RACP
Specialists. Together
EDUCATE ADVOCATE INNOVATE

RACP submission

Australian Government's National Dust Disease Taskforce – Second phase of consultation

November 2020

About The Royal Australasian College of Physicians (RACP)

The RACP trains, educates and advocates on behalf of over 18,000 physicians and 8,500 trainee physicians, across Australia and New Zealand. The RACP represents a broad range of medical specialties including general medicine, paediatrics and child health, cardiology, respiratory medicine, neurology, oncology, public health medicine, infectious diseases medicine, occupational and environmental medicine, palliative medicine, sexual health medicine, rehabilitation medicine, geriatric medicine, and addiction medicine. Beyond the drive for medical excellence, the RACP is committed to developing health and social policies which bring vital improvements to the wellbeing of patients.

About the Australasian Faculty of Occupational and Environmental Medicine

The Australasian Faculty of Occupational and Environmental Medicine (AFOEM) of the Royal Australasian College of Physicians is the peak medical body for Occupational and Environmental Physicians, comprising over 500 medical specialists in Australia and New Zealand.

The AFOEM specialist training programme is centred on combining high level clinical expertise with a strong work focus to develop specialist knowledge and skills in preventing and managing ill-health, injury and disability in workers; promoting safe and healthy workplaces; and reducing the impact of environmental hazards on the community.

Occupational and Environmental Physicians are specialist ‘work doctors’, with clinical skills and knowledge applicable to the worker, employers, organisations and government bodies.

We provide independent, evidence-based knowledge using a worksite specific approach. We have expertise in the early identification and health risk assessment of workplace hazards. Through the design and application of heath surveillance and monitoring programs we can provide tailored advice and management for the individual worker and organisation to prevent and address identified work related health issues.

We work effectively and productively in multidisciplinary teams consisting of a broad range of stakeholders that includes, the worker, treating practitioners, allied health professionals, health and safety personnel, employers, unions, insurers, organisations and government regulatory authorities.

About respiratory medicine

The RACP’s Adult Medicine Division (AMD) oversees the training and professional development of over 33 medical specialties including respiratory medicine.

Respiratory medicine is concerned with the diagnosis, treatment and continuing care of adults of all ages who suffer from a wide range of respiratory conditions.

Lung disease is one of the commonest causes of hospital admission and illness in the community. Respiratory physicians diagnose and treat common conditions such as asthma, chronic bronchitis and emphysema, pneumonia and lung cancer, as well as important public health infections like SARS-COV-2, influenza and tuberculosis.

Respiratory medicine also includes diagnosis and treatment of occupational lung diseases such as silicosis, coal workers’ pneumoconiosis, and asbestosis and its scope ranges from rare genetic disorders such as cystic fibrosis to lung transplantation.

Respiratory physicians have a long tradition of involvement in the community and workplace, and in epidemiology and preventive health.

Submission

Thank you for this opportunity to make a submission to the National Dust Disease Taskforce in response to the Taskforce's Second Consultation Paper released in September 2020.[1] This submission has been led by RACP expert Fellows in occupational and environmental medicine and in thoracic medicine in consultation with the Thoracic Society of Australia and New Zealand (TSANZ) who is also making a separate submission to this consultation.

Should you require any further information about this submission, please contact Ms Claire Celia, Senior Policy & Advocacy Officer via Policy@racp.edu.au.

Introduction

We commend the ongoing work of the Australian Government's National Dust Disease Taskforce established in July 2019. The Taskforce has a crucial role in driving the development of a national approach for the prevention, early identification, control and management of dust diseases in Australia and we welcome the extended timeframe it has been granted to submit its final report due to COVID-19 related disruptions and delays.

We remain deeply concerned by the current epidemic of accelerated silicosis, a preventable occupational lung disease, arising in young workers as a result of the manufacture and installation of artificial stone bench tops. Silicosis is preventable, and no cases should be occurring in Australia. We hope that the Taskforce's final report will provide a strong imperative and guidance on how best to achieve early identification, optimal treatment and management of workers suffering from accelerated silicosis and other dust diseases across all Australian jurisdictions.

Previous submission to the National Dust Disease Taskforce

In November 2019, The RACP, its Australasian Faculty of Occupational and Environmental Medicine (AFOEM), and TSANZ issued a joint submission[2] to the National Dust Disease Taskforce to inform the Taskforce's interim advice. This joint submission recommended the following measures be implemented across all jurisdictions and nationally to address the current epidemic of accelerated silicosis and identify and control other new or emerging occupationally acquired lung diseases:

1. The development of a nationally endorsed, consistently applied, exposure history questionnaire.
2. Urgent implementation of standardised respiratory health assessments of all workers (past and present) in the high-risk industry sectors using state-of- the-art investigations.
3. Statutory, or codified, continuing review of the dust control measures used in the industry, including independent monitoring of dust levels.
4. Comprehensive enforcement of hazardous substance regulations related to silica dust exposure and the requirement for regular health monitoring.
5. Engaging of appropriately qualified and experienced medical personnel to provide strategic and operational advice concerning logistic and organisational responses to the epidemic.
6. Active enforcement of an immediate prohibition on dry cutting techniques.
7. The development of a clinical pathway for diagnosing and managing cases of artificial stone silicosis and other dust diseases, including return to work guidelines and multidisciplinary teams for diagnosis of occupational lung disorders.
8. The establishment of a National Dust Disease Registry
9. Utilising the expertise of occupational and environmental and respiratory medicine physicians in all jurisdictional regulating authorities and work, health and safety scheme administering agencies in order to prevent, monitor, analyse and improve work, health and safety.

---

[1]Available online: https://consultations.health.gov.au/ohp-regulatory-policy-branch/second-phase-national-dust-disease-taskforce/supporting_documents/10861RR%20Health%20NDDTF%20Consultation%20Paper_Sept%202020_FAtagged.pdf [last accessed 09/11/2020]
[2]Available online: https://www.racp.edu.au//docs/default-source/advocacy-library/racp-including-the-australasian-faculty-of-occupational-and-environmental-medicine-and-the-thoracic-society-of-australia-new-zealand-joint-submission.pdf?sfvrsn=a012e31a_12 [last accessed 09/11/2020]

That previous joint submission also highlighted the key shortcomings in the regulatory and enforcements frameworks as follows:

- Lack of specialist medical capability integrated with the regulatory regime.
- Inconsistent and outdated health surveillance (screening) and monitoring.
- Poor workplace dust monitoring and management.
- Lack of integration between regulatory and health frameworks.
- No longitudinal monitoring of exposure or workplace safety.
- Difficulty in monitoring exposed workers in a highly mobile and ethnically diverse workforce.
- Adequacy of control measures.

At the end of 2019, the Taskforce provided interim advice[3] to the Commonwealth Minister for Health on the prevention, early identification, control, and management of occupational dust diseases in Australia, particularly accelerated silicosis. That advice identified five immediate and short-term national actions to address specific issues related to the re-emergence of silicosis:

1. Developing a targeted education and communication campaign to raise awareness of the risks of working with engineered stone.
2. Ongoing staged development of a national dust disease registry, with specific data requirements recommended by the Taskforce.
3. Targeted investment in key research activities, to improve understanding of prevention, diagnosis and treatment.
4. Developing national guidance on screening workers working with engineered stone.
5. Development of a national approach to identify occupational silica dust exposure and other future occupational diseases.

These recommendations are supported by the RACP and its AFOEM and it is very encouraging that the Australian Government has accepted them all.

Feedback on consultation questions from the Taskforce's Consultation Paper

This current submission focuses on providing feedback on the consultation questions provided in the Taskforce's Consultation Paper released in September 2020 as outlined below.

Regulatory and governance

Q1. From a regulatory perspective, what should be considered 'engineered stone'? Please provide the rationale for your recommendation.

The RACP understands the importance of a careful definition in this area. Any adopted definition should reflect that there are many different types of engineered stone, that it is a composite material made of crushed stone bound together by an adhesive and other additives and that it differs from a naturally occurring stone, which is one formed by natural (not man-made) processes.

We also recommend that **every engineered stone be clearly labelled** as such and have its **constituents also labelled, including crystalline silicates, resins and metals with relevant percentages** as it is important to know the constituents of these materials and what a worker is likely to inhale before allowing its use. In particular, the percentage of silica should be highly visible and highlighted on the label, and the use of a warning symbol should be considered.

Q2. Various jurisdictions have already banned uncontrolled dry processing of engineered stone. What other practical measures could be introduced to reduce worker exposure to silica dust?

Workers in the engineered stone sector mostly work for small businesses which have limited resources to conform with regulation and this brings additional challenges that need to be acknowledged.

[3] National Dust Disease Taskforce Interim Advice to Minister for Health (December 2019): https://www1.health.gov.au/internet/main/publishing.nsf/Content/562CF83B7AECFC8FCA2584420002B113/$File/nat-dusk-interim-advice-dec2019.pdf [last accessed 09/11/2020]

However, despite education and the establishment of codes of practice in some jurisdictions, we continue to see unsafe work practices with infringement notices and corrective actions being taken after workers have already been exposed.

All states and territories throughout Australia need to implement a complete ban on dry cutting of any stones (engineered or natural) and no silica-containing substance should be cut or drilled without appropriate precautions. The use of methods other than water for dust suppression should be evidence-based to ensure they are safe and effective. Regulatory agencies should ensure that regulators are well trained and understand their roles and responsibilities.

Other measures which should be considered to reduce worker exposure to silica dust include:

- Establishing a certification or licensing system to ensure that there is a central register of all businesses which work with silica-containing materials. This system could be linked with regulatory checks/visits to ensure that appropriate safety measures and training are implemented in the workplace.
- Implementing mandatory periodic monitoring of dust levels (crystalline silica, silicates and other substances e.g. metals) and regular worker periodic respiratory surveillance as per the recommendations made by TSANZ in its recently released position statement on respiratory surveillance for coal mine dust and artificial stone[4] included in the Appendix.
- Provision of detailed information regarding the constituents of engineered stone as well as labelling of high silica containing products.
- Fostering co-operation and co-accountability between all relevant stakeholders, including regulatory agencies, employers, trade unions and professional associations to increase awareness of health effects and safe practices.
- Promoting alternatives and reduce the use of engineered stone
- Improving education and awareness so that all stakeholders (i.e. industry, consumers, kitchen providers) can make informed decisions about the dangers versus benefits of using engineered stone products.

Q3. Relevant to dust-related diseases, what mechanisms exist or could be further developed to ensure effective enforcement of regulations and codes of practice?

The RACP suggests the following mechanisms should be considered to improve the enforcement of regulations and codes of practice:

- Make national reporting of detected cases of dust related diseases to a national registry mandatory to ensure early awareness and warnings can be observed and acted upon.
- Require regular workplace respiratory and other relevant health monitoring and health surveillance of workers by specialist occupational and environmental or respiratory medicine physicians mandatory where there is potential risk of dust related diseases in at-risk industries.
- Mandate crystalline free silicates assessment for high risk activities.
- Provide resources and funding for crystalline silica assessments.
- Mandate baseline respiratory surveillance prior to a worker entering a dust-exposed industry to identify any pre-existing respiratory disease.

Q4. Hazard elimination sits at the top of the hierarchy of control measures (see https://www.safeworkaustralia.gov.au/risk for an example of a hierarchy of control measures). Do you consider a ban (either total or partial) of high silica content engineered stone material, a proportionate and practical response to the emergence of silicosis in the engineered stone benchtop industry in Australia?

The hierarchy of control should be applied first and all appropriate hazard control measures should be effectively implemented following this approach (i.e. substituting the hazard with a safer alternative, isolating the hazard from people, reducing the risks through engineered control, using PPE and reducing exposure

[4] Perret, J.L., Miles, S., Brims, F., Newbigin, K., Davidson, M., Jersmann, H., Edwards, A., Zosky, G., Frankel, A., Johnson, A.R. and Hoy, R., Respiratory surveillance for coal mine dust and artificial stone exposed workers in Australia and New Zealand: A position statement from the Thoracic Society of Australia and New Zealand. *Respirology*. October 2020. Available online: https://onlinelibrary.wiley.com/doi/full/10.1111/resp.13952 [last accessed 09/11/2020]

through administrative control) to reduce exposure risk for engineered stone workers. These measures should be complemented by the establishment of a common licensing framework as detailed in our response to Q5.

If once applied appropriately, these measures do not lead to safe work conditions, then a ban on engineered stone would be necessary to ensure the health of workers in the industry is safeguarded.

Q5. The Taskforce is aware some jurisdictions are considering a licensing scheme for engineered stone. Do you consider this a proportionate and practical response in relation to the following:

a. ***restricted (under licence) or otherwise prohibited manufacture in Australia?***
b. ***restricted (under licence) or otherwise prohibited importation and distribution?***
c. ***fabrication and installation performed only under licence?***
d. ***licence required after installation modifications or repurposing of installed engineered stone?***

We are aware that Victoria is developing a licensing scheme to reduce the risks of workers contracting silicosis. Under the Victorian scheme, all businesses that work with engineered stone in the state will need to prove compliance with safety measures and obtain a licence to work with engineered stone.

We support the establishment of a licensing scheme for engineered stone to complement all other appropriate hazard measures that follow the hierarchy of control approach to reduce exposure risk for engineered stone. Such a scheme should apply to the importation, distribution, fabrication and installation of these products in Australia. Consideration should also be given to the recommendations for the re-surfacing, renovation and disposal of installed product. It would enable the control of these products at source and awareness of their distribution and use. It would also facilitate licenced fabricators and installers having their workplaces monitored and reported, and regular health surveillance with national reporting for all workers in that industry.

We recommend that jurisdictions consider a component of licensing to facilitate better education and training. A licensing scheme should include the requirement to routinely sample dusts for crystalline silica and silicates and demonstration that employees in businesses using engineered stone have been appropriately trained in its safe use.

Q6. What learnings from the re-emergence of accelerated silicosis as an occupational health and safety risk can be applied to enhance workplace health and safety systems more generally?

The major lesson from the re-emergence of accelerated silicosis as an occupational health and safety risk is that having legislation and regulation in place does not guarantee compliance. Workers in the engineered stone sector mostly work for micro and small businesses which have limited understanding or resources to conform with regulation. Overall, the re-emergence of accelerated silicosis has demonstrated dangerous gaps in the health and safety environment in Australia.

Unlike industrial accidents, with occupational diseases there is often a long lead time (i.e. 10 to 40 years) between exposure and the development of disease so workplaces need to have regular monitoring by qualified independent assessors who have the ability to identify hazards which may result in occupational diseases. Workers also need to undergo mandatory health surveillance conducted by or under the direction of specialist occupational and environmental physicians so that exposure histories are obtained and recorded as well as essential clinical findings and investigations. This would ensure the detection of early disease and/or excessive exposure at an early stage when prevention measures will be more effective. The previous example of the re-emergence of occupational lung disease among Queensland coal miners and the review findings of major limitation in worker health monitoring demonstrates that regular high-quality health monitoring is needed for hazardous industries of any size. OHS regulations in the jurisdictions usually require this, but this is often not done or is done in a low-quality way.

A consistent approach to worker health monitoring is needed. This could be facilitated by the establishment of an ongoing multidisciplinary independent expert advisory body and an agency capable of rapid investigation of occupational disease outbreaks. This approach would allow flexibility and adaptability to the changing industrial and health environment and allow for health monitoring processes to keep up-to-date with best practice techniques for screening and management.

The national mandatory reporting of dust diseases to a national registry, in addition to health surveillance of workers using hazardous substances is essential as a key component of effective prevention and control of occupational lung diseases. This should be extended to all occupational diseases. Currently, only around 10 per cent of all workers compensation claims are classified as occupational diseases even though we know that occupational disease is a far more important cause of morbidity and mortality than workplace accidents.[5]

Additional comments on regulatory and governance issues

In 2012-2013, Safe Work Australia estimated that work-related injury and disease cost the Australian economy $61.8 billion (approximately 4% of GDP), of which the majority of the cost (95%) was borne by the individuals and society.[6] Improving regulation and compliance measures, in conjunction with increased workplace and health surveillance, will positively impact on the prevention of the disease and present valuable opportunities to reduce the significant human costs, the burden of disease and the costs to the workers' compensation system from silicosis which are significant.

There should be harmonisation of regulation to ensure equitable health outcomes across jurisdictional boundaries. Harmonisation of regulation would allow identical regulatory and governance systems across all Australian jurisdictions. Silica does not respect state and territory borders, and workers often move between jurisdictions. Responses to prevent and monitor occupational disease need to transcend state and territory borders.

Australia's effective response to the COVID-19 pandemic has demonstrated the value of expert advice in solving difficult health policy problems. There has been a notable absence of specialist occupational and environmental medicine expertise in the jurisdictional policy and regulatory departments, and workers compensation insurers across Australia for several decades. Workplace health and safety policy should be informed by engagement of relevant medical expertise, including occupational and environmental physicians, respiratory physicians, and other specialists (renal, cardiologists, rheumatologists, psychiatrists, and psychologists) where appropriate. Another important role would be to review health monitoring requirements being undertaken in workplaces by Authorised Medical Officers.

There has been a notable absence of specialist occupational and environmental medicine expertise in the jurisdictional policy and regulatory departments, and workers compensation insurers across Australia for several decades. This needs to be rectified if workers are to be protected from occupational diseases. Specialist occupational and environmental physicians should be engaged to provide expert advice on policy and evaluation as they can provide the essential interface between regulations and the health impacts of occupational diseases on workers. Another important role would be to audit health monitoring being undertaken in workplaces, preferably within a system of Authorised Medical Officers engaged by workplaces.

Appropriate respiratory surveillance needs to be available life-long for workers in high risk industries.

In addition, we recommend consideration of the following measures:

1. Minimisation of compliance costs for employers and workers and development of a mechanism to cover downstream costs of health monitoring, surveillance and compliance.
2. Development of an easily accessible reference guide which lists the content of all stones used in Australia. There are more than 200 of these and it is currently difficult to get information about the content of each.
3. Development of a job exposure matrix to identify the need for measurement of dust exposures (crystalline silica, asbestos and total respirable dust, and whatever others are relevant to each worker).
4. Funding of prospective epidemiological surveillance studies to allow appropriate evaluation of measures which have been implemented, including enhanced surveillance methods and efficacy of reduction in dust.

[5] Alif SM, Glass DC, Abramson M, Hoy R, Sim MR Occupational Lung Diseases in Australia. 2020 Feb. Pages 1-86. Safe Work Australia
[6] SafeWork Australia, *Cost of injury and illness statistics* (2012-2013). Available online: https://www.safeworkaustralia.gov.au/statistics-and-research/statistics/cost-injury-and-illness/cost-injury-and-illness-statistics [last accessed 09/11/2020]

Workplace organisational culture

Q7. Given the nature of the building and construction industry, and the increase in the number of smaller, often independent businesses and suppliers, what particular strategies and supports are needed to ensure that these businesses are able to provide adequate protection for workers?

We acknowledge that the nature of the industry and the increase in the number of smaller businesses and suppliers is a challenging issue as small businesses tend to have limited resources to conform with regulation. These businesses need access to specialist occupational and environmental physicians to provide independent advice on the nature and control measures of workplace hazards. Certification and education before use of silica-containing materials and regular assessment of dust levels across the sector are also important elements of a prevention strategy.

Some of the strategies and supports that could be put in place across the industry include:

- Facilitating ready access to occupational and environmental medicine services.
- Making small business work health and safety concerns a research priority to better understand the specific challenges they face and how best to assist them.

Q8. What health and safety strategies can be improved?

There are several measures that could be adopted to improve health and safety in the industry.

Specifically, the RACP recommends:

- Further implementation of education, surveillance, training in PPE (none of which are currently performed regularly, if at all) noting that there are four strata for ongoing surveillance for all workers who are *potentially* exposed including administrative and other support staff as follows:
    1. Workers including contractors with no findings of concern:
        - 1.1 Those who have left the industry
        - 1.2 Those who remain in the industry
    2. Workers including contractors with finding that indicate a need for a higher frequency of surveillance or surveillance with more expensive resources (e.g. DLCO or HRCT)
    3. Workers including contractors who develop diagnostic criteria but appear to have stable or quiescent disease
    4. Workers including contractors who have active progressive disease
- Improved dust monitoring including for a wider range of dusts rather than just crystalline silica
- Early referral to appropriately trained occupational health professionals, with links established to enable this process and appropriate resourcing (e.g. an item number to cover such referrals).
- Considering ways to reduce the administrative burden of compliance on businesses, such as through online portals.

Q9. What return to work support is available or should be considered to assist workers following a diagnosis of silica-associated disease, including for those who are unable to return to the engineered stone industry?

Workers should be supported to access advice on fitness for work and alternative roles from specialist occupational and environmental physicians who have the skills, knowledge and expertise in such assessments and in preventing and managing ill-health, injury and disability in workers.

Workers should also have access to the full range of support they need for an effective return to meaningful work, including medical support (nursing, physiotherapy, occupational therapy, etc), pulmonary rehabilitation, psychological and social work support. Where workers have respiratory impairment but it is not severe enough to prevent return to work in some capacity, they should have access to appropriate rehabilitation and retraining to facilitate vocational redirection. This was highlighted in a recent report by occupational and environmental physicians, respiratory physicians and related disciplines for the Queensland Government.[7]

---

[7] Almberg KS, Go LHT, Yates DH, Waite TD, Cohen RA. Silicosis Return to Work review: Return to Work and Vocational Rehabilitation Support for Workers Suffering from Silicosis. October 2020

Q10. What are examples of good dust exposure workplace monitoring processes? (Where possible please provide evidence to support the effectiveness of these processes).

We recommend implementing mandatory periodic monitoring of dust levels (crystalline silica, silicates and other substances e.g. metals) and regular worker periodic respiratory surveillance as per the recommendations made by TSANZ in its recently released position statement on respiratory surveillance for coal mine dust and artificial stone.[8] This could be a requirement of a licensing scheme.

Additional comments on workplace organisational culture

Employers need to understand and appreciate the hazards workers face from silica exposure and workers need to be encouraged to take respiratory health seriously. A 'no-fault' culture is needed to enable early action in cases of excessive dust exposures and to make it easier for workers to report unsafe work practices without fear of dismissal or discrimination.

Resourcing and capability

Q11. What specific resources (e.g. information, education, other supports etc.) are required, that are not currently available, for small to medium sized businesses, to ensure that owners and staff are fully informed of the availability and correct use of control methods, including by workers from non-English speaking backgrounds?

Micro and small businesses are heterogeneous, ever-changing, and geographically scattered, they tend to need support with ICT, innovation, statistics, import/export, taxes and compliance costs.

The RACP recommends that every worker and every business should have access to appropriate educational resources and advice including online information, training courses, web-based training, and expert advice where appropriate (e.g. from an occupational hygienist, nurse and/or occupational and environmental physician or occupationally trained respiratory medicine physician).

Resources should be available in key languages, in a format adapted to suit different audiences and provided through appropriate channels. A licensing scheme for businesses working with engineered stone should require evidence of completing appropriate training for businesses to be approved to use engineered stone.

Opportunities for learning and development should be created through events bringing together businesses, regulators, professional associations and industry occupational health and safety mentors.

The RACP website has a "Find a Consultant" page[9] which includes contact details of occupational and environmental physicians by jurisdiction. A link to this webpage could be made available on the SafeWork Australia website and other relevant regulator websites to enable businesses to find specialist occupational and environmental physicians in their jurisdiction.

Q12. With a specific focus on dust related diseases, what mechanisms exist that could be used as a basis for providing a coordinated national system with representation across stakeholder disciplines for identifying and communicating emerging issues?

The RACP's view is that a National Dust Disease Registry needs to be implemented urgently to provide a coordinated and consistent national system of workplace health assessments and management of workers with silicosis across all jurisdictions. Please refer to the November 2019 joint RACP/AFOEM/TSANZ submission to the National Dust Disease Taskforce for further information[10] which includes the joint RACP/AFOEM/TSANZ proposal for a national occupational lung disease (OLD) registry which was discussed

---

[8] Perret, J.L., Miles, S., Brims, F., Newbigin, K., Davidson, M., Jersmann, H., Edwards, A., Zosky, G., Frankel, A., Johnson, A.R. and Hoy, R., Respiratory surveillance for coal mine dust and artificial stone exposed workers in Australia and New Zealand: A position statement from the Thoracic Society of Australia and New Zealand. *Respirology*. October 2020. Available online: https://onlinelibrary.wiley.com/doi/full/10.1111/resp.13952 [last accessed 09/11/2020]

[9] https://www.racp.edu.au/about/college-structure/australasian-faculty-of-occupational-and-environmental-medicine/find-a-consultant [last accessed 09/11/2020]

[10] Available online: https://www.racp.edu.au//docs/default-source/advocacy-library/racp-including-the-australasian-faculty-of-occupational-and-environmental-medicine-and-the-thoracic-society-of-australia-new-zealand-joint-submission.pdf?sfvrsn=a012e31a_12 [last accessed 09/11/2020]

at the meeting of the Australian Health Ministers' Advisory Council's (AHMAC) Clinical Principal Committee on 7 February 2019. This proposal includes the following information:

- Purpose of the National Occupational Lung Disease Registry
- Structure of the Registry
- Location of the Registry
- Resourcing of the Registry
- Notifications to the Registry
- Summary information on overseas OLD registries

In addition, the RACP recommends that Safe Work Australia should be complemented with specialist advice to enable optimal identification, planning and communication of existing and emerging occupational disease issues.

There is also a need to develop a centralised surveillance system for occupational respiratory disease such as the systems already long-established in the UK[11] through the SWORD program[12] and the United States through the Work-Related Lung Disease Surveillance System (eWoRLD) program.[13]

The RACP and AFOEM already represent a national coordinated system of medical professionals relevant to the health of these workers, and specialty societies such as TSANZ and the Australian and New Zealand Society of Occupational Medicine (ANZSOM) can also assist. There are also many other national bodies which can work with government and health and safety agencies in this area (Royal Australian and New Zealand College of Radiologists, Royal Australian College of General Practitioners, Australian Institute Occupational Hygienists, universities etc).

Additional comments on resourcing and capability

Australia has excellent capability but little in the way of current resources to enable these changes and the costs of projects and deliverables can be prohibitive. In addition, duplication of initiatives and poor communication across jurisdictions is an issue that needs to be addressed through strengthened national coordination and harmonisation of regulations.

Capability already exists in the sector but is not always available to businesses as it is not well supported by financial incentives.

Enhancing capability and developing innovative strategies could potentially provide a resource for other countries in our region. The provision of adequate resources will save expense and lives in the medium to long term.

Research and development

Q13. What industry mechanisms could be introduced to ensure workers have appropriate competencies for handling engineered stone or performing processes that generate silica dust?

We recommend the industry and its workers should be required to have annual certification and regular dust assessments as part of the licensing scheme outlined in our response to Q5. These should include regular air monitoring at appropriate intervals to be determined according to best practice and regular spirometry as indicated, undertaken by qualified personnel.

Vocational courses already exist and allow apprentices to learn early about dust hazards and controls. These need to be enhanced and links between these and businesses should be strengthened and integrated into the licensing scheme.

There also needs to be a culture change in the industry regarding control measures including the correct use of PPE to ensure that workers at all levels are trained in the appropriate use of PPE and that checks are undertaken to make sure PPE is being used appropriately as part of a coordinated, industry-specific health and safety policy.

---

[11] UK Health & Safety Executive (HSE): https://www.hse.gov.uk/ [last accessed 09/11/2020]

[12] Reynolds, Carl J., and Paul Blanc. "Into ploughshares: forging effective surveillance for work-related lung disease." (2019): 783-784.

[13] Centers for Disease Control and Prevention (CDC) National Institute for Occupational Safety and Health (NIOSH): https://wwwn.cdc.gov/eworld/ [last accessed 09/11/2020]

Partnerships between occupational health and safety agencies and grant funding bodies such as the National Health and Medical Research Council (NHMRC), the Australian Research Council (ARC) and the Medical Research Future Fund (MRFF) would help to develop stronger research capability to support a national occupational lung disease registry and promote research training through existing research funding programs, such as Centres for Research Excellence.

Other measures could include:

- Putting in place specific competency requirements for managers and workers.
- Implementing additional education about management and controls of silica dust risks and hazards.
- Enhancing supervision and mentoring of untrained workers.

Q14. What are the specific challenges related to linking workplace exposure with disease development (at a later date) and how should these be addressed?

The main challenges are:

1. Lack of knowledge about the risks and harms of dust at work.
2. Lack of knowledge of actual constituents of stones.
3. Lack of clear direction and of information available to SMEs on where to obtain expert health advice– what to do, when to do it, and how to manage the results. Businesses carry the obligation to perform the health risk assessment, but there is no direction or advice provided on where and from whom they should seek the expertise. Further consideration should be given to specifying suitably qualified medical practitioners (SQMPs) and the standards for a SQMP (i.e. an occupational and environmental physician with relevant experience or other suitable specialists such as a respiratory medicine physician and specialist GP with relevant expertise in occupational medicine).
4. Lack of funding and resources to manage dust hazards and risks.
5. The long latency of some diseases.

These could be overcome but require a sustained, national and collaborative approach. A national registry would assist with this.

Assessing the duration and intensity of exposure and how it affects an individual's risk of disease is complex and needs to be done on a case by case basis by a health professional with expertise in occupational medicine (i.e. occupational and environmental physician or respiratory medicine physician with expertise in occupational medicine) in consultation with an occupational hygienist.

A further need is a clear process for health professionals to follow up or recommend investigation and management of other workers in a given workplace wherever they find a worker with silicosis, akin to contact tracing of persons who may have had concurrent exposures with the index case.

Entry of unskilled workers into dusty trades also needs to be considered. We recommend that all workers be screened for potentially transmissible respiratory diseases e.g. tuberculosis according to Australian standards, and also to exclude other prior work-related diseases. Ideally, no worker should be recruited without a prior clear chest radiograph and tuberculosis testing.

Q15. What are three key pieces of information about dust disease that you would like to see collected at a national level? What are the three key uses of the information collected at a national level?

In our view, the three key pieces of information about occupational dust disease that need to be collected at the national level are:

1. Accurate information about the incidence and burden of dust-related diseases (i.e. diseases related to dust exposures, not just silicosis), reported annually and for each state and territory. This should reflect doctor-diagnosed diseases, rather than compensated cases. Burden includes not just numbers, but types of diseases, extent of early changes, relevant exposures, severity of disease and outcomes, including return to work. Specific details about other diseases and comorbidities (e.g. tobacco, vaping) should also be included in the national registry.
2. Specific information about workplace dust exposures (including crystalline silica and silicates, and other dusts e.g. asbestos) and metals including exceedances and levels in different workplace environments. Data on exceedances needs to be maintained to ensure that workplaces remain safe. These need to be reported centrally and linkable to each individual worker for every industry with dust

exposure, as well as to groups of workers and industries. It requires a genuine culture of investigation of exceedances, appropriate monitoring and optimal reduction of dust levels and a move away from a blame culture which may be present in some workplaces.

3. Actual numbers of dust-exposed workers nationally and by jurisdiction, industry and ethnicity, to provide an accurate understanding of the incidence of disease relative to the number of exposed workers. This would also allow trends in incidence to be monitored and identification of high-risk groups.

This information would enable us to better understand:

- Where the heaviest dust burdens are in terms of exposure levels, intensity, particle size, etc.
- How many workers are at risk..
- The disease mechanisms and how they relate to bioactivity of workplace contaminants.

Q16. What alternative products are currently available which could replace high silica-content engineered stone? How could we drive innovation in relation to products?

There are many potential substitutes available which were used before engineered stones came on the market which are safer bench tops material including sustainable, hard, durable and thermally stable alternatives such as timber, plastic, stainless steel, concrete, granite, acrylics, laminates, porcelain/ceramics, etc.

There is a need to increase awareness of these alternative products among consumers so they can make safer, more informed choices.

Q17. The interim advice identified immediate research priorities which has led to a research funding grant opportunity announced by the Medical Research Future Fund and National Health and Medical Research Council. Are there other research priority areas that have not been identified in the interim advice that should be considered, and why? What research areas should be a priority following this first round of research funding?

In our view, the following areas should also be research priorities:

- Long-term prospective cohort studies to evaluate the consequences of low dust exposure levels including the development of malignancy related to crystalline silica exposure, auto-immune diseases and mental health outcomes. This type of research should also include return to work outcomes.
- Prospective actuarial studies to evaluate the real costs of dust diseases to Australian society (especially ongoing health care costs e.g. with lung transplantation). These studies need to include an assessment of worker vs employer vs societal dollar costs and also quality of life estimates.
- Development of point-of-care assessment of dust levels (including crystalline silica) and biological response to dusts, using real-time monitoring of workers with portable, user-friendly devices located within the breathing zone which conform to international standards. Such devices are feasible using modern technologies but require significant research investment.
- Development of task-specific exposure questionnaires for assessment of relevant past and current silica exposures.
- Evaluation of control measures to investigate whether their introduction can lead consistently to exposure levels below the revised WES of .05mg/m3.
- Research into other industry sectors where workers are exposed to respirable crystalline silica to estimate the health burden in those industries.

Additional comments on research and development

TSANZ has recently published its Position Paper on optimal surveillance for silica and coal mine dust exposed workers included in the Appendix to this submission.[14] The RACP supports this position statement and recommends prospective evaluation of such methods using a national approach. This strategy aligns with the

---

[14] Perret, J.L., Miles, S., Brims, F., Newbigin, K., Davidson, M., Jersmann, H., Edwards, A., Zosky, G., Frankel, A., Johnson, A.R. and Hoy, R., Respiratory surveillance for coal mine dust and artificial stone exposed workers in Australia and New Zealand: A position statement from the Thoracic Society of Australia and New Zealand. *Respirology*. October 2020. Available online: https://onlinelibrary.wiley.com/doi/full/10.1111/resp.13952 [last accessed 09/11/2020]

NHMRC, Lung Foundation and Cancer Council's respective positions with regard to screening for lung disorders and has the potential to provide excellent population data for accurate data gathering on occupational lung disease incidence.

Appendix - TSANZ position statement on respiratory surveillance

POSITION STATEMENT

Respiratory surveillance for coal mine dust and artificial stone exposed workers in Australia and New Zealand: A position statement from the Thoracic Society of Australia and New Zealand*

JENNIFER L. PERRET,[1] SUSAN MILES,[2,3] FRASER BRIMS,[4,5] KATRINA NEWBIGIN,[6] MAGGIE DAVIDSON,[7] HUBERTUS JERSMANN,[8] ADRIENNE EDWARDS,[9] GRAEME ZOSKY,[10,11] ANTHONY FRANKEL,[12,13] ANTHONY R. JOHNSON,[14] RYAN HOY,[15] DAVID W. REID,[16] A. WILLIAM MUSK,[5,17] MICHAEL J. ABRAMSON,[15] BOB EDWARDS,[6] ROBERT COHEN[18] AND DEBORAH H. YATES[19,20]

[1]Allergy and Lung Health Unit, Centre for Epidemiology and Biostatistics, The University of Melbourne, Melbourne, VIC, Australia; [2]Department of Medicine, Calvary Mater Newcastle, Newcastle, NSW, Australia; [3]School of Medicine and Public Health, University of Newcastle, Newcastle, NSW, Australia; [4]Curtin Medical School, Curtin University, Perth, WA, Australia; [5]Department of Respiratory Medicine, Sir Charles Gairdner Hospital, Perth, WA, Australia; [6]Wesley Dust Disease Research Centre, Brisbane, QLD, Australia; [7]Health and Management School of Science, Western Sydney University, Sydney, NSW, Australia; [8]Department of Thoracic Medicine, Royal Adelaide Hospital, Adelaide, SA, Australia; [9]Christchurch Public Hospital, Canterbury District Health Board, Christchurch, New Zealand; [10]Menzies Institute for Medical Research, College of Health and Medicine, University of Tasmania, Hobart, TAS, Australia; [11]School of Medicine, College of Health and Medicine, University of Tasmania, Hobart, TAS, Australia; [12]Bankstown Hospital, South Western Sydney Local Heath District, Sydney, NSW, Australia; [13]Department of Medicine, University of New South Wales, Sydney, NSW, Australia; [14]Department of Thoracic Medicine, Liverpool Hospital, Sydney, NSW, Australia; [15]School of Public Health and Preventive Medicine, Monash University, Melbourne, VIC, Australia; [16]QIMR-Berghofer Institute of Medical Research, Brisbane, QLD, Australia; [17]School of Population Health, University of Western Australia, Perth, WA, Australia; [18]School of Public Health, University of Illinois, Chicago, IL, USA; [19]Department of Thoracic Medicine, St Vincent's Hospital, Sydney, NSW, Australia; [20]University of NSW, Sydney, NSW, Australia

ABSTRACT

Coal mine lung dust disease (CMDLD) and artificial stone (AS) silicosis are preventable diseases which have occurred in serious outbreaks in Australia recently. This has prompted a TSANZ review of Australia's approach to respiratory periodic health surveillance. While regulating respirable dust exposure remains the foundation of primary and secondary prevention, identification of workers with early disease assists with control of further exposure, and with the aims of preserving lung function and decreasing respiratory morbidity in those affected. Prompt detection of an abnormality also allows for ongoing respiratory specialist clinical management. This review outlines a medical framework for improvements in respiratory surveillance to detect CMDLD and AS silicosis in Australia. This includes appropriate referral, improved data collection and interpretation, enhanced surveillance, the establishment of a nationwide Occupational Lung Disease Registry and an independent advisory group. These measures are designed to improve health outcomes for workers in the coal mining, AS and other dust-exposed and mining industries.

Key words: coal mine dust lung disease, pneumoconiosis, prevention, respiratory surveillance, silicosis.

INTRODUCTION

The recent reappearance of coal workers' pneumoconiosis (CWP)[1,2] and emergence of artificial stone (AS)-associated silicosis[3–5] has represented a failure of preventive systems to protect the respiratory health of workers in Australia. This resurgence of pneumoconiosis has occurred at a time when production has increased, mining techniques have been further mechanized and responsibilities for medical care outsourced, despite state- and nation-specific regulations to control respirable dust levels. In 2016, the Thoracic Society of Australia and New Zealand (TSANZ) highlighted key issues relating to the pressing need to improve periodic health surveillance for coal mine workers.[6] Some but not all of these recommendations have been implemented.

Correspondence: Deborah H. Yates, Department of Thoracic Medicine, St Vincent's Hospital, 438 Victoria St, Darlinghurst, Sydney, NSW 2010, Australia. Email: deborahy88@hotmail.com

*This study was endorsed by the TSANZ Board on 18 March 2020, following review by the TSANZ Clinical Care and Resources Subcommittee. Received 28 May 2020; invited to revise 7 July 2020; revised 19 July 2020; accepted 11 August 2020

Associate Editor: Michael Keane; Senior Editor: Philip Bardin

BOX 1. Goals and directions proposed by the Thoracic Society of Australia and New Zealand

Goals of this review

- To promote awareness among physicians and healthcare professionals about artificial stone (AS) silicosis and the spectrum of coal mine dust lung disease (CMDLD), and provide the rationale to support enhanced respiratory surveillance of exposed workers in Australia and New Zealand.
- To highlight optimal surveillance strategies which will identify workers at risk of CMDLD and AS-associated silicosis at an early stage in order to allow timely implementation of effective interventions and advance personalized management.

Proposed directions

- Improvements in collection of periodic health surveillance data and its interpretation in accordance with established practice and international guidelines, emphasizing longitudinal comparisons within individuals and enabling these data to become available for research and clinical decision-making.
- Enhanced surveillance methods to include diffusing capacity measurements, computed tomography for coal miners and AS workers where applicable at as low dose as possible; increased frequency of surveillance for symptomatic and high-risk groups, and evaluation of these strategies within prospective studies.
- Improved availability of cumulative dust exposure measurements for supervising medical advisors at the time of examining exposed workers, for respiratory physicians after referral, and to enable improved research into dose–response relationships between exposure and disease.
- Diagnoses of CMDLD/AS silicosis to be confirmed by occupational respiratory multidisciplinary teams with the recording of all such diagnoses within a centralized national registry as notifiable conditions, facilitated by the establishment of a central expert Occupational Lung Disease Advisory Group.

BOX 2. Occupational definitions as adapted from Wagner[7]

Respiratory surveillance
Respiratory surveillance is a component of public health practice involving the periodic collection, analysis and reporting of information in a workplace for disease detection and prevention. In contrast to population screening, respiratory surveillance is directed towards improvement of the health of workers who are exposed to a known workplace respiratory risk factor.

Case-finding of an individual after a 'sentinel event' has occurred
Case-finding uses medical testing to make a presumptive diagnosis of disease before an individual would normally seek medical care, usually when an available intervention can favourably affect the person's health. Case-finding aims to detect disease in its 'preclinical' stage. This allows monitoring of outbreaks and subsequent secondary prevention of disease in workplaces and communities.

Population screening
Screening is defined by the International Labour Office (ILO) as 'the presumptive identification of unrecognized disease in an apparently healthy, asymptomatic population by means of tests, examinations or other procedures that can be applied rapidly and easily to the target population. A screening programme must include all the core components in the screening process from inviting the target population to accessing effective treatment for individuals diagnosed with disease'. Population screening is not the same as respiratory surveillance.

This paper provides a framework for an optimal surveillance system of these workers in Australia and New Zealand and for improvements in the existing respiratory surveillance programme (Box 1). We emphasize that respiratory surveillance differs from targeted case finding such as has been implemented for AS workers in some states, and also from population screening for non-occupational diseases (Box 2).[7]

Detection of coal mine dust lung diseases (CMDLD) and AS silicosis at an early stage should facilitate more effective management and allow avoidance of further dust exposure to benefit individual workers. Our framework is based on existing literature including the review of the Queensland Coal Mine Worker's Health Scheme,[8] WorkCover Queensland's (WCQ) review of stonemasons with silicosis,[9] targeted literature searches and international guidelines. It also includes opinion from national and international experts in the field. This framework could potentially be used in construction, crafts and related trades as well as other mining operations which involve exposure to mineral dusts. Although the outbreak of pneumoconiosis has to date primarily affected Australia, this position paper has been developed co-operatively and includes expertise from both countries, being intended to apply to both

Australia and New Zealand. We aim to inform occupational physicians, general practitioners with special training in occupational disease and respiratory surveillance, and to provide a reference framework for respiratory physicians who are referred such patients. We also aim to benefit the workforce more broadly through identifying workplaces and work practices that need further hazard assessment.

This framework will expire 5 years from the date of publication but will be discussed at future TSANZ meetings as per TSANZ standard procedure for position papers. Dust control is critical to disease prevention but is outside the scope of this document. Specific recommendations for dust control are available.[10–13]

POSITION STATEMENT

Clinical aspects of CMDLD

CMDLD comprise several diseases in addition to classical CWP,[1,14,15] an interstitial lung disease resulting from chronic inhalation of coal mine dust, otherwise known as 'black lung'. CWP is characterized by nodular, and less commonly irregular opacities, on plain chest radiographs.[1] Most coalmine dust also contains a component of respirable crystalline silica (RCS) which is more fibrogenic than coal dust, potentially leading to silicosis or mixed dust pneumoconiosis (MDP).[16] The spectrum of CMDLD, which includes chronic obstructive pulmonary disease (COPD), is summarized in Table 1.[15,17] Notably, diagnoses can be missed by medical surveillance programmes that focus only on classical radiographic-nodular CWP. The current clinical pathway for CMDLD in Queensland is outlined in Figure 1, where such respiratory surveillance has recently been made mandatory with centralized reporting.

Table 1 Spectrum of disease in CMDLD and silicosis

Diagnoses
Bronchial anthracosis†
Chronic bronchitis
Caplan's syndrome (rheumatoid pneumoconiosis)
Coal workers' pneumoconiosis (CWP)
• Simple CWP
• Rapidly progressive pneumoconiosis
• Progressive massive fibrosis
Dust-related diffuse fibrosis
Mixed dust pneumoconiosis
Silicosis
• Acute
• Accelerated (e.g. artificial stone workers)
• Chronic (or classical)
COPD (with or without smoking)
Tuberculosis (including latent tuberculosis and non-tuberculous mycobacterial infection)
Lung cancer
Kidney disease
Autoimmune disorders including MCTD, Sjögren's syndrome and others

Adapted from Perret *et al.*,[15] with permission.
†Bronchoscopic and/or pathological diagnosis.
CMDLD, coal mine dust lung disease; COPD, chronic obstructive pulmonary disease; CWP, coal workers' pneumoconiosis; MCTD, mixed connective tissue disease.

In individuals exposed to coal mine dusts, CWP may develop into progressive massive fibrosis (PMF), which may ultimately be fatal. PMF may also occur in open cut or surface miners involved in drilling/blasting without a prior history of underground mining.[18] Rapidly progressive pneumoconiosis (RPP) is defined by the development of PMF and/or an increase in small opacity profusion greater than one International Labour Office (ILO) subcategory over 5 years.[19,20] This is associated with respiratory failure, right heart failure and premature death. RPP is associated with annual lung function declines of forced expiratory volume in 1 s (FEV_1) >60 mL/year compared with miners without CWP,[21] and occurs in CWP, silicosis and MDP. There has been an alarming rise of RPP/PMF diagnosed in the USA over the last 15 years,[1,19,22,23]; it is not yet clear whether this has also occurred in our countries.

CMDLD also includes chronic bronchitis and emphysema, which were documented in coal mine workers in the 1940s.[24] While initially attributed to smoking alone, coal dust-related obstructive chronic bronchitis (OCB), emphysema and accelerated lung function decline have since been amply confirmed.[25,26] These effects are additive rather than attributable to smoking alone and can also occur without radiological CWP on chest radiographs.[25,27–29] Interstitial pulmonary fibrosis related to coal mine dust exposure (dust-related diffuse fibrosis or DDF) also occurs, and can be identical clinically to other types of progressive fibrosing interstitial lung disease.[1]

Clinical aspects of AS silicosis

AS silicosis, which progresses more rapidly than classical silicosis, is an emerging global public health issue in workers in the kitchen/bathroom bench-top industry.[3,5] Cutting and grinding AS without dust controls such as water suppression and local exhaust ventilation (LEV) can generate very high levels of RCS and also other substances potentially toxic to the lung. Unfortunately, poor work practices have occurred in this industry and periodic surveillance has been infrequently performed.

This progressive form of silicosis is not yet fully understood. Disease may occur within 5 years of exposure, with rapid lung function loss and radiological progression.[4] Symptoms may be delayed, resulting in severe disease at first presentation.[17] The clinical features of AS silicosis include lung function restriction, interstitial radiographic nodules and positive auto-antibodies, similar to those seen in classical silicosis, and younger men are often affected.[3,17] Shorter latency periods, rapid progression to PMF and silico-proteinosis-like patterns on computed tomography (CT) scanning and histopathology may be found.

Lack of any effective treatment has added urgency to primary prevention. Dust suppression, including a combination of wet cutting methods and ventilatory

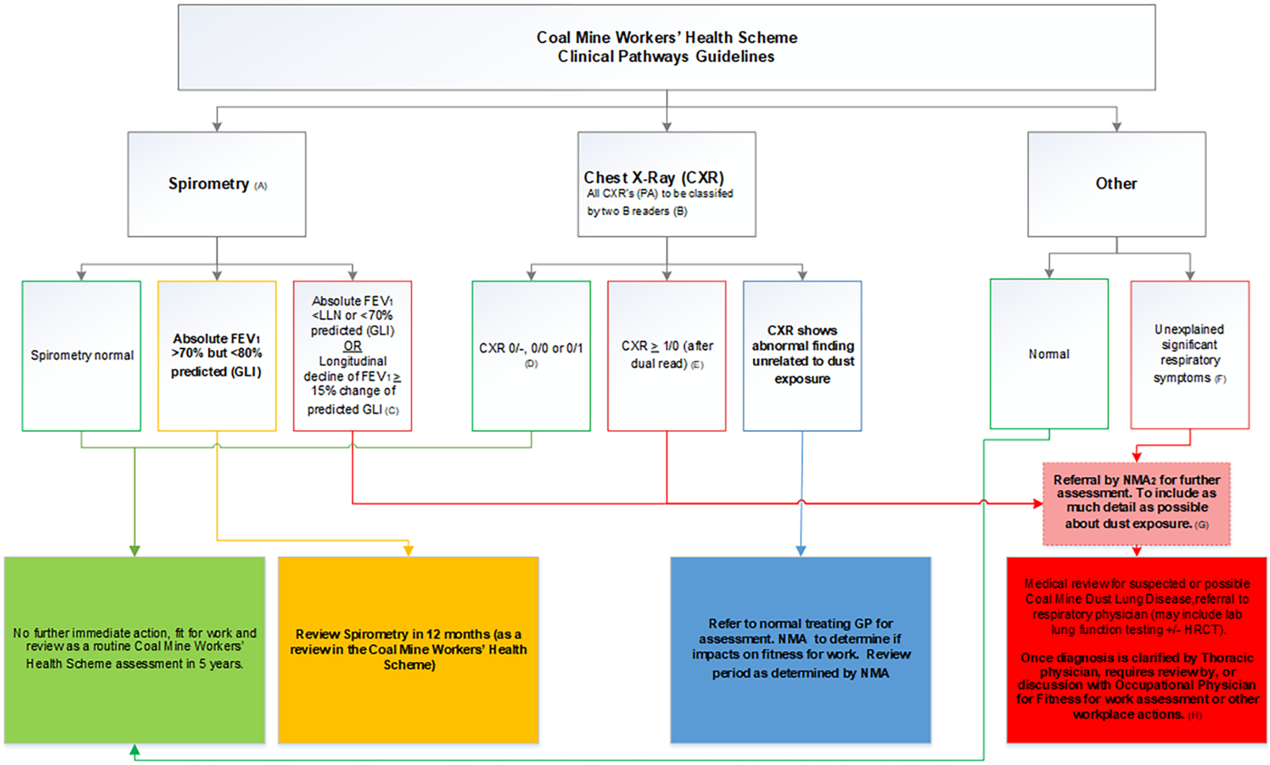

Figure 1 Coal Mine Workers' Health Scheme. This clinical pathway guideline documents the currently recommended process for follow-up investigation and referral to appropriate medical specialists of workers with abnormal results. Additional information supporting the guideline is available from https://www.dnrme.qld.gov.au/__data/assets/pdf_file/0005/1278563/cmwhs-clinical-pathways-guideline.pdf. Adapted from *Department of Natural Resources, Mines and Energy* of the Queensland Government, with permission. FEV_1, forced expiratory volume in 1 s; GLI, Global Lung Function Initiative; GP, general practitioner; HRCT, high-resolution computed tomography; LLN, lower limit of normal; NMA, nominated or supervising medical practitioners; PA, postero-anterior.

controls, can reduce RCS levels,[30] but even wet cutting of AS can produce levels that exceed the current workplace exposure standard for Safe Work Australia's time weighted average (TWA) of 0.05 mg/m^3, which is currently identical in New Zealand (NZ).[11,13] (see also http://hcis.safeworkaustralia.gov.au/ExposureStandards/Details?exposureStandardID=1042).

Further controls need to be considered in relation to the hierarchy of control, ordered from most to least effective (i.e. product substitution, engineering changes, administrative controls and then personal protection equipment (PPE)), as captured in the Australian and New Zealand Work Health and Safety Legislation: clause 36 of the model Work Health and Safety (WHS) for Australia[11] and clause 6 of the NZ Health and Safety at Work (general risk and workplace management) Regulation.[13]

Use of PPE is the least effective control measure and therefore should be regarded as the very last resort. Periodic surveillance of workers to detect early disease and optimal case management of diagnosed disease in these young-to-middle-aged workers is critical.[17] In a recent retrospective review of 78 AS masons in Queensland who had been given a clinical diagnosis of silicosis following active case finding and using high-resolution CT (HRCT) scanning, 34 (43%) had normal plain chest radiographs.[9] Of these, at least two-thirds had spent >50% of their total work tenure cutting and grinding without appropriate dust controls. Some false-negative findings occurred using chest radiographs alone, and HRCT was a more sensitive diagnostic test.[31] Although these are early data,[9] surveillance of workers with high levels of exposure using low-dose CT (LDCT) is much more likely to detect disease at an earlier stage compared with plain radiographs, when removal from dust exposure can assist long-term outcomes.

Improvements in lung function and imaging techniques

Techniques for investigating occupational lung disorders have improved significantly over recent decades and should be incorporated into modern respiratory surveillance methods. Improvements in lung function testing, in predicted values for interpretation, and computerized analysis of results should assist diagnosis. Lung function testing beyond spirometry which includes static lung volumes and diffusing capacity of the lung for carbon monoxide (DLCO),[32–34] should enable detection of the full spectrum of CMDLD. Although DLCO can be reduced by factors including smoking,[35,36] its ability to evaluate the gas exchange surface is highly relevant for early detection of silicosis and coal-related emphysema. Furthermore, the equipment has become increasingly portable, so it can easily be taken to the point of testing (e.g. remote mine sites).

Respirology published by John Wiley & Sons Australia, Ltd on behalf of Asian Pacific Society of Respirology.

Other developments include the derivation of internationally accepted reference values,[37,38] novel software to assist with monitoring rates of longitudinal lung function decline[39] and the option of secure, cloud-based centralized data storage.

Importantly, more sensitive and specific radiological techniques have been developed for the detection of lung disease at an earlier stage. The diagnostic utility of HRCT scans is superior to plain chest imaging in both detecting and evaluating small parenchymal opacities and in staging disease in CWP[40–42] and silicosis. Application of computerized software is increasingly allowing quantification of extent of emphysema and interstitial lung disease, as well as assessment of the airway components of COPD. The use of LDCT with typical radiation exposure of 1.5 mSv has also enabled early detection of lung cancers and screening is recommended for those at increased risk in several countries.[43,44] The ionizing radiation doses of ultralow-dose CT (uLDCT) protocols now approaches that of plain chest radiographs (0.12–0.20 vs 0.10 mSv),[45,46] without substantially losing diagnostic quality.[45,47] This contrasts with the estimated annual exposure for an average Australian of 1.5 mSv from natural sources.[48] However, uLDCT has not yet been validated for the surveillance of coal- and silica-related pneumoconioses.

CT scans should be interpreted by an experienced thoracic radiologist with understanding of the International Classification of Occupational and Environmental Respiratory Diseases (ICOERD) system[49] and RANZCR recommendations.[50] Ideally, the ICOERD system should be updated and adopted internationally. Radiological grading scales provide prognostic risk of disease progression in individuals with advanced disease. For example, coal mine workers with ILO grade >2/1 have an estimated 1 in 8 chance (12.5% risk) of developing PMF within 5 years.[51] At a population level, such reporting in accordance with occupational imaging classification standards can more accurately estimate incidence, prevalence and severity of occupationally acquired lung diseases.

There is a need to regularly monitor clinician competency in interpreting images, such as the 'B' reader course, which has recently been introduced in Queensland, although no such certification exists for CT scanning. TSANZ's course on occupational lung diseases provides the opportunity for an annual update for clinicians, but optimally this area requires further development.

The way forward: optimizing respiratory periodic health surveillance

Improving collection of exposure data (dust sampling)

Exposure to respirable coal mine dust has been subject to much research; however, this is not true for AS exposure. Measurements of workplace RCS are needed to understand cumulative exposures a worker may have experienced but need to be analysed by an accredited analytical facility. Dust monitoring should occur under typical working conditions, not when work is performed at less than usual capacity. Careful review of compliance to national standards for RCS collection and analysis[52] is required. Ideally, individual exposure data should be available at the time of surveillance, accessible via a centralized database. Although outside the scope of this paper, improved national and international collaboration is needed between occupational health staff, engineers involved in dust control and treating doctors.

A detailed occupational exposure history is essential for all workers including a full chronological history of all jobs, use (or lack of) of appropriate dust controls in current and previous employment and other exposures, particularly concurrent smoking and vaping. Accurate dust measurements suitable for pooled data analysis are required to better inform policy on appropriate respirable dust limits; this requires close collaboration with occupational hygienists.

Improving health record documentation and interpretation

The review of the coal miners' periodic health surveillance system in Queensland highlighted multiple areas where improvements were needed.[8] These included poor performance and interpretation of spirometry, and deficiencies in quality control and administrative procedures. Chest radiograph interpretation was limited by suboptimal film quality, lack of clinical information and lack of recognition of early disease. Surface workers exposed to dust in open cut mines were not routinely included in surveillance despite being at risk of CMDLD.[8] There was lack of a quality assurance programme and of adherence to international standards. The B reader programme using chest radiographs which is used in the USA and is evidence based and relies on regular clinician training[53–55] was not in operation, and no quality control programme for clinician competency was followed.

Our proposed improvements in periodic surveillance programmes for the conduct and interpretation of testing as well as other directions are shown in Table 2. Illustrative references have been provided as a full discussion is beyond the scope of this paper.

For surveillance for CMDLD, we recommend that the diagnostic utility of uLDCT needs to be compared with that of the ILO classifications of plain chest radiographs in prospective studies. While randomized controlled trials would provide the best evidence for the evaluation of comparative efficacy, such studies would need to be performed over long periods, due to the prolonged latency periods of these diseases.

When interpreting spirometry, a fixed cut-off value of post-bronchodilator FEV_1/forced vital capacity (FVC) <0.70 has previously been recommended to define airways obstruction.[62] However, this under-diagnoses airflow obstruction for younger and taller working adults up to their early 40s, and overestimates this in older, shorter subjects. The internationally recognized Global Lung Function Initiative (GLI) predicted values has allowed better definition of the limits of normality,[37,38] and should be adopted; multiple serial measurements are needed for optimal accuracy.[39]

Databases used for health surveillance need to compare serial lung function data over a working life. It is highly desirable to link these databases with

Table 2 Optimizing periodic health surveillance in the coal and AS industry

Proposed improvements to periodic health surveillance	Citation/s
Regular training of staff in accordance with international standards including quality control and quality assurance, including accurate interpretation of lung function data by supervising medical practitioners	8,32,33,39
Plain chest radiographs to be performed using ILO recommended techniques and to be technically acceptable. Classification only by qualified thoracic radiologists, preferably with B-reader qualifications, and compared with previous images	8,20
Individual spirometry results to be interpreted using reference values of the GLI, with serial data compared with longitudinal predicted values, while adopting the lower limit of normal to define lung function abnormality	8,37–39
Dust monitoring information under typical working conditions (≥75% capacity) and considered if substantive changes are made to facility, processes and practices, to be recorded using an accredited facility, with individualized data available at the time of periodic surveillance	3,10,11
Extending surveillance methods for AS exposure to potentially include LDCT, reported by expert thoracic radiologists; careful evaluation of the role for uLDCT for coal miner and AS workers within longitudinal prospective studies	9,56
Extending surveillance methods for all workers to include lung diffusing capacity according to ATS/ERS standards at intervals of 3 years or less with careful evaluation of such surveillance within longitudinal prospective studies	27,32,33,56
A flexible approach to the timing of surveillance of coal mine dust workers, including annual spirometry and DLCO if results are abnormal but do not yet fulfil diagnostic criteria for disease	7,56,57
For AS workers previously exposed to high RCS levels, active case-finding using conventional HRCT/ spirometry/DLCO performed at accredited respiratory laboratories and radiological facilities using recommended protocols; follow-up by expert treating specialists/teams, preferably at occupational respiratory MDTs	9,32,33,50,58,59
For AS workers, pre-employment plain chest radiographs to exclude major abnormalities. For AS workers undergoing active case-finding without abnormal CXR or HRCT, annual spirometry/DLCO and imaging 3-yearly or more often depending on individual factors and test results	17
Complementing surveillance CXR imaging with HRCT scans in high-risk groups, for example, where borderline fibrosis is found on plain chest radiographs and/or where discrepancy exists with lung function findings	49,60
Improving existing medical databases to allow capacity to compare serial lung function data, occupational exposure history, imaging findings and dust measurements	39,61
Early review of the diagnostic utility of 'best available tests' (LDCT, uLDCT and DLCO) by comparisons with plain chest radiographs and spirometry collected prospectively with consent from workers, ideally in a research setting	

AS, artificial stone; ATS/ERS, American Thoracic Society/European Respiratory Society; CXR, chest X-ray; DLCO, diffusing capacity of the lung for carbon monoxide; GLI, Global Lung Function Initiative; HRCT, high-resolution computed tomography; ILO, International Labour Office; LDCT, low-dose CT; MDT, multidisciplinary team; RCS, respirable crystalline silica; uLDCT, ultralow-dose CT.

occupational histories and occupational hygiene data, enabling medical practitioners to be better informed regarding type, duration and intensity of exposures. Doctors assessing serial lung function data require appropriate and ongoing training to identify lung function decline beyond that of age-related decline and measurement variability, using longitudinal analysis software such as SPIROLA.[39] The SPIROLA software also allows monitoring of the quality of spirometry for the purposes of quality assurance which is also important for medical surveillance.

Frequency of surveillance and individual management

Most existing surveillance programmes in the mining industries use a uniform system regardless of individual risks; however, the field is now moving beyond the 'one-size-fits-all' approach. Although workers who have been consistently employed in roles associated with higher dust exposures appear at greater risk of developing lung disease, other factors may contribute (e.g. genetic predisposition,[15] concomitant smoking and/or pre-existing respiratory diseases). One important benefit from this 'personalized' approach could be to facilitate a worker's knowledge of potential adverse effects from respirable dust exposures, provide smoking cessation advice and encourage the reporting of new respiratory symptoms that might represent early disease or disease progression.

The frequency with which respiratory surveillance is performed in coal miners is not standardized within Australia and New Zealand, but it usually occurs 3–5 yearly. International recommendations suggest more frequent lung function testing to identify accelerated lung function decline at an earlier stage.[1,57] The U.S. National Institute for Occupational Safety and Health (NIOSH) programme consists of mandatory spirometry/chest X-ray examination upon entry into mining and after 3 years, then annual spirometry and chest

Respirology published by John Wiley & Sons Australia, Ltd on behalf of Asian Pacific Society of Respirology.

X-ray examination every 2–5 years for both underground and surface miners working in the industry over their lifetime.[7,56] Findings from mining regions that exceed current respirable dust exposure limits support at least annual testing of spirometry, especially for young smoking miners with bronchitis symptoms,[26,63] but ideally spirometry should not be dependent on dust measurements. Assessment of cross-sectional data other than the baseline testing is generally not as useful as serial measurements, especially if a worker begins his/her career with above average readings. Whenever possible, longitudinal patterns of lung function decline should be estimated using the free SPIROLA software.[39,61] A web-based version of this software is due for release soon (https://www.cdc.gov/niosh/topics/spirometry/spirola-software.html).

Where radiological and physiological changes are found but do not yet meet diagnostic criteria for clinical disease, more frequent monitoring is indicated on an individual basis, depending on the risk profile. For example, a repeat chest X-ray in 2 years is suggested for coal mine workers if there is radiological evidence of category 1/0 or higher pneumoconiosis, and annual spirometry if results are below the lower limit of predicted normal and/or if there is accelerated FEV_1 decline.[56] Individuals with acute intense exposures may warrant monitoring more frequently. It is important that health surveillance continues after ceasing employment because workers are still at risk in subsequent years,[64,65] especially if a resignation was prompted by health concerns.[28] Specialist medical evaluation is appropriate if there is uncertainty.

Implementing surveillance for AS workers

Given the exceptionally high exposure to RCS in the AS industry in Australia, respiratory surveillance needs to be considered separately from coal mine dust exposure. Prior to the first Australian report of AS silicosis cases,[4] there was little workplace awareness of existing regulations or the need for appropriate surveillance. Subsequently, specific case finding programmes have been implemented in some states to detect AS silicosis in its 'preclinical stage' using conventional HRCT.[50] Early results suggest that individual cases identified by targeted screening may require frequent monitoring with full lung function tests and CT, given the potential for rapid progression of disease.[4]

The TSANZ supports optimal respiratory surveillance methods in order to increase the detection of early disease. For individuals with significant exposure but no current evidence of disease, there is consensus among professional bodies including TSANZ, RANZCR, Royal Australasian College of Physicians (RACP) and Australasian Faculty of Occupational and Environmental Medicine (AFOEM) that surveillance with LDCT is preferable to plain chest radiography. Currently, it remains unclear whether LDCT is non-inferior to HRCT. Similarly, annual lung function testing and radiological surveillance at intervals 3-yearly or less is preferred. Interval cases may occur if the surveillance tests are spaced too far apart. For workers new to the industry, it is not yet clear whether LDCT is feasible as a baseline pre-employment test.

We acknowledge the lack of evidence regarding enhanced radiological surveillance, and therefore suggest further research. In the interim, RANZCR recommendations should be followed. While we have suggested it may be reasonable to initially adopt LDCT given its use in lung cancer screening, it is essential that future studies fully address the question of whether the sensitivity of LDCT is sufficient to adequately detect smaller and/or ground-glass nodules that are characteristic of silicosis. A role for uLDCT in occupational respiratory surveillance needs investigation if the use of LDCT becomes established. It is important to recognize that improvements in dust control measures in this industry would be expected to reduce the incidence of AS silicosis, but that lifelong respiratory surveillance will still need to be conducted due to the long latency between exposure and disease development. Respiratory surveillance, as a secondary screening tool, should be conducted regardless of how well dust control measures improve, and should continue after the worker has left the employment and as long as the worker agrees to this. Optimal respiratory surveillance will ensure that new exposures or failures in exposure controls are identified quickly and that remediation occurs, while protecting workers' respiratory health.

Formalizing clinical pathways to specialist review

For equivocal and confirmed diagnoses identified by case finding or periodic surveillance, early specialist referral to an expert respiratory physician is recommended, while acknowledging potential difficulties with accessibility and costs. These factors are influenced by state, federal and healthcare systems. Establishing links between employers, local, national and international professional bodies can facilitate these processes. As already demonstrated for lung cancer and idiopathic pulmonary fibrosis, diagnosis and recommendations for clinical care are enhanced by a specific multidisciplinary team (MDT) meeting that enables consensus-based diagnosis and management. Further investigation may require invasive procedures such as bronchoscopy, endoscopic bronchial ultrasound-guided or surgical lung biopsy. However, it should be emphasized that these procedures are invasive and should only be necessary in few cases. Optimal management includes smoking cessation interventions, psychological counselling and access to supportive care such as pulmonary rehabilitation, vaccination and oxygen therapy where appropriate.[1] Vigilance is needed given the predisposition to mycobacterial infection after silica exposure. Referral for lung transplantation may be required.[1] This multidisciplinary approach is likely to improve diagnostic accuracy and improve workers' health.

Establishing a centralized registry and Occupational Lung Disease Advisory Group

Currently, information regarding the number and type of cases of occupational lung diseases in Australia and New Zealand is very poorly documented. The TSANZ, with the support of key medical professional bodies, has proposed the establishment of a national registry to record all cases of occupationally acquired lung disease. Formal registration of individuals with confirmed occupationally related respiratory diagnoses within this central registry would facilitate gathering of accurate data and allow targeted interventions to protect other workers. Diagnostic accuracy is paramount and should be overseen by experts in occupational lung disease at occupational lung MDT meetings (Occ-L-MDT). A system of MDTs is already established in each Australian state and in New Zealand for lung cancer and interstitial lung diseases, and could easily be implemented more widely. The formation of a national advisory group (potentially also to include New Zealand) consisting of expert practitioners in occupational and respiratory medicine, occupational hygiene, radiology and respiratory physiology could provide expert and timely advice to practitioners and governments. Systems for notification of occupational lung diseases are already being reviewed at state and national levels in Australia and New Zealand. The recording of radiological images, lung function measurements and dust exposure data from industry and/or state mine regulatory authorities within a central registry would allow analysis of disease features and monitoring of epidemiological trends nationally.

CONCLUSIONS

The recent resurgence of CMDLD and the rapid emergence of AS-associated silicosis in Australia have highlighted a failure of enforcement of current regulations for dust control as well as poor periodic respiratory surveillance. Given these past deficiencies, the TSANZ now provides a framework to enhance existing programmes and comply with international standards. These includes the conduct, interpretation and audit of respiratory surveillance testing, improvements in database systems, a flexible approach to enhance individual surveillance and expansion of surveillance testing to include lung diffusing capacity and CT scanning. TSANZ also recognizes the need to establish a firm evidence base for enhanced surveillance by performing appropriate research. Furthermore, TSANZ proposes the establishment of a national registry for occupationally acquired lung diseases and an independent Occupational Lung Disease Advisory Group. This would facilitate the continued improvement in existing programmes, reduce preventable respiratory disease and promote a positive and supportive workplace culture for Australian and New Zealand workers.

Disclosure statement: F.B. has received unrestricted research grants to examine optimal radiology approaches for screening AS workers: iCare DDB and Royal Perth Hospital. D.H.Y. has been a PI on a peer-reviewed grant from the Coal Services Trust, NSW.

Abbreviations: RANZCR, Royal Australian and New Zealand College of Radiologists; AS, artificial stone; CMDLD, coal mine dust lung disease; CT, computed tomography; CWP, coal workers' pneumoconiosis; CXR, chest X-ray; DLCO, diffusing capacity of the lung for carbon monoxide; FEV_1, forced expiratory volume in 1thinspaces; GLI, Global Lung Function Initiative; ICOERD, International Classification of Occupational and Environmental Respiratory Disease; ILO, International Labour Office; LDCT, low-dose CT; MCTD, mixed connective tissue disease; MDP, mixed dust pneumoconiosis; MDT, multidisciplinary team; NZ, New Zealand; PMF, progressive massive fibrosis; PPE, personal protection equipment; RCS, respirable crystalline silica; RPP, rapidly progressive pneumoconiosis; TSANZ, Thoracic Society of Australia and New Zealand; uLDCT, ultralow-dose CT

REFERENCES

1 Petsonk EL, Rose C, Cohen R. Coal mine dust lung disease. New lessons from old exposure. *Am. J. Respir. Crit. Care Med.* 2013; **187**: 1178–85.

2 Newbigin K, McBean R, Parsons R, Tatkovic A, Lau H, Cleveland D, Driscoll T. A clinical, radiological and occupational review of coal mine dust lung disease in Queensland. Final report. Wesley Dust Disease Research Centre, Queensland, Australia, 2019.

3 Leso V, Fontana L, Romano R, Gervetti P, Iavicoli I. Artificial stone associated silicosis: a systematic review. *Int. J. Environ. Res. Public Health* 2019; **16**(4): 568

4 Hoy RF, Baird T, Hammerschlag G, Hart D, Johnson AR, King P, Putt M, Yates DH. Artificial stone-associated silicosis: a rapidly emerging occupational lung disease. *Occup. Environ. Med.* 2018; **75**: 3–5.

5 The Lancet Respiratory Medicine. The world is failing on silicosis. *Lancet Respir. Med.* 2019; **7**: 283.

6 Zosky GR, Hoy RF, Silverstone EJ, Brims FJ, Miles S, Johnson AR, Gibson PG, Yates DH. Coal workers' pneumoconiosis: an Australian perspective. *Med. J. Aust.* 2016; **204**: 414–8.

7 Wagner GR. Screening and surveillance of workers exposed to mineral dust. Geneva: World Health Organization, 1996. [Accessed 16 July 2020.] Available from URL: https://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/publication/wcms_154922.pdf

8 Sim M, Glass D, Hoy R, Roberts M, Thompson BR, Cohen R, Go LH, Almberg KS, Deponte K. Review of respiratory component of the Coal Mine Workers' Health Scheme for the Queensland Department of Natural Resources and Mines. Final report. Monash Centre for Occupational and Environmental Health, School of Public Health and Preventive Medicine, Monash University, Melbourne, Australia, in collaboration with the School of Public Health, University of Illinois, Chicago, USA, 2016.

9 Newbigin K, Parsons R, Deller D, Edwards R, McBean R. Stonemasons with silicosis: preliminary findings and a warning message from Australia. *Respirology* 2019; **24**: 1220–1.

10 Safe Work Australia. Managing risks of hazardous chemical in the workplace. Code of Practice. Section 5.2. 2018. [Accessed 16 July 2020]. Available from URL: https://www.safeworkaustralia.gov.au/system/files/documents/1901/code_of_practice_-_managing_the_risks_of_hazardous_chemicals_0.pdf

11 Safe Work Australia. Model work health and safety regulations. Parliamentary Counsel's Committee, 2019. [Accessed 16 July 2020]. Available from URL: https://www.safeworkaustralia.gov.au/system/files/documents/2003/model-whs-regulations-dec2020.pdf

12 WorkSafe Mahi Haumaru Aotearoa. Safety alert: accelerated silicosis. 2019. [Last updated 13 Jan, Accessed 16 July 2020.] Available from URL: https://worksafe.govt.nz/about-us/news-and-media/accelerated-silicosis/

13 WorkSafe Mahi Haumaru Aotearoa. Workplace exposure standards and biological exposure indices. Edition 11. 2019. [Accessed 16 July 2020]. Available from URL: https://worksafe.govt.nz/topic-and-industry/work-related-health/monitoring/exposure-standards-and-biological-exposure-indices/

Respirology published by John Wiley & Sons Australia, Ltd on behalf of Asian Pacific Society of Respirology.

14 Laney AS, Weissman DN. Respiratory diseases caused by coal mine dust. *J. Occup. Environ. Med.* 2014; **56**(Suppl. 10): S18–22.
15 Perret JL, Plush B, Lachapelle P, Hinks TS, Walter C, Clarke P, Irving L, Brady P, Dharmage SC, Stewart A. Coal mine dust lung disease in the modern era. *Respirology* 2017; **22**: 662–70.
16 Cohen RA, Petsonk EL, Rose C, Young B, Regier M, Najmuddin A, Abraham JL, Churg A, Green FH. Lung pathology in U.S. coal workers with rapidly progressive pneumoconiosis implicates silica and silicates. *Am. J. Respir. Crit. Care Med.* 2016; **193**: 673–80.
17 Centre for Disease Control and Prevention. Severe silicosis in engineered stone fabrication workers – California, Colorado, Texas, and Washington, 2017–2019. Morbidity and Mortality Weekly Report. Vol. 68 No. 38. US Department of Health and Human Services, Atlanta, GA, USA, 2019.
18 Halldin CN, Reed WR, Joy GJ, Colinet JF, Rider JP, Petsonk EL, Abraham JL, Wolfe AL, Storey E, Laney AS. Debilitating lung disease among surface coal miners with no underground mining tenure. *J. Occup. Environ. Med.* 2015; **57**: 62–7.
19 Antao VC, Petsonk EL, Sokolow LZ, Wolfe AL, Pinheiro GA, Hale JM, Attfield MD. Rapidly progressive coal workers' pneumoconiosis in the United States: geographic clustering and other factors. *Occup. Environ. Med.* 2005; **62**: 670–4.
20 International Labour Office, 2011. Guidelines for the use of the ILO international classification of radiographs of pneumoconiosis (Revised Edition 2011). International Labour Office, Geneva, Switzerland. [Accessed 2 Sept 2016.] 2011. Available from URL: http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/publication/wcms_168260.pdf
21 Stansbury RC, Beeckman-Wagner LA, Wang ML, Hogg JP, Petsonk EL. Rapid decline in lung function in coal miners: evidence of disease in small airways. *Am. J. Ind. Med.* 2013; **56**: 1107–12.
22 Laney AS, Attfield MD. Coal workers' pneumoconiosis and progressive massive fibrosis are increasingly more prevalent among workers in small underground coal mines in the United States. *Occup. Environ. Med.* 2010; **67**: 428–31.
23 Almberg KS, Halldin CN, Blackley DJ, Laney AS, Storey E, Rose CS, Go LHT, Cohen RA. Progressive massive fibrosis resurgence identified in U.S. coal miners filing for black lung benefits, 1970-2016. *Ann. Am. Thorac. Soc.* 2018; **15**: 1420–6.
24 Stewart A. Pneumoconiosis of coal-miners; a study of the disease after exposure to dust has ceased. *Br. J. Ind. Med.* 1948; **5**: 120–40.
25 Coggon D, Newman Taylor A. Coal mining and chronic obstructive pulmonary disease: a review of the evidence. *Thorax* 1998; **53**: 398–407.
26 Wang ML, Wu ZE, Du QG, Peng KL, Li YD, Li SK, Han GH, Petsonk EL. Rapid decline in forced expiratory volume in 1 second (FEV1) and the development of bronchitic symptoms among new Chinese coal miners. *J. Occup. Environ. Med.* 2007; **49**: 1143–8.
27 Santo Tomas LH. Emphysema and chronic obstructive pulmonary disease in coal miners. *Curr. Opin. Pulm. Med.* 2011; **17**: 123–5.
28 Soutar CA, Hurley JF. Relation between dust exposure and lung function in miners and ex-miners. *Br. J. Ind. Med.* 1986; **43**: 307–20.
29 Lewis S, Bennett J, Richards K, Britton J. A cross sectional study of the independent effect of occupation on lung function in British coal miners. *Occup. Environ. Med.* 1996; **53**: 125–8.
30 Cooper JH, Johnson DL, Phillips ML. Respirable silica dust suppression during artificial stone countertop cutting. *Ann. Occup. Hyg.* 2015; **59**: 122–6.
31 Fernandez Alvarez R, Martinez Gonzalez C, Quero Martinez A, Blanco Perez JJ, Carazo Fernandez L, Prieto Fernandez A. Guidelines for the diagnosis and monitoring of silicosis. *Arch. Bronconeumol.* 2015; **51**: 86–93.
32 Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A, Crapo R, Enright P, van der Grinten CP, Gustafsson P *et al.* Standardisation of spirometry. *Eur. Respir. J.* 2005; **26**: 319–38.
33 Macintyre N, Crapo RO, Viegi G, Johnson DC, van der Grinten CP, Brusasco V, Burgos F, Casaburi R, Coates A, Enright P *et al.* Standardisation of the single-breath determination of carbon monoxide uptake in the lung. *Eur. Respir. J.* 2005; **26**: 720–35.
34 Wanger J, Clausen JL, Coates A, Pedersen OF, Brusasco V, Burgos F, Casaburi R, Crapo R, Enright P, van der Grinten CP *et al.* Standardisation of the measurement of lung volumes. *Eur. Respir. J.* 2005; **26**: 511–22.
35 Ryder R, Lyons JP, Campbell H, Gough J. Emphysema in coal workers' pneumoconiosis. *Br. Med. J.* 1970; **3**: 481–7.
36 Kibelstis JA. Diffusing capacity in bituminous coal miners. *Chest* 1973; **63**: 501–4.
37 Quanjer PH, Stanojevic S, Cole TJ, Baur X, Hall GL, Culver BH, Enright PL, Hankinson JL, Ip MS, Zheng J *et al.* Multi-ethnic reference values for spirometry for the 3-95-yr age range: the Global Lung Function 2012 equations. *Eur. Respir. J.* 2012; **40**: 1324–43.
38 Stanojevic S, Graham BL, Cooper BG, Thompson BR, Carter KW, Francis RW, Hall GL; Global Lung Function Initiative TLCO Working Group; Global Lung Function Initiative (GLI) TLCO. Official ERS technical standards: Global Lung Function Initiative reference values for the carbon monoxide transfer factor for Caucasians. *Eur. Respir. J.* 2017; **50**: 1700010.
39 Hnizdo E, Yan T, Hakobyan A, Enright P, Beeckman-Wagner LA, Hankinson J, Fleming J, Lee Petsonk E. Spirometry Longitudinal Data Analysis Software (SPIROLA) for analysis of spirometry data in workplace prevention or COPD treatment. *Open Med. Inform. J.* 2010; **4**: 94–102. Also available from URL: https://www.cdc.gov/niosh/topics/spirometry/spirola-software.html
40 Remy-Jardin M, Degreef JM, Beuscart R, Voisin C, Remy J. Coal worker's pneumoconiosis: CT assessment in exposed workers and correlation with radiographic findings. *Radiology* 1990; **177**: 363–71.
41 Xing J, Huang X, Yang L, Liu Y, Zhang H, Chen W. Comparison of high-resolution computerized tomography with film-screen radiography for the evaluation of opacity and the recognition of coal workers' pneumoconiosis. *J. Occup. Health* 2014; **56**: 301–8.
42 Savranlar A, Altin R, Mahmutyazicioglu K, Ozdemir H, Kart L, Ozer T, Gundogdu S. Comparison of chest radiography and high-resolution computed tomography findings in early and low-grade coal worker's pneumoconiosis. *Eur. J. Radiol.* 2004; **51**: 175–80.
43 Kauczor HU, Bonomo L, Gaga M, Nackaerts K, Peled N, Prokop M, Remy-Jardin M, von Stackelberg O, Sculier JP; European Society of Radiology; European Respiratory Society. ESR/ERS white paper on lung cancer screening. *Eur. Respir. J.* 2015; **46**: 28–39.
44 Brims F, McWilliams A, Fong K. Lung cancer screening in Australia: progress or procrastination? *Med. J. Aust.* 2016; **204**: 4–5.
45 Wang R, Sui X, Schoepf UJ, Song W, Xue H, Jin Z, Schmidt B, Flohr TG, Canstein C, Spearman JV *et al.* Ultralow-radiation-dose chest CT: accuracy for lung densitometry and emphysema detection. *AJR Am. J. Roentgenol.* 2015; **204**: 743–9.
46 Mettler FA Jr, Huda W, Yoshizumi TT, Mahesh M. Effective doses in radiology and diagnostic nuclear medicine: a catalog. *Radiology* 2008; **248**: 254–63.
47 Lee JY, Chung MJ, Yi CA, Lee KS. Ultra-low-dose MDCT of the chest: influence on automated lung nodule detection. *Korean J. Radiol.* 2008; **9**: 95–101.
48 Australian Government, Australian Radiation Protection and Nuclear Safety Agency. ARPANSA fact sheet – ionizing radiation and health. 2015. [Accessed 19 Sept 2019.] Available from: https://www.arpansa.gov.au/sites/default/files/legacy/pubs/factsheets/IonisingRadiationandHealth.pdf
49 Weissman DN. Role of chest computed tomography in prevention of occupational respiratory disease: review of recent literature. *Semin. Respir. Crit. Care Med.* 2015; **36**: 433–48.
50 Imaging of Occupational Lung Disease. Position statement. Version 1. The Royal Australian and New Zealand College of Radiologists, The Faculty of Clinical Radiology, Sydney, Australia, 2019.
51 Hurley JF, Alexander WP, Hazledine DJ, Jacobsen M, Maclaren WM. Exposure to respirable coalmine dust and incidence of progressive massive fibrosis. *Br. J. Ind. Med.* 1987; **44**: 661–72.
52 Australian Standard. 2009. AS 2985-2009. Workplace atmospheres - Method for sampling and gravimetric determination of respirable dust Standards Australia, Sydney, Australia.

53 Felson B, Morgan WK, Bristol LJ, Pendergrass EP, Dessen EL, Linton OW, Reger RB. Observations on the results of multiple readings of chest films in coal miners' pneumoconiosis. *Radiology* 1973; **109**: 19–23.
54 Halldin CN, Hale JM, Weissman DN, Attfield MD, Parker JE, Petsonk EL, Cohen RA, Markle T, Blackley DJ, Wolfe AL *et al*. The National Institute for Occupational Safety and Health B reader certification program – an update report (1987 to 2018) and future directions. *J. Occup. Environ. Med*. 2019; **61**: 1045–51. Also available from URL: https://www.cdc.gov/niosh/topics/chestradiography/breader.html
55 Halldin CN, Blackley DJ, Petsonk EL, Laney AS. Pneumoconioses radiographs in a large population of U.S. coal workers: variability in a reader and B reader classifications by using the International Labour Office classification. *Radiology* 2017; **284**: 870–6.
56 U.S. Department of Health and Human Services, 1995. Criteria for a recommended standard: occupational exposure to respirable coal mine dust 1995. DHHS (NIOSH) Publication 95–106. [Accessed 17 Mar 2019.] Available from URL: https://www.cdc.gov/niosh/docs/95-106/
57 Wagner, Gregory R, World Health Organization & WHO Meeting on the Screening and Surveillance of Workers Exposed to Mineral Dust (1993: Geneva, Switzerland). (1996). Screening and surveillance of workers exposed to mineral dust/Gregory R. Wagner. World Health Organization https://apps.who.int/iris/handle/10665/41876
58 Kusaka Y, Hering KG, Parker JE, *International Classification of HRCT for Occupational and Environmental Respiratory Diseases*. Japan, Springer, 2005.
59 Kubo T, Ohno Y, Nishino M, Lin PJ, Gautam S, Kauczor HU, Hatabu H; iLEAD Study Group. Low dose chest CT protocol (50 mAs) as a routine protocol for comprehensive assessment of intrathoracic abnormality. *Eur. J. Radiol. Open* 2016; **3**: 86–94.
60 Meijer E, Tjoe Nij E, Kraus T, van der Zee JS, van Delden O, van Leeuwen M, Lammers JW, Heederik D. Pneumoconiosis and emphysema in construction workers: results of HRCT and lung function findings. *Occup. Environ. Med.* 2011; **68**: 542–6.
61 Townsend MC; Occupational and Environmental Lung Disorders Committee. Spirometry in the occupational health setting – 2011 update. *J. Occup. Environ. Med*. 2011; **53**: 569–84.
62 Pauwels RA, Buist AS, Calverley PM, Jenkins CR, Hurd SS. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. NHLBI/WHO Global Initiative for Chronic Obstructive Lung Disease (GOLD) workshop summary. *Am. J. Respir. Crit. Care Med.* 2001; **163**: 1256–76.
63 Wang ML, Wu ZE, Du QG, Petsonk EL, Peng KL, Li YD, Li SK, Han GH, Atffield MD. A prospective cohort study among new Chinese coal miners: the early pattern of lung function change. *Occup. Environ. Med*. 2005; **62**: 800–5.
64 Go LH, Krefft SD, Cohen RA, Rose CS. Lung disease and coal mining: what pulmonologists need to know. *Curr. Opin. Pulm. Med.* 2016; **22**: 170–8.
65 Kimura K, Ohtsuka Y, Kaji H, Nakano I, Sakai I, Itabashi K, Igarashi T, Okamoto K. Progression of pneumoconiosis in coal miners after cessation of dust exposure: a longitudinal study based on periodic chest X-ray examinations in Hokkaido, Japan. *Intern. Med.* 2010; **49**: 1949–56.

Respirology published by John Wiley & Sons Australia, Ltd on behalf of Asian Pacific Society of Respirology.