image format.

Fortunately, several solutions are available. Configuring a dedicated PACS workstation with appropriate high-resolution monitors is the initial step. The facility must develop a method to receive transmitted images via virtual private network (VPN) or upload chest radiograph images, for example, on CD, to a database for viewing. Once the ILO digital standards and the examinee images are available in the same database, simultaneous viewing is required. Free BViewer software is available through the NIOSH site[20] but requires a set-up which is not easy to execute. Other free DICOM (Digital Imaging and Communications in Medicine) viewers which perform satisfactorily are more easily employed and, depending on the local setup, allow a parallel display of the examinee and standard images. In all cases, however, one has to purchase the standard image digitised set from the ILO. There is also purchasable vendor software (for example, OsiriX FDA-approved version for Mac) which allows two images to open side-by-side for comparative viewing. Alternatively, side-by-side workstations could be employed; however, this adds the expense of a second workstation solely for comparison with the standards.

Training and materials

To promote reliability in the interpretation of reading radiographs of the pneumoconiosis, the NIOSH 'B reader program' was created in 1974. It is restricted to medical graduates. (An 'A reader' was a candidate who had completed a NIOSH-approved training course without an examination; however, such certification has been discontinued.) Initially focused on coal workers' lung disease, the content of the programme was expanded to include pneumoconiosis related to asbestos and silica. The B reader examination is offered a number of times a year at the NIOSH facilities in Morgantown, West Virginia,[27] as well as from time to time in other countries. To achieve B reader certification, a candidate must pass a timed exam consisting of 125 radiographs and consistently apply the ILO system in four major areas: technical quality, parenchymal abnormalities, pleural abnormalities, and other abnormalities. Certification must be renewed every four years. The training course offered by the ACR in previous years has been discontinued.

Information and training in the use of the ILO system is available from a number of sources. The guideline/booklet already cited[13] and digital standard images can be ordered from the ILO.[21] A NIOSH self-study syllabus (including a CD or hard-copy images) is offered by the NIOSH via its website.[20]

In the near future, a set of consensus-read images will be available via the Safety in Mines Research Advisory Committee (SIMRAC) and the MHSC. These are images that were acquired in the study described above, and which achieved a high degree of consensus among the expert readings.

The importance of the archive and information system

The availability of prior radiological, occupational and clinical information provides the time dimension and is one the great advantages of serial surveillance. This advantage is lost if images are read as one-off investigations, with the risk of both missing diagnoses and duplicating previous investigations at unnecessary cost. This is particularly the case in a population with a high prevalence of silicosis, and both previous and active tuberculosis. Comparison of the most recent chest image with previous images is necessary to identify new appearance or progression of silicosis, and changes which might suggest active tuberculosis, particularly against a background of old tuberculosis.[11,12]

For both diseases, the diagnosis is clinical. Apart from a chest image showing changes consistent with silicosis, the diagnosis of silicosis requires a history of sufficient exposure to inhaled silica, typically in the order of 10-20 years, depending on the intensity of silica exposure. Time since first exposure (latency), independently of the number of years exposed, may add further risk. Ideally, the occupational database should contain cumulative dust information for each miner but, lacking this, a full job history can serve as a proxy for likely relative intensity of exposure.

Similarly, knowledge of the miner's previous history of tuberculosis and other chest conditions and HIV status will assist in interpretation of an abnormal image. Such correlative information requires a PACS or equivalent, and a clinical and occupational database accessible by the practitioner responsible for radiographic surveillance. A paperless system is ideal.

The importance of using all clinical and occupational information available on each miner, to maximise the efficiency and effectiveness of the examination of the individual miner, cannot be overemphasised. Since the site may be physically remote, a mechanism needs to be in place for contacting responsible parties if an abnormality requiring immediate action is required. In the current context, this will most often be suspicion of active tuberculosis. The archival system needs to provide for backing up and confidentiality of medical information, as required by South African law, and security against physical events, such as fire or flooding, and human agency, such as cyber incursion.

Hard copies, the MBOD, and digitisation

The printing of digital chest radiographic images onto hard-copy and their submission to the MBOD for compensation purposes is still in current practice. However, the study reported in this paper and previous work[14] have clearly shown that soft-copy readings are recommended above hard-copy readings. This is because hard-copy readings overestimate the prevalence of pneumoconioses. We therefore do not recommend the use of hard-copy images. In this regard, the current wording 'X-ray photograph' used in the current amended version of the ODMW Act is ambiguous and should be replaced by the words 'radiographic image'.

The MBOD is in the process of setting up a digital radiography and reading system which enables it to receive and read digital images, submitted with claims for compensation under the ODMW Act. This will require substantial investment but is a necessary goal given the statutory requirement for radiographic medical surveillance in the South African mining industry. Such a system will need to be logistically meshed with the archive of the individual miner's history and analogue films held by the MBOD, and will need to include a PACS system to manage the flow of radiographic images, as well as viewing software and suitable hardware to read the images.

CONCLUSION

Radiological surveillance for silicosis and tuberculosis in the South African mining industry has an important role to play in the prevention and management of both diseases, to the benefit of miners and their families and mine management and owners.

To fulfil this role, radiological surveillance needs to be undertaken with a clear understanding of its goals, and ability to achieve these goals should be

subject to evaluation from time to time. Such programmes require training of readers, irrespective of their backgrounds. Meticulous attention needs to be paid to choice and quality control of software and hardware, including workstation environment, use of standard images, and archiving of images and information. Finally, closure of the loop from reading to reporting and action, must be assured.

DECLARATIONS

RE has written expert reports for plaintiffs' lawyers in silicosis litigation. AF has written reports on behalf of defendants in silicosis and asbestos litigation. JtWN has worked for lawyers setting up compensation funds for asbestos, silicosis and tuberculosis-affected miners. CAM has worked as a B reader in several large studies supported by the National Industrial Sand Association, and has provided medical expert testimony in coal workers' pneumoconiosis litigation.

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LESSONS LEARNED

- Digital soft copy (on screen) has been shown to be equivalent to traditional film images in the reading of silicosis and tuberculosis. Digital hard copy is not recommended.
- For reading soft copy, the reading environment, hardware and software systems should comply with recommended standards for pneumoconiosis, where available, and be equipped with the digitised International Labour Organization (ILO) chest radiograph set.
- Training of readers of pneumoconiosis and tuberculosis is essential, making use of established programmes and/or materials developed by projects such as the consensus-read image set described in this paper.
- Efficient and effective surveillance for silicosis and tuberculosis in the mining industry requires that prior occupational, clinical and radiological information be available as well as a rapid referral mechanism for abnormal findings.

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A method for reading plain chest X-rays

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INTRODUCTION

Chest X-rays (CXRs) are an important investigation in lung disease. Many occupational lung diseases can be diagnosed by chest radiography which is routinely used in occupational medical surveillance and screening. We are often faced with the task of reading a CXR that may be normal, has a plethora of abnormalities, or an abnormality which is easy to spot but we then forget to read the rest of the image. It helps to have a systematic approach such as the one presented here, which allows a comprehensive reading of the subject's image. The putative advantage of the method presented here is that the areas read are both alphabetical and contiguous. There are many similar systems[1] and radiologists suggest that we find a system that works for us, and use it consistently.[2]

The CXR compliments the medical examination; it is not a substitute. It is important to keep in mind that it is a two dimensional snapshot of the chest, where the multiple structures visualised are flattened into a single representation. More information is gained by requesting a lateral view, or requesting a computed tomography (CT) scan of the chest, which is a three dimensional view. Although this involves higher costs and radiation, CT scans can be invaluable in providing more definitive information as to the nature of an abnormality found on a CXR. The value of comparing the current CXR with previous films cannot be over-emphasised.

A FEW INITIAL CONCEPTS

Positioning

In a postero-anterior (PA) CXR, the X-rays penetrate from the back of the patient to the image capture plate in the front. PA CXRs facilitate moving the scapulae off the lung fields, and the heart is captured close to the actual size as the heart is an anterior structure.

Radiographic densities

Five radiographic densities are described in Table 1, in descending order of density.

STANDARDS OF QUALITY

Chest radiographs are acquired according to international standards.[3] For occupational medicine purposes, the reading guidelines set by bodies such as the International Labour Organization (ILO) and the National Institute for Occupational Safety and Health (NIOSH), are excellent benchmarks. They have both published standards for the reading of CXRs.[4,5]

One first reads for quality and then reads the image itself. Prior to this, however, one needs to ensure that the reading environment is suitable. The reading room should be evenly lit with low ambient light, no direct sunlight, no glare, with clean viewing surfaces, and be clean, quiet and free from distractions.[4] One should be able to appreciate subtle density differences on the images one is viewing. Digital images need to be viewed on a medical grade monitor, where the pixel pitch (the dark space between individual pixels) is less than 0.2 mm. As to the eye-to-image distance, for analogue one can read as close as 25 cm from the lightbox, but 40-60 cm is favoured by many. With digital images, similar guidelines apply, except that the image should be at least two thirds the full size, whether it is viewed on the screen or as a printed copy.

ASSESSING IMAGE QUALITY

The image must be clearly labelled with the subject's name, the date that the image was acquired, and a marker for left or right. An adequate inspiration allows one to count six or seven anterior ribs and/or nine to ten posterior ribs above the diaphragm. It is easier to count on the right side.

To assess positioning, check whether the thoracic spinous processes (Vs) are centrally aligned and are equidistant from the medial ends of the clavicles. The spinous processes are posterior, the medial ends of the clavicles are anterior, and this makes it easy to see if there is rotation or poor positioning. If there is significant rotation, the lung densities may appear dissimilar and the cardiac silhouette abnormal. The scapulae should be entirely excluded from the thoracic cage which should also not be cut off at the top (apices), the bottom (costophrenic angles), or on either side.

On a well-exposed image, detailed pulmonary vessels and spine are seen behind the heart, with the intervertebral discs just visible. If the image is under-penetrated one will not be able to see the thoracic vertebrae.

The most common quality errors to look for are over- or under-exposure,

Table 1. Radiographic densities

	Density	Comments
5	Metal	Usually absorbs all X-rays and appears the densest, e.g. barium, foreign bodies
4	Calcium	The naturally most dense occurring material, e.g. bones with calcium and phosphate (absorbs most X-rays)
3	Liquid/tissue	Both fluid (e.g. blood) and soft tissue (e.g. muscle) have same densities on plain radiographs e.g. muscles. Heart muscle and blood in the heart are indistinguishable as they have the same density
2	Fat	Grey, somewhat more lucent than soft tissue
1	Gas	Absorbs the least radiation and appears the least dense, e.g. trachea, lungs, and the stomach or intestine, where these contain air

under-inspiration, rotation in any axis, cut-off areas such as the apices and costophrenic angles, scapulae overlying the lungs, slightly unfocused images (possibly due to movement), and artefacts (opacities that are not part of the intended image). The advent of digital chest imaging has reduced, but not eliminated, such quality errors.

MAKING SPECIFIC FINDINGS

One has to examine each area. One does not merely see the important findings without looking specifically at that area.

An obvious abnormality on CXR carries a caveat – do not give in to 'search satisfaction'. This is because an obvious abnormality may not be the most important. Note it and continue with a systematic check of the rest of the image.

The method for reading progresses alphabetically and traces contiguous areas, as indicated Figure 1.

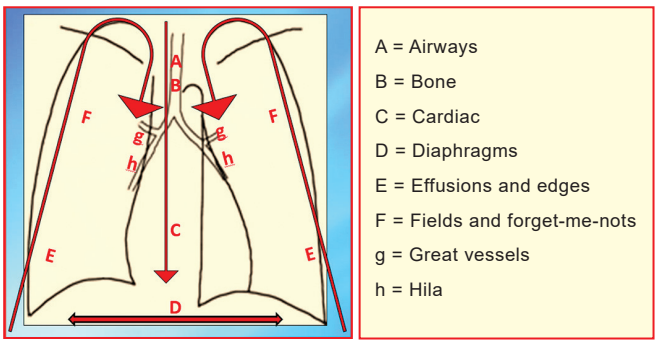

Figure 1. A diagrammatical representation of the order of reading, following the alphabet and contiguous areas
(Source: Jim teWaterNaude)

One is looking for the usual patterns when one examines each area, for structures or areas that are different from what one would expect, or four Bs: bigger, bolder, budged (displaced), or bilaterally dissimilar.

Airway

Check that the trachea is in the midline, and that the inside walls are parallel all the way down to the carina where the bifurcation angle averages 70-80 degrees, but has a wide range, with >90 degrees deserving attention. Note that, as the trachea is followed downwards, it might slope slightly towards the right. (Outside of the emergency setting, two of the more common causes of tracheal displacement are an enlarged thyroid and unfolding of the aortic arch, which may occur in the elderly or in hypertension.)

Bones

Check the bones for broad symmetry and abnormalities, checking the clavicles, the ribs and spine first, followed by the scapulae and shoulder area. Look for fractures, osteoporosis, missing ribs, densities and lucencies.

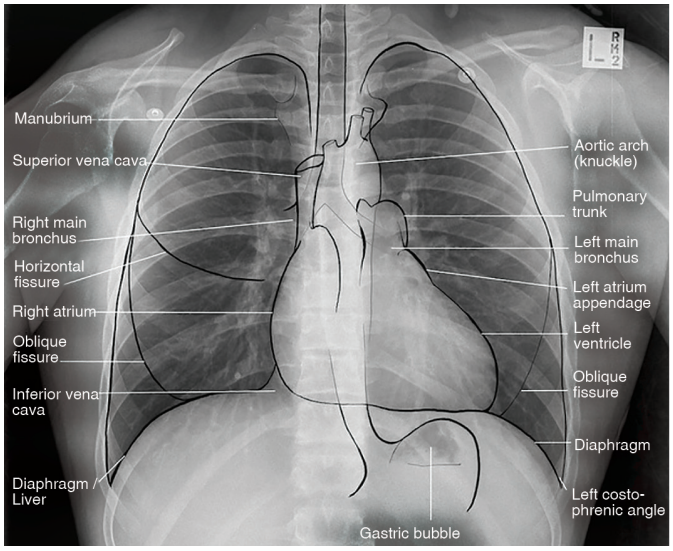

Figure 2. A normal frontal chest radiograph, with the main structures sketched and annotated. Note that, of the fissures, only the horizontal fissure and the lower end of the oblique fissure on the right might be seen on a normal CXR
(Source: http://www.ivline.org/2012/06/quick-guide-to-chest-X-rays.html)

Cardiac

The heart has a teardrop-like shape with one-third on the right, and two-thirds to the left, of the midline. The transverse diameter of the heart (the distance between vertical lines abutting the outermost margins of the right and left borders) should be less than half the transverse diameter of the chest, being the widest horizontal line between the inside edges of the rib margins. The left and right borders are uninterrupted.

The right heart border is formed by the right atrium, and the left border by the left atrial appendage and the left ventricle. Cardiac margins are sharp because there is a contrast between the fluid-density of the heart and the contiguous air-density of the lung. One cannot visualise the partition of the ventricles because there is no contrast between them, both being of fluid-density. If the adjacent lung is devoid of air, the clarity of the silhouette will be lost. This silhouette sign is extremely useful in localising lung lesions, as indicated in Table 2.

Having searched vertically and centrally, the next steps are to trace the structures laterally.

Diaphragm

Each hemidiaphragm is dome shaped, with the right being slightly higher by 1.5-3 cm (in approximately 5% of people, the left hemidiaphragm may be slightly higher than the right, as a normal variant). The outlines of each are smooth, with the highest part being in the middle of the lung field, sloping down laterally to the costophrenic angles which should be sharp and bilaterally similar.

Table 2. Lesion location using the silhouette sign

Structure obscured on the right	Structure obscured on the left
	Aortic knuckle – left upper lobe
Ascending aorta – right upper lobe	Descending aorta – left upper or lower lobe
Right heart border – right middle lobe	Left heart border – lingula segment
Right hemidiaphragm – right lower lobe	Left hemidiaphragm – left lower lobe

Check for bolder densities or lucencies along the outlines, flattening of the domes, blunting of the angles, and loss of clarity of the outlines.

The search then continues upwards along the inner margin of the lateral edge of the ribs.

Edges and effusions

Effusions fill up the costophrenic angles if there is about 300 ml of free fluid in the pleural space. They are visible in the posterior costophrenic sulcus on a lateral chest radiograph, with as little as 75 ml fluid. Effusions may be small and subtle, where they are recognised by blunting, by displacement (budging) of the highest part of the apparent hemidiaphragm laterally, and by bilateral dissimilarities. Larger and more obvious effusions have concave medial margins.

The inner lateral edges of the ribcage are examined in turn, tracing each side up to the apex and midline, looking at the overlapping ribs and the most peripheral 2 cm inside the ribs. The pleurae are not normally visible. One is looking for plaque-like pleural densities, normal fat lines running parallel and inside the rib margins, lucencies as in pneumothoraces, short thin lines abutting and perpendicular to the pleural surface, and any unusual peripheral opacities.

Fields and forget-me-nots

Each lung field is examined in turn. Normal broncho-vascular markings should taper from each hilum and be almost invisible at the lung periphery. The areas to examine systematically are the apices, behind the clavicles, below the clavicles, and the bottom half of each visible lung. One looks for asymmetry, infiltrates (interstitial or alveolar), masses, nodules, homogenous or non-homogenous areas of opacification, air bronchograms, and bronchial cuffing. The minor and major fissures may be visible in the presence of pleural thickening or fluid. There may also be diffuse patterns in the lung field, essentially dots, lines or nets, and these should be described.

The forget-me-nots, or so-called review areas, are the apices, behind the clavicles, behind the heart, and below the diaphragms. In the ABC system, this is where one can describe foreign bodies which can be outside the body, e.g. buttons, hair and jewellery, or inside, e.g. clips, drains, ECG leads, lines, pacemakers, tubes and valves.

Having done a full circuit of the radiograph, one returns to the top and examines two more areas.

Great vessels and environs

The great vessels are contained in the area below the thoracic inlet and above the ventricles. They are the ascending aorta, the aortic arch (the three major branches that arise from the arch are not normally visible), the descending aorta, and the superior vena cava. The brachiocephalic veins are not normally visible. The azygos vein may be seen as an ovoid density, adjacent to the concavity formed by the upper margin of the right main bronchus at the tracheal bifurcation. With hypertension, the aortic knuckle may become prominent and extend more than 4.5 cm laterally of the left tracheal border. Widening of the upper mediastinum (wider than the vertebrae) and changes to the right paratracheal stripe (loss of continuity, increase in thickness, or distortion) are almost always signs of abnormal pathology. Normally, the right paratracheal stripe extends from the clavicle to the right tracheobronchial angle and is 2-3 mm wide. Below the aortic arch and above the pulmonary artery on the left, is the aorto-pulmonary window which is usually concave. If it is not concave, consider a possible pathology, especially involving lymph nodes.

Hila

The hilum is the portal of entry and exit to the lung and includes bronchi, pulmonary arteries, pulmonary veins and lymph nodes. On the frontal view, most of the hilar shadows represent the left and right pulmonary arteries. The right hilum is lower than the left in contrast to the normal right hemidiaphragm being higher than the left.

Reminder: the hila can be bigger, budged (displaced) up or down, bolder or bilaterally dissimilar.

Increases in size may be caused by masses, lymphadenopathy, or pulmonary hypertension. The last may cause enlarged pulmonary trunks (more than 16 mm in diameter) with quick tapering of the vessels and their virtual invisibility in the outer third of the lung fields, commonly referred to as peripheral pruning.

If the hila are higher or lower than usual, there is probably loss of volume from lobar scarring, lobectomy, atelectasis or collapse.

Calcified lymph nodes may be seen as a dense focal area, and are often caused by prior tuberculosis infections. In silicosis or sarcoidosis, one looks for eggshell calcification of the nodes.

Impression

Concluding, one summarises the findings, and then gives the entire CXR another short examination to gain a second impression. A way to do this is to de-focus, sit back and relook.

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- http://teachmeanatomy.info/thorax/

Musculoskeletal pain among school teachers: are we underestimating its impact?

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ABSTRACT

Background: **Musculoskeletal disorders (MSDs) are a common occupational health condition which may significantly impact both work attendance and performance. School teachers represent an occupational group among which there appears to be a high prevalence of neck and/or shoulder pain (NSP) and low back pain (LBP). Epidemiological data on NSP and LBP in South African teachers are limited.**

Objectives: **To determine the prevalence of NSP and LBP among primary school teachers in the Central Durban area of KwaZulu-Natal, South Africa; to identify predominant occupational factors associated with NSP and LBP pain; and to highlight key actions associated with such factors so as to direct future preventive measures/interventions.**

Methods: **A cross-sectional, questionnaire-based study was conducted on teachers from 12 randomly selected primary schools.**

Results: **Among the 97 completed questionnaires, the prevalence of NSP and LBP was 80.4% and 68.0%, respectively. There was no association between age and NSP ($p < 0.250$) or LBP ($p < 0.595$). However, there were higher prevalence rates of NSP and LBP among the 45-54 years age group (39.2% and 33.0%, respectively). Factors associated with NSP included marking of assessments (56.7%; n = 55), and writing on a blackboard (39.2%; n = 38); prolonged standing was associated with LBP (83.5%; n = 81). These findings highlighted specific actions, such as forward-bending of the head for prolonged periods (61.9%; n = 60), backward-bending of the head for prolonged periods (20.6%; n = 20), and reaching/stretching with arms above chest height (41.2%; n = 40).**

Conclusion: **Key occupational factors associated with MSP, and associated actions identified in this study can be used as a basis to direct strategies that can be applied to reduce the prevalence of MSP and the onset of MSD in teachers.**

Keywords: **musculoskeletal disorders, musculoskeletal pain, neck and/or shoulder pain, low back pain, occupational risk factors**

INTRODUCTION

Musculoskeletal disorders (MSDs) are defined as inflammatory and degenerative conditions, involving the tendons, muscles, ligaments, peripheral nerves, joints and supporting blood vessels.[1] Such conditions result in overexertion of bones, ligaments and muscles, and typically manifest as musculoskeletal pain (MSP) with subsequent functional impairment.[2,3] Musculoskeletal disorder represents one of the most common and expensive occupational health disorders in developed and developing countries.[4] Additionally, MSP impacts negatively on quality of life, has financial implications with regard to compensation costs and wages,[5] reduces work productivity, and often leads to ill health retirement.[4]

Pope et al.[6] found that the prevalence of MSP was increased in people with occupations that are monotonous, involve high workloads with little personal autonomy, and are demanding in terms of time-based outputs. As such, school teachers are susceptible to the development of MSP and subsequent MSD. Recent epidemiological studies confirm this in reports of significantly high prevalence rates of MSP amongst school teachers.[4,5,7,8] MSP has been associated with factors such as heavy lifting; awkward postures; bending, twisting or stooping; prolonged sitting or standing; and repetitive motions.[4,8-11] A Saudi Arabian study conducted among female school teachers corroborated that a high work and improper posture is associated with frequent reports of neck and/or shoulder pain (NSP), upper limb pain (ULP), and low back pain (LBP).[2] In Scotland, MSP has been reported to be the second most common cause of ill-health retirement in teachers.[12,13] Erick and Smith (2015) postulated that "If little or nothing is done to reduce the prevalence of this crucial workplace problem, MSD may potentially lead to reduced teacher performance, increased absenteeism, ill-health, early retirement and increased health care costs".[14]

More recently, in 2017, LBP and NSP in high school teachers were correlated with psychological distress and work-related psychosocial characteristics.[15] Multivariate analysis demonstrated an association of both self-reported LBP and NSP, with depression and anxiety. The incidence and management of MSP among teachers warrants further research,[5,10,16,17] particularly in Africa.[18] Despite the wide exploration of both prevalence of, and risk factors for, MSDs, especially in the workplace, there is a paucity of studies that investigate the prevalence of, and risk factors associated with, MSP among South African teachers.[19]

This study aimed to calculate the prevalence of NSP and LBP among primary school teachers in the Central Durban area of KwaZulu-Natal, South Africa; to identify occupational factors associated with NSP and LBP; and to identify associated key actions, to direct future preventive measures and/or interventions.

METHODS

A cross-sectional study was conducted among primary school teachers in randomly selected public schools in the Central Durban area, KwaZulu-Natal, during July to September 2015. Twelve schools were randomly selected from a list of 95 public primary schools obtained from the KwaZulu-Natal Department of Education. All teachers employed in the selected schools (approximately 20 teachers per school) were invited to participate in the study. A total of 177 self-administered questionnaires were distributed.

The questionnaire was constructed and adapted from the Dutch Musculoskeletal Questionnaire.[20] Demographic variables, teaching history, and information on NSP and LBP (with possible associated occupational risk factors), formed the basis of the questionnaire.

Ethical considerations

Ethical clearance from the institutional research ethics committee at the Durban University of Technology was obtained prior to conducting the study (REC 68/14). Permission to conduct research within schools was obtained from the KwaZulu-Natal Department of Education and from the principals of the selected schools. The teachers received letters outlining the study, explaining their voluntary participation, and assuring confidentiality of the data provided. A letter of informed consent was signed by each participant.

Statistical analyses

Data were analysed using the SPSS statistical package (version 21), with statistical significance set at $p \leq 0.05$. Descriptive analyses were performed on categorical variables (summarised as frequencies and percentages) and continuous variables (summarised as means and standard deviations). Associations of factors with MSP were assessed using bivariate analyses (chi-squared tests and independent t–tests), where appropriate.

RESULTS

The response rate was 54.8% (97 of the 177 questionnaires were returned). Most of the participants were female (80.4%, n = 78). Nearly 60% were Indian (58.8%, n = 57), 18.6% were coloured (n = 18), 12.4% were black (n = 12), and 8.3% were white (n = 8). Almost half of the respondents (44.3%, n = 43) were in the 45-54 years age group; a minority was in the 55-65 years age group (12.4%, n = 12). There was an even distribution of participants in the 25-34 (16.5%, n = 16) and 35-44 (19.6%, n = 19) years age groups.

Most of the respondents experienced NSP (80.4%, n = 78) and/or LBP (68.0%, n = 66) in the previous 12 months. Marking of written assessments was significantly associated with both NSP

Table 1. Association between MSP and demographics/period of onset (N = 97)

Category	NSP			LBP		
	n	%	p-value	n	%	p-value
Sex			0.576			0.300
Male	9	9.3		7	7.2	
Female	63	64.9		54	55.7	
Ethnicity			< 0.001*			0.008
White	5	5.2		3	3.1	
Black	5	5.2		4	4.1	
Indian	51	52.6		44	45.4	
Coloured	16	16.5		14	14.4	
Age			0.247			0.594
25-34 years	11	11.3		10	10.3	
35-44 years	16	16.5		13	13.4	
45-54 years	38	39.2		32	33.0	
55-65 years	10	10.3		9	9.3	
Time of day			0.097			0.097
Morning	6	6.2		5	5.2	
Afternoon	16	16.5		9	9.3	
Evening	15	15.5		14	14.4	
Time of the week			0.417			0.584
Beginning of work-week	1	1.0		4	4.1	
End of work-week	4	4.1		6	6.2	
Weekend	3	3.1		4	4.1	

*statistically significant ($p \leq 0.05$)

Table 2: Key actions associated with occupational factors contributing to MSP (N = 97)

Region of pain	Activity	Key action	n	%	p value
Neck/ shoulder	Marking assessments	• Forward-bending of head for a prolonged time	60	61.9	0.001*
	Writing on a blackboard	• Stretching arms above shoulder height	40	41.2	0.766
		• backward-bending of head for a prolonged time	20	20.6	0.016*
	Carrying/lifting equipment/ teaching resources	• Carrying heavy loads	17	17.5	0.120
		• Carrying heavy loads in awkward posture	8	8.3	0.055*
		• Carrying heavy loads that are difficult to hold	8	8.3	0.558
Low back	Prolonged gait	• Standing for a prolonged time	81	83.5	0.000*
		• Sitting for a prolonged time	24	24.7	0.743
		• Walking for a prolonged time	27	27.8	0.365
	Prolonged postural discomfort	• Stooping for a prolonged time	9	9.3	0.789
		• Working in a bent posture for a prolonged time	33	34.0	0.059*
		• Working in a twisted posture for a prolonged time	10	10.3	0.163
		• Working in a bent and twisted posture for a prolonged time	10	10.3	0.486
		• Working in uncomfortable postures	23	23.7	0.054

n and % indicate the number and proportion of participants who responded positively when asked about the actions performed during the various activities.
* statistically significant ($p \leq 0.05$)

(56.7%; n = 55; p = 0.001) and LBP (40.2%; n = 39; p = 0.016). In addition, 39.2% (n = 38) of the respondents indicated that writing on a blackboard contributed to their NSP, while 25.8% (n = 25) reported that it contributed to LBP. Computer use and carrying/lifting equipment/teaching resources was also reported to be a contributor to MSP: 34.0% (n = 33) and 25.8% (n = 25) for NSP, respectively; and 21.7% (n = 21) and 23.7% (n = 23) for LBP, respectively.

The associations between MSP (NSP and LBP) and selected demographic variables are shown in Table 1. We failed to demonstrate any statistically significant associations between age and gender, and the onset of MSP. Despite the statistical difference observed amongst race groups, we did not conduct a post-hoc test to determine the between group effect (i.e. between which race groups the statistical difference was). The small sample size of some of the race groups reduced the statistical power for such a comparison. Although more incidents of MSP were reported during the afternoons/evening in comparison to the mornings, the difference was not statistically significant. There were also no significant differences in the frequency of MSP at the beginning of the work-week, and the end of the work-week or weekend.

Work-related activities associated with the onset of NSP and LBP

Table 2 highlights the key actions associated with the occupational factors contributing to NSP and LBP. Holding the head in a forward-bent posture (61.9%; n = 60) and reaching/stretching with arms above chest height (41.2%; n = 40) were reported as the most common risk factors linked to the onset of NSP. In addition, standing for a prolonged time (83.5%; n = 81) and working in a bent posture for prolonged periods (34.0%; n = 33) were associated with LBP. It is possible that marking assessments (when the head in forward-bent posture), and writing on a blackboard (when the head is in backward-bent posture and the arms are stretched forward above chest height) might be activities that aggravate the frequency and onset of NSP. Standing for prolonged periods and working in a bent posture for prolonged periods might be aggravators of LBP.

DISCUSSION

Primary school teachers are predisposed to MSP since the bulk of their time is spent walking or standing in an attempt to supervise or ensure complete learner understanding of the teaching material.[2] The increased mobility and reduced rest breaks between class sessions may be key in understanding the risks attached to MSP. Our study demonstrated a 80.4% prevalence of NSP and a 68.0% prevalence of LBP in the 12 months prior to administration of the questionnaires. These findings are much higher than those from a recent Chinese study that reported prevalence rates of 48.7% and 45.6% for NSP and LBP, respectively,[4] and a Turkish study that reported prevalence rates of 42.5% for neck pain, 28.7% for shoulder pain, and 43.8% for LBP.[16] However, they are similar to those from a Hong Kong study conducted among secondary school teachers, which reported a prevalence of 69.3% for neck pain.[21] The high prevalence observed in the teachers in our study might be related to the increased job demands in the South African context, which include dealing with the steadily increasing number of students in the classroom, particularly in public schools.

Despite the lack of a statistically significant difference between age, and either NSP (p = 0.247) or LBP (p = 0.594), the highest prevalence of NSP (39.2%) and LBP (33.0%) was in the 45-54 years age group. Similar prevalence rates have been reported for NSP in the 46-50 and 40-49-year age groups in Asia[16,22] and it has been suggested that NSP is associated

with age-associated degenerative changes within the joints, muscles, ligaments and tendons.[23] Ehsani and coworkers recently (in 2018) reported a significantly higher prevalence of NSP amongst teachers older than 40 years,[24] which might be linked to age-associated physical deterioration, reduced restoration of damaged tissue, and joint cartilage weakening.[4]

There was no statistically significant association between gender and MSP in our study, but this might be due the small number of males in the study (n = 16). Other studies have shown higher prevalence rates of NSP in women,[4,24,25] and have attributed this to the housework commonly done by women.[26]

Association between NSP and LBP and work-related factors

Occupational activities, such as marking written assessments, writing on blackboards, and standing for long periods are accompanied by awkward and static occupational positions/postures.[4,8,9,11] These occupational postures may result in shortened muscles which compress the nerves, resulting in weakened muscles and muscle imbalances.[27] We found associations between NSP and forward-bent posture of the head/backward-bent posture of the head, and lifting of heavy loads. These results support findings from previous studies in which significant associations between neck pain and static and repetitive neck positions, especially with prolonged neck flexion, and static and repetitive or forceful movements of the arms, were found.[9,28]

Marking of assessments was identified as the largest aggravating factor for both NSP (56.7%) and LBP (40.2%). The majority of respondents with NSP reported that teaching required them to keep their heads in a forward-bent posture for a prolonged time, which can be expected due to the hours spent marking, reading, writing and leaning forward to help scholars. Our study corroborates the findings from a study by Chiu and Lam (2007)[21] which showed that 85.1% of neck pain was due to a head-down posture. Similarly, Ehsani and co-workers studied NSP in Iranian teachers,[24] and reported that occupational activities such as computer usage, and marking and reviewing of examination scripts, which support a head-down posture, increased vulnerability to NSP.[24] They also reported that age, sex, physical inactivity, occupational satisfaction, overall physical health and employment duration predisposed the teachers to NSP.[24]

Da Silva and Almeida (2012)[29] also explored the posture and physical activities to which teachers are exposed during their daily classroom routines. They reported that changes in posture as a result of the different occupational activities that teachers are required to perform, predispose them to MSP.[29] They also suggested that postural changes, combined with general fatigue in the classroom, increase the vulnerability of teachers to disease and MSP if they are not physically active. A more recent study, conducted in Sweden, revealed that MSP amongst teachers may be more strongly linked to psychosocial factors than to physical workload.[30] The emotional demands that teachers experience within the classroom might increase their risk of MSP.

Recent studies found LBP to be associated with standing for a prolonged time, specific sitting habits, a sudden change in posture, and carrying heavy objects.[31,32] These studies also reported a correlation between LBP in teachers and routine classroom activities, such as marking of examination scripts and increased computer use.[31,32] These reports support our findings of a relationship between standing for a prolonged time and LBP. In our study, standing for a prolonged time was the second most common aggravating factor for LBP, after marking. Others suggest that prolonged standing and resultant LBP might be attributed to the lack of spinal movement, which increases the load on lumbar spinal tissues, and subsequently causes MSP.[33] Andersen et al.[34] reported that LBP might be associated with standing for longer than 30 minutes.

Limitations

The cross-sectional nature of the study allows for associations to be identified, but no inferences on causality could be established. The questionnaire used relies on recall and self-reporting, which might result in recall bias, and underestimation of the prevalence. The small sample size and poor response rate might have also resulted in bias: those with MSP might have been more likely to participate in the study. Other potential contributors to MSP, such as personal and work-related psycho-social stressors which might contribute to MSP, over and above the occupational physical demands, were not incorporated into the questionnaire.

CONCLUSION AND RECOMMENDATIONS

This is the first study, to our knowledge, on MSP among teachers in South Africa. MSDs are an important consideration in the workplace. School teachers, due to physical demands related to the profession, are at risk of developing MSDs. Strategies need to be developed to reduce the prevalence of MSDs in teachers. These include primary prevention strategies at an organisational level (such as educational drives to inform teachers of the implications of MSDs, education about ergonomics and appropriate postures); primary prevention strategies at an individual level (such as taking rest breaks between activities, keeping physically active, and engaging in regular muscle flexibility exercises); and secondary prevention strategies (such as improved access to healthcare, supported and subsidised by the organisation).

We recommend further research, targeting various job types/occupational activities within the teaching community to provide information on MSD from a wider representation of teachers. Future studies should use a longitudinal study design to determine the role of psychosocial factors (both work-related and external) in the development of MSP among teachers.

ACKNOWLEDGEMENTS

The authors would like to thank the Durban University of Technology for seed funding and Tonya Esterhuizen, for her statistical input.

DECLARATION

The authors declare that they have no conflicting interests.

LESSONS LEARNED

- Prevalence rates of NSP and LBP among teachers in South Africa might be higher than in many other countries.
- NSP and LBP in teachers are related to the specific activities performed in the profession.
- Strategies to reduce the incidence of MSD in teachers need to take into account the activities undertaken, and postures adopted, during working activities.

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Message from the SASOM Chair

SASOM ACTIVITIES

At the Department of Labour's (DoL) Occupational Health Forum quarterly meeting held on 14 February 2018, various issues were discussed, including the recommendation for occupational health service providers to be made public via DoL platforms. The meeting was attended by representatives of the three sister organisations: The South African Society of Occupational Medicine (SASOM) (Daan Kocks, Adriaan Combrinck, Jenny Sapire, Funeka Ngcakani); the South African Society of Occupational Health Nursing Practitioners (SASOHN) (Denise Minnie, Kim Davies, Trudie Oates, Lindie Jansen van Rensburg, Karen Michell); and the Southern African Institute for Occupational Hygiene (SAIOH) (Jaco Pieterse). Dr Lucas Mosidi, representative from the DoL Compensation Fund, also attended. On 16 February 2018, Daan Kocks (SASOM) and Kim Davies (SASOHN) met with DoL representatives to discuss recommended changes for the Hazardous Biological Agents (HBA) regulations. SASOM and SASOHN have been reviewing the recommendations for changes to the regulations (in terms of requirements for occupational health service providers) as a combined effort, to inform labour and employers, via the DoL. The meeting was also attended by representatives from the National Institute for Communicable Diseases (NICD) of the National Health Laboratory Service (NHLS), and the Hospersa union.

The first meeting of the year of the SASOM Executive Committee was held on 13 February. Prof. Mary Ross (SASOM lifetime member) represented SASOM at the annual *Occupational Health Southern Africa* Presidents' meeting on 16 February 2018.

HELLO AND GOODBYE: PASSING THE BATON

After close to 15 years of dedicated service to SASOM, Ms Jenny Acutt, in her capacity of Project Coordinator at the SASOM National Office, will be retiring officially. Jenny, an occupational health nurse by training, has managed the SASOM National Office very competently for many years, and has been responsible for much of the behind-the-scenes work that is required to ensure the smooth running of day-to-day tasks, the maintenance of the membership database, and the SASOM special projects, such as the administration required for the SASOM guidelines and communication with members, the annual congresses, the meetings of the SASOM Executive Committee, and the SASOM Annual General Meetings and Academic Days. Jenny has been an active and enthusiastic SASOM promoter and supporter who has lectured to many Diploma in Occupational Health students at various tertiary institutions over the years.

The end of an era is the beginning of a new chapter: Ms Jenny Acutt (left) retires officially as the SASOM National Office Project Coordinator and passes the baton to Ms Margarethie Bredenkamp, her successor. SASOM wishes both ladies much success in their respective future endeavours *Photograph: Daan Kocks*

SASOM has appointed Ms Margarethie Bredenkamp as the successor to Jenny, from 1 March 2018. Margarethie has extensive experience in all aspects of office management and administration, project management and budgeting, and a good working knowledge of procedures and protocols (national and international) across sectors. An economist by qualification, Margarethie has worked for the Departments of Trade and Industry, National Treasury, and as a consultant for the Global Growth Green Trust and the Climate Resilient Infrastructure Development Programme.

Jenny will continue to be employed as a SASOM contractor, to ensure a smooth transition in the SASOM office, and to assist and support Margarethie with her on-boarding to the SASOM office tasks, procedures and responsibilities.

SASOM takes this opportunity to thank Jenny for her invaluable contribution to the success and sustainability of the Society and her dedication to her work over many years, and welcomes Margarethie as the new SASOM Project Coordinator, wishing her a successful and rewarding career at SASOM.

SASOM MEMBERSHIP FEES 2018 AND NEW OFFICE HOURS

SASOM members are reminded that their membership fees for 2018 are due, as per invoices sent in December 2017. Members are asked to please ensure that SASOM has their correct contact details to secure receipt of all issues of *Occupational Health Southern Africa*, the subscription of which is included in the annual membership fee.

Please note that, from 1 March 2018, the office hours of the SASOM National Office are 08:00-13:00 daily.

SAVE THE DATE – SASOM ANNUAL CONGRESS 2018

SASOM is pleased to announce that this year's Annual Congress will take place on 22 and 23 June 2018, at the Protea Hotel by Marriott, ORTI Airport, Kempton Park. The theme of the Congress is 'Occupational Health – Looking back to move forward: Old lessons inform solutions for new issues'. The congress programme is under development, and we will keep members informed of progress.

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Report from SAIOH President and Council Members

MESSAGE FROM THE SAIOH PRESIDENT

SAIOH Strategic Planning Session – February 2018

February has been a busy month for the Southern African Institute for Occupational Hygiene (SAIOH) Council. As well as our normal Council meeting, we held a strategic planning session which was very well attended by your representatives on Council, allowing many varied and important projects to be considered. The session revealed that the Presidents and their respective Councils of the past three years really embraced the strategic goals set in 2015, with between 40% and 90% completion of the past three years' objectives. Finalising these objectives is ongoing with management, and priorities have been set to attain full delivery.

The session allowed us to relook at the southern African marketplace and our own SAIOH membership demographics, and informed the realignment of our objectives to better serve all stakeholders. We are able to announce a change in Council portfolios and several new projects which we hope will enhance our organisation and serve all stakeholders better.

The formation of a Mining Forum – this will aid SAIOH in better understanding the mining industry and the challenges faced by our mine-based members, and aims to improve support and development for these members. The Mining Forum is our key initiative for 2018; it will be chaired by Brian Mongoma, the recently nominated Vice Chair of the SAIOH Professional Certification Committee (PCC), ably supported by Cas Badenhorst – two wonderful champions.

SAIOH Council considers this initiative to be one of the most important developments in many years, and we are gearing to launch the forum formally at the 2018 SAIOH Annual Conference.

The SAIOH ethics, complaints and investigation procedures also take centre stage this year. This is an area where major changes were required, and we hope that the new streamlined system, presently in development under the ownership of Kenneth Hlungwane (Immediate Past President), Cas Badenhorst and Julie Hills, will allow us to ensure that non-compliances with regard to ethical practice and poor professional service delivery are fairly investigated and, more importantly, that offenders are suitably punished. A word of caution to our members – ensure that your professional service is above board!

The roll-out of the regional structure to enable SAIOH to serve members better across South Africa, and beyond our borders to neighbouring countries, will begin in earnest. It was decided that, due to the volume of work related to this and the need to replicate the system in all three regions, SAIOH will trial one region as a pilot. The learnings and outcomes can then be transferred as a workable system to the other two regions. This project will be managed by Norman Khoza and the present branch chairpersons; job descriptions for the Regional Coordinators have been drafted and the posts will be advertised soon.

The introduction of a new portfolio: Policy and Planning – under the ownership of the SAIOH President and Vice President. This portfolio will ensure that systems are developed and documented to ensure constant and quality management of SAIOH as a business concern, with tracked KPIs and deliverables. This will also encompass strict financial management to ensure that SAIOH offers value for money to its members.

SAIOH ANNUAL CONFERENCE 2018 – STATUS UPDATE

Planning for the 2018 Conference at Champagne Sports Resort in the central Drakensberg is forging ahead, and the KZN branch committee is working hard to develop the programme. This will be an exciting conference, with the stimulating theme: *Raising the bar in Occupational Hygiene: Informed control reduces worker exposures*.

Two excellent Professional Development Courses (PDCs) have been confirmed to date, where international experts in their respective fields of speciality will workshop important topics:

Draw card 1 – Practical measurement of local exhaust ventilation (LEV) systems, presented by Adrian Sims (UK), member of the Institute of LEV Engineers (ILEVE); the Institute is accredited for LEV design, and commissioning, testing and installation of LEV systems.

Adrian is the Managing Director of VENT-TECH and has presented British Occupational Hygiene Society (BOHS) modules on the measurement of LEV systems proficiency training around the world. He is currently the only professional in the UK holding a Certificate of Competence in LEV and the BOHS's Faculty of Occupational Hygiene's Specialist Member Grade for LEV.

Draw card 2 – Practical noise control, presented by Dennis P. Driscoll (USA).

Dennis is the President and Principal Consultant of Associates in Acoustics Inc., and Past President of the National Hearing Conservation Association (NHCA); he is a registered Professional Engineer and a Board Certified Noise Control Engineer. Active in his field since 1980, his specialties in acoustics include measurement of equipment

Champagne Sports Resort in the central Drakensberg, venue for the 2018 SAIOH Annual Conference
Source: www.safarinow.com

noise levels and employee noise exposures, the design of engineering controls, and environmental surveys. Dennis is one of the most popular PDC facilitators in the USA and presents this PDC annually due to the high demand!

SAIOH is considering the possibility of an additional PDC, and repeating the two PDCs which are already confirmed, should there be enough interest from our members; we will keep you posted on these initiatives via the SAIOH website and mail drops.

As already mentioned, the Conference will run for a day longer than usual, with the launch of the SAIOH Mining Forum. This will be a day of acknowledgement for our mine-based colleagues and the value they add to our profession. It is early days and we are still evaluating ideas for format and content, but SAIOH is pleased to announce that Anglo American will be sponsoring Brian Davies, a renowned Australian occupational hygienist working in the mining sector, to be the keynote presenter.

The conference draft programme is under development and will be announced within the next few months. Please save the dates of 23-26 October 2018 for the SAIOH flagship event of the year: PDCs (23 October); the launch of the SAIOH Mining Forum and associated activities, in parallel with a second offering of the PDCs (24 October); and the main conference (25-26 October).

DRAFT ASBESTOS REGULATIONS

The new draft Asbestos Regulations were released on 19 January 2018 and have been circulated to SAIOH members for review. The regulations are important and members are urged to make an effort to review them and provide comments or suggestions for changes. SAIOH will submit a joint response to the Department of Labour (DoL); to this end, SAIOH has a team of members who has offered to critique the document and content, and to formulate an official response on behalf of SAIOH, in conjunction with our sister organisation, the South African Institute of Occupational Safety and Health (Saiosh), and the Master Builders Association. Please forward your comments and inputs for inclusion in the document to info@saioh.co.za, as soon as possible.

REMINDER: SAIOH ANNUAL MEMBERSHIP 2018

SAIOH members are reminded that they are required to submit their CPD points for 2017 and to ensure that their mandatory annual membership fees are paid, to remain in good standing and certified to practise in the field of occupational hygiene.

In my capacity as SAIOH President, I would like to end off by assuring our SAIOH membership that your Council members are working hard to serve your needs and we thank you for your continued support. Council also welcomes your inputs and ideas for improving SAIOH's value-add for its members.

Keep safe and healthy.

Report by:
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Report on the ICOH Scientific Committee on Education and Training in Occupational Health Symposium

October 2017 saw the Scientific Committee on Education and Training in Occupational Health (SCETOH) convening a joint symposium with the Scientific Committees on Rural Health and Effectiveness in Occupational Health Services, titled *Education in occupational safety and health, emerging trends and unmet needs.* The symposium was held in the beautiful city of Zagreb, Croatia, under the auspices of the Croatian Institute for Health Protection and Safety at Work which, in collaboration with SCETOH, led by Marija Bubas and Frank van Dijk, also organised the event.

The symposium opened on Thursday evening at the Palace of the Croatian Academy of Sciences and Arts where delegates were welcomed by the President of the Class of Medical Sciences of the Croatian Academy of Sciences and Arts, as well as a representative of Mrs Kolinda Grabar Kitarovic, the President of the Republic of Croatia. This prestigious delegation of welcoming officials represented the status afforded this international symposium, with delegates representing 60 countries.

Following the welcome, four keynote presentations set the scene for the following day and a half of oral and poster presentations. Frank van Dijk from the Netherlands highlighted the research needs and opportunities in education and training in occupational health (OH). Van Dijk's presentation urged delegates to consider appropriate designs for evaluation research in OH education and training, and encouraged participants to implement effective evaluation studies on education systems and educational interventions. Davide Bosio from Italy presented the new International Labour Organization (ILO) International Training Centre (ITC) Masters degree in Occupational Safety and Health (OSH) programme, presented at the University of Turin, Italy. This one-year course is offered through blended learning with two Internet-based distance-learning phases and an 11-week residential period in Turin. Jadranka Mustajbegovic from Croatia gave a talk on education in occupational medicine in Croatia, titled 'Known, knowns and unknowns - the present state'. Mustajbegovic drew attention to the fact that occupational medicine is infused throughout many of the medicine courses at an undergraduate level, as well as at a post-graduate level. The School of Medicine at the University of Zagreb has one of the oldest occupational medicine courses in the world, started in 1949. Marija Bubas closed this session with a talk on training in interdisciplinary team work in the Croatian Institute for Health Protection and Safety at Work (CIHPSW). The CIHPSW has both occupational physicians and safety experts working together for workers' health and safety. A particularly interesting aspect of the symposium was that it addressed the education and training of not only OH professionals, but also workers.

Friday morning opened with a round table session where presenters from Europe, Japan, China, India, Australia, Africa (South Africa – Penny Orton), Latin America and the USA described experiences in training health professionals: 'Current situation and unmet needs around the globe'. There was a preponderance of training of occupational medicine practitioners and only one presentation on the education of specialist OH nurses. This presentation was well supported by delegates and it was acknowledged that medicine and nursing need to work more closely on the education and training of the various OH professionals. The afternoon was split into four parallel sessions, followed by poster presentations. The parallel sessions included: international collaboration in strengthening capacities in OSH training; education of students and professionals – troubleshooting and how to do it; education of old and new target groups; education and training in agricultural health and safety; and exchange of experiences in teaching methods, blended-learning and organising a repository of electronic materials. Twenty posters were presented on a variety of topics where worker education predominated; many posters were presented by members of the CIHPSW. Presentations were made to small groups of delegates who moved between the posters in order to make the process manageable.

South Africa was represented by Muzi Zungu from the National Institute for Occupational Health (NIOH) and the University of Pretoria, and Penny Orton, representing the South African Society of Occupational Health Nursing Practitioners (SASOHN) and the Durban University of Technology (DUT). There were two occupational medicine practitioners from Mozambique, one of whom is specialising in occupational medicine at the University of Cape Town (UCT). Zungu presented a paper on occupational health and safety for naïve health workers in South Africa, which concluded that health workers who enjoy the support of their senior management can be trained to conduct basic occupational health and safety activities at work. Orton presented on OH nurse training in southern Africa and concluded that the time was right for the specialist training of nurses' curriculum to be influenced by international trends as the curriculum is currently being redesigned. The training of specialist OH nurses to the level to which they are trained in South Africa is advanced in

Dr Muzi Zungu (NIOH, Johannesburg) and Dr Penny Orton (Durban University of Technology, Durban).
Photographer: Unknown

comparison with the rest of the world, where it appears that specialist OH nurse education is still a 'short course' and not presented at the post-graduate level of the qualifications offered in South Africa. The integration of basic OH services into primary healthcare in order to reach more workers was promoted on many occasions during the symposium. This presents an opportunity for educational institutions and health services which educate and train primary healthcare providers.

Saturday concluded the symposium with a further two sessions of five and six presentations each. Frank van Dijk closed the symposium with a summing up of the main messages, which are believed to need increased attention and should guide further work:

1. Education of workers, managers and students in vocational schools is a tool for change.
2. Education for workers, managers and vocational students is under-estimated and there is a need to increase these offerings in order to improve health and safety in the workplace.
3. More attention needs to be paid to interdisciplinary collaboration in OSH training: "Education and training of experts in OSH deserves much more attention as the needs are high, compared with the numbers of experts and training capacities. Occupational health nurses can play a key role. Cordial and effective interdisciplinary collaboration has to be part of education dedicated to the common goal of supporting workers and enterprises in occupational safety and health."[1]
4. Basic occupational healthcare is urgently needed and should be infused into the training of primary/community healthcare providers, agricultural healthcare workers and medical students.
5. The evaluation of OSH education is important - "no education without evaluation."
6. There is a need to improve teaching techniques, particularly in blended learning and electronic learning.
7. Think about OH learning needs in context – learning objectives must be relevant to the prevailing context, which should form the base for educational advancement.
8. Collaboration, nationally and internationally, between organisations, institutions and networks is important.

Some of the many resources to which I was introduced through various speakers, and which readers might be interested in exploring further, include:

1. Foundation Learning and Developing Occupational Health (LDOH) [www.ldoh.net]
2. Basic Occupational Healthcare in Agriculture: a concise course for practitioners in primary healthcare [https://ldoh.net/]
3. National Centre for Farmer Health in Australia [www.farmerhealth.org.au]
4. European Network Education and Training in Occupational Safety and Health [www.enetosh.net]
5. HealthWISE, a joint initiative between ILO and WHO – work improvement in health services [http://www.ilo.org/beijing/what-we-do/publications/WCMS_237276/lang--en/index.htm and http://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/instructionalmaterial/wcms_237276.pdf]
6. Virtual patient training materials [www.virtualpatient.net]
7. Occupational Hygiene – advancing occupational hygiene worldwide [http://ohlearning.com/default.aspx]

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Report by: Dr Penny Orton
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NATIONAL INSTITUTE FOR OCCUPATIONAL HEALTH
Division of the National Health Laboratory Service

Seminar on new approaches to occupational health and safety in the informal economy and extractives industry

The discipline and practice of occupational health and safety (OHS) faces a number of challenges in the 21st century. These apply both to sectors in which OHS practitioners have long been involved, such as the extractives industry, and to newer areas of work, such as the informal economy. Both areas have in common the fact that OHS practitioners are searching for new ways of approaching difficult problems. This seminar, jointly hosted by the National Institute for Occupational Health (NIOH) and Women in Informal Employment: Globalizing & Organizing (WIEGO), aimed to explore these problems and possible solutions through presentations from the editors (Sophia Kisting, Leslie London, Francie Lund and Rajen Naidoo) of two special editions of the progressive journal New Solutions: A Journal of Occupational and Environmental Health Policy (http://journals.sagepub.com/home/new).

Francie Lund (WIEGO) and Rajen Naidoo (UKZN) began the proceedings, presenting on their New Solutions special edition which focuses on the informal economy (http://journals.sagepub.com/toc/newa/26/2). According to the International Labour Organization (ILO) and WIEGO data (http://www.ilo.org/stat/Publications/WCMS_234413/lang--en/index.htm), the informal economy occupies a large and growing part of the global workforce, making up over 80% of the workforce in some developing countries. Many informal workers work outside of employment relationships and in informal places of work that are not covered by labour regulation. The world of work is changing, and the regulation of OHS has to catch up, argued Naidoo. Lund pointed out that the availability of reliable data on the informal economy has allowed for advances in the development of appropriate policies aimed at supporting informal workers. However, as Naidoo pointed out, it is still very difficult to collect reliable epidemiological data, which means that the health risks that informal workers face often remain invisible to policy makers. Both editors stressed the need to understand the heterogeneity of the informal economy – that it is not an isolated sector but part of the mainstream economy, existing within all sectors of the labour force and involving multiple linkages to the formal economy. This means that occupational health risks, and the solutions to them, are not uniform. A domestic worker, for example, will face different hazards to a waste reclaimer working on a landfill site, and the options for regulating these two spheres of work will also be very different. Lund presented a range of options for health interventions, emphasising the importance of including organisations of informal workers in the development of policies and regulations.

Sophia Kisting (NIOH) and Leslie London (UCT) then presented their special edition on the extractives industry (http://journals.sagepub.com/toc/newa/25/4). Several important issues emerged. Out of the 100 largest economies in the world, 63 are corporations and 37 are countries. This means that corporations – many of which are involved in the extractives industry – are often more powerful than the nation

Participating in a robust panel discussion, from L-R: Sophia Kisting; Steven Leeuw (respondent for the informal economy); Francie Lund; Rajen Naidoo; Leslie London and Richard Spoor (respondent for the extractives industry) *Photograph: Mr Guy Hall*

states that regulate them. This power differential makes it difficult to think about the imposition of effective health and safety regulations, argued London, who then emphasised the importance of attempts by the United Nations (UN) to regulate corporations transnationally through human rights frameworks and the harmonisation of cross-national health and safety standards. A second key issue that emerged was the importance of moving away from an approach to OHS focused solely on the individual worker. The need to link occupational health and compensation systems for workers in the extractives industry (mainly men), to the women and children in the communities living around work sites, was emphasised by Kisting. As an example, she pointed to inequities in compensation for mesothelioma linked to asbestos mining in the Northern Cape, where it is only mine workers – and not those who suffer from the disease in the community – who are able to claim compensation from the government under the Occupational Diseases in Mines and Works Act*. Kisting also emphasised the importance of the often neglected area of prevention within health systems. "When you've spent your whole career seeing people who are sick from work, you want to find a way to prevent ill-health," she said.

Lawyer, Richard Spoor, and informal worker leader, Steven Leeuw, provided responses to the presentations, and drew out a number of important themes. Spoor argued that the political and economic forces that have resulted in the trend towards sub-contracting, outsourcing and the casualisation of labour in the extractives industry, have also led to the undermining of OHS regulation, so that it is not only the informal economy that now suffers from a lack of appropriate regulation and standards. There has been a wholescale breakdown in the 'idealised' model of work, he argued. He linked the development of the urban informal economy to displacement caused by the extractives industry – the placement of mines regularly driving communities off rural land and into urban areas where they are absorbed into low-income and precarious informal work. Leeuw argued that a key issue affecting the incomes and health of informal waste reclaimers (his own sector) was the criminalisation of their work by the state, the inability to include cooperatives of waste reclaimers into municipal solid waste management systems appropriately, and being pushed out of the waste stream by private companies with which the state is more likely to contract. Spoor drew parallels between this situation and that faced by artisanal miners. Just decriminalising informal work – whether it be waste reclaiming or mining – would be an important step towards improving incomes and health outcomes, he argued.

The formal presentations were followed by a robust discussion in plenary with panellists taking questions from the audience which included health professionals, worker organisations, non-government organisations (NGOs), and government officials. The discussion served to highlight the intersections of politics and economics on both the incomes and health of workers in South Africa, providing an important forum in which to bring together the perspectives of different stakeholders.

**In some cases, community members can claim compensation through non-state channels.*

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Presenting the NIOH seminar, from L-R: Ms Laura Alfers (WIEGO); Dr Francie Lund (WIEGO); Prof. Rajen Naidoo (UKZN); Dr Sophia Kisting (NIOH); and Prof. Leslie London (UCT) *Photograph: Mr Guy Hall*

Compensation for deceased miners and ex-miners

According to the Occupational Diseases in Mines and Works Act of 1973 (ODMWA), anyone who has been exposed to risk work while working on the mines or classified works has the right to have his or her lungs and heart examined after death. It does not matter what the cause of death is. According to this Act it is the duty of the last doctor who attends to the deceased person to arrange for the removal of the lungs and heart.

On the mines, workers may be exposed to dust (e.g. silica dust), fibres (e.g. asbestos fibres) and/or fumes (e.g. diesel fumes). These are inhaled and may cause damage to the lungs. In time, the damaged areas may enlarge and eventually take up a lot of space in the lungs, making it difficult for the lungs to work normally.

While working on the mines, miners have regular medical examinations (checkups). In retirement, ex-miners have benefit medical examinations. Many tests are done during these examinations. Damaged areas of the lung (if present) may show up on a chest X-ray. However, sometimes the damage is not seen on the X-ray. The best way to see if damage has occurred is by examining the lung itself. This can only be done after a person has died.

Which diseases are considered for compensation?

Compensation may be given for:

- Pneumoconiosis (silicosis, asbestosis and coal workers' pneumoconiosis)
- Tuberculosis
- Joint tuberculosis and pneumoconiosis (phthisis)
- Obstructive airways disease (emphysema)
- Asbestos-related lung cancer and mesothelioma

Besides the presence of disease, there are other requirements that must be met for the disease to be considered compensable, such as severity of disease, and length of service.

Definitions of compensable lung diseases

Silicosis is a lung disease that develops after prolonged exposure to silica (quartz) dust.

Pneumoconiosis is fibrosis and scarring of the lungs caused by long-term inhalation of dust such as silica, asbestos and coal dust.

Pulmonary tuberculosis (PTB) is an infection of the lungs by a bacterium called *mycobacterium tuberculosis*, causing progressive wasting of the body.

Mesothelioma is a form of cancer that is usually associated with previous exposure to asbestos. It grows in the pleura which surrounds the lungs.

Emphysema is a lung disease in which the air sacs in the lung are enlarged and damaged, making it difficult to breathe.

Lung cancer is caused by the uncontrolled growth of cells in the lung, giving rise to a tumour.

Who examines the lungs?

Doctors in the Pathology Division at the National Institute for Occupational Health (NIOH) examine the lungs and hearts on behalf of the Medical Bureau for Occupational Diseases (MBOD).

Who gives permission for the lungs to be examined?

The lungs and heart of a deceased miner will only be removed if the miner had given consent while alive or if relatives do this after his or her death. Consent is given in writing by the signing of a consent form. The signed consent form, together with other documents and the lungs and heart, are sent to the NIOH for examination.

NB: Without a signed consent form, the lungs and heart will not be examined.

Who pays for the examination of the lungs and heart?

The MBOD receives money from the Government to pay for the removal and examination of the lungs and heart.

Who decides if the disease is compensable?

The pathologist at the NIOH writes a report on each case, which is sent to the MBOD where the Certification Committee studies it, together with the service (occupational) history and any previous certification awarded to the deceased. The Committee decides if the disease in the lungs is compensable according to the ODMWA.

The findings of the Certification Committee are provided in a compensation certificate that states whether or not the deceased had an occupational lung disease and how severe it was.

There are three categories of findings:

i. No compensable lung disease, where no disease is found;
ii. First degree disease, where the damage to the lungs (cardio-respiratory disability) is 10% to 40%; and
iii. Second degree disease, where the damage is more than 40%.

Who is responsible for compensation payments?

The compensation certificate is sent to the Compensation Commissioner for Occupational Disease in Johannesburg, who then pays money to the family of the deceased.

Please note:

1. Not every case that is examined qualifies for compensation.
2. Compensation is only paid if there is compensable occupational lung disease.

Exposure to mining dust, fumes and fibers does not always result in the development of occupational lung diseases, even if a person has worked on the mines for many years. On the other hand, some people work on the mines for a short time and develop severe disease at a young age. This is because people respond differently to agents that cause disease.

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Occupational cancer
Workplace carcinogen: Benzene

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Cancer is one of the leading causes of death worldwide, with around 14 million new cases in 2012.[1] Cancer accounted for 8.8 million deaths in 2015.[2] Several risk factors play a role in the development of cancer, including:[1,3]

- Biological carcinogens: infections from viruses, bacteria or parasites
- Family history of cancer, age, sex and race
- Personal habits (smoking, drinking and diet)
- Physical/environmental carcinogens: ionising and ultraviolet radiation, air pollution
- Workplace carcinogens, such as chemicals (e.g. benzene) and metals (e.g. cadmium)

According to the World Health Organization (WHO),[2] 30-50% of cancers can be prevented by avoiding or minimising these risk factors. If an occupational carcinogen cannot be avoided, it is important to understand how the carcinogen increases the risk of cancer by altering cellular metabolism or damaging DNA directly in cells, in order to manage it. The main aim remains to prevent the cancer associated with the exposure. The International Agency for Research on Cancer (IARC) has classified benzene as a human carcinogen (Group 1), as it is associated with the development of acute myeloid leukaemia, non-Hodgkin's lymphoma and multiple myeloma.[4]

SOURCES OF EXPOSURE

In the early 1900s, benzene was isolated from coal tar. Later in the 1900s, the first industrial scale isolation of benzene began. Leading up to World War II, benzene remained a by-product in the steel industry. Following this, as the demand for plastic increased, benzene was produced from petroleum and, today, most of the benzene comes from the petrochemical industry.[5] From an occupational health perspective, benzene was one of the earliest industrial chemicals to be implicated in the health of workers, as early as 1897.[6]

Benzene is commonly found in the environment – industrial processes and fire emissions are the main sources. Currently, with the exponential increase in motor vehicles globally, benzene, as an air pollutant in exhaust fumes, increases human exposure. Tobacco smoke is another source of benzene.[7]

The industries that produce benzene include petro-chemical manufacturing; petroleum refining; coke and coal chemical manufacturing; rubber tyre manufacturing; gasoline storage, shipment, and retail operations; plastics and rubber manufacturing; and shoe manufacturing. Other workers exposed to benzene include laboratory technicians, fire-fighters, and petrol station employees.[7]

ABSORPTION AND METABOLISM

Absorption of benzene occurs mainly through skin contact and inhalation of vapours.[8] According to Susten et al.,[9] dermal absorption in the workplace could contribute to 20-40% of the total dose absorbed. A fraction of absorbed benzene is excreted unchanged in urine (0.1%)[10] and exhaled air (10-50%),[8] the remaining fraction is metabolised (see Figure 1).

BIOLOGICAL MONITORING

The measurement of total phenol in urine is recommended in the Occupational Health and Safety Act, 1993 (Act 85 of 1993) Regulations for Hazardous Chemical Substances. However, it stipulates a 'B' and 'C' notation, as follows:

- '*B' notation indicates that the determinant is usually present in a significant amount in biological specimens collected from subjects who have not been occupationally exposed. Such background levels are included in the Biological Exposure Index (BEI).*
- *'C' notation indicates that the determinant is non-specific, since it is observed after exposure to some other chemicals. These non-specific tests are preferred because they are easy to use and usually offer a better correlation with exposure than specific tests. In such instances, a BEI for a specific, less quantitative biological determinant is recommended as a confirmatory test.*

The measurement of total phenol was acceptable when the acceptable exposure amounted to 10 ppm.[8] Annex III of Directive 2004/37/EC (EU Parliament and Council Directive 2004) specifies a time-weighted average (TWA) limit value for occupational exposure to benzene of 1 ppm.[12] The background concentration of phenol in urine will prevent any reliable detection of a TWA lower than 5 ppm.[13] The tests now considered to assess benzene exposure reliably are benzene in blood; and S-phenylmercapturic acid (S-PMA), t,t-muconic acid (t,t-MA) and benzene in urine.[8] The measurement of benzene in urine may, however, be problematic due to the possibilty of contamination of urine sample during collection.[14]

Benzene in blood

The half-life of benzene in blood is eight hours.[15] Therefore, blood sampling should be performed at the end of an exposure period to provide reliable results. As blood sampling requires invasive collection methods, this method is infrequently used.

S-phenylmercapturic acid

The half-life of S-PMA ranges from nine to thirteen hours.[8] As accumulation of S-PMA is not likely, S-PMA can be considered as a biomarker of recent exposure and does not reflect mid- or long-term exposure.[12] S-PMA in end-of-shift samples has been shown to be a reliable indicator of benzene exposure at 0.3 ppm[8], but recent studies show that it can be a reliable marker at 0.1 ppm.[12]

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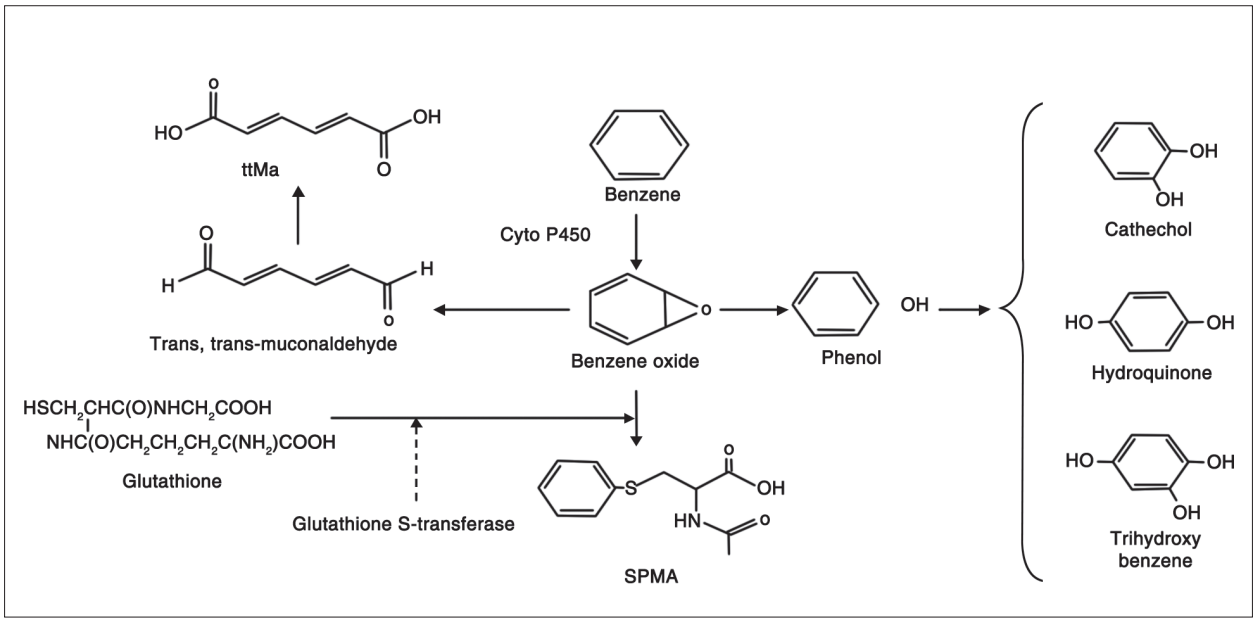

Figure 1. Benzene metabolism[11]

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t,t-muconic acid

The mean half-life of t,t-MA is five hours.[8] Human genetic factors can influence the levels of t,t-MA excreted in urine. Furthermore, in cases of occupational co-exposure to toluene, t,t-MA urinary levels are suppressed.[12] t,t-MA in end of shift samples has been shown to be a reliable indicator of benzene exposure for levels of benzene ≥0.5 ppm,[8] keeping in mind that dietary intake of sorbic acid may contribute to t,t-MA background levels.[12]

BIOLOGICAL EFFECT MONITORING

Monitoring full blood counts at regular intervals can detect the haematological effects of chronic benzene exposure. The United States Occupational Safety and Health Administration (OSHA) recommends monthly counts and removal of workers with white blood cell counts <4000/mm^3 (4 10^9/L), or erythrocyte counts <4 000 000/mm^3 (4 10^{12}/L).[16]

CONCLUSION

Benzene is a known occupational carcinogen but risk mitigation to eliminate or reduce exposure is not always possible. By measuring the appropriate metabolites for the exposure level (TWA), as well as monitoring full blood count levels at regular intervals, it is possible to minimise the risk of occupational cancer due to benzene exposure.

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