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Emerging and re-emerging occupational illness and disease surveillance, monitoring, and foresight:
An evidence and practice review supplemented by 10 evidence profiles

Insights brief

Authors
Paul Kellner
Diki Tsering
Pritania Astari
Danni Teychenne
Shannon Gray
Michael Di Donato
Alyse Lennox
Veronica Delafosse

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The MSDI Evidence Review Service (ERS) supports government, industry and others to address pressing issues in sustainability, health and other areas. The central aim of the ERS is to connect knowledge to power. We believe that research and other credible knowledge can add value to problem-solving by illuminating potential solutions as well as areas where investment may be wasted on strategies that have failed elsewhere. All ERS reviews are based on established principles of review science which we have applied across a broad array of disciplines and settings for over 10 years. Our reviews are tailored to our clients' timelines, which vary from as little as one day to several months. The ERS has a strong track record of supporting government, industry and others to address pressing issues in health, sustainability and other areas. Our recent clients include: The Royal Commission into Victoria's Mental Health System, The Royal Australasian College of Physicians, The Paul Ramsay Foundation (a leading Australian philanthropic organisation focused on addressing disadvantage), The Global Buildings Performance Network (a global network of building practitioners committed to green building) and two major Australian banks.

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BehaviourWorks Australia, Monash Sustainable Development Institute
Monash University, Victoria 3800, Australia
+61 3 9905 9656
behaviourworksaustralia@monash.edu

EXECUTIVE SUMMARY

BACKGROUND

Despite progress in occupational health and safety measures that has reduced the incidence of work-related injury and illness, new hazards continuously emerge alongside shifting work practices and technologies, and certain diseases once thought controlled or eradicated may resurface due to changing environmental factors or inadequate preventive measures.

Occupational illnesses and diseases often affect workers who are less experienced, especially younger workers and apprentices, casual hires, and temporary workers including culturally and linguistically diverse workers, who generally have lower awareness of the risks of exposure to hazards (e.g., such as silica dust), and less confidence in questioning workplace processes and directions, even in jurisdictions that actively promote health and safety issues. These challenges require a considered systematic approach to public health screening, data review, and literature analysis to detect changes in population health so as to provide early indicators of potential emergence of workplace hazards.

The ability to identify emerging risks and issues through structured information, data and data source horizon scanning will enable WorkSafe to develop and adopt pre-emptive proactive systems, controls and interventions for occupational illness and disease. Broad horizon scanning to establish systems with robust dynamic data and intelligence sources will provide a knowledge platform to actively identify issues and opportunities to prevent and minimise harms from new, emerging, and existing occupational health hazards arising from societal changes. To this end, WorkSafe Victoria commissioned a project exploring the following questions.

1.1. What is the evidence regarding any potential for re-emergence or significant increase of known disease and illness issues?

1.2. Is there emerging evidence re new disease and illnesses linked or related to work practices?

1.3. Are there new risk control options to reduce harm from occupational illness and disease?

2.1. Are there new and emerging data sources for disease markers to assist public health monitoring for workplace safety in next five years and beyond?

2.2. Are there any new systems and/or emerging means of monitoring for workplace safety?

METHODS

A suite of bespoke methodologies was developed to respond to the above questions:

- A practice review involving 8 interviews with experts.
- A series of 10 topic profiles (brief snapshots of recent, subjectively selected peer-reviewed evidence to provide a sense of the current state of evidence on the topic).
- A rapid evidence review focused on a subset of emerging surveillance and monitoring tools being used for a category of diseases (AI and big data for zoonotic disease surveillance).

SUMMARY OF KEY INTERVIEW FINDINGS

Eight interviews were undertaken with experts with backgrounds in medicine, public health/epidemiology, occupational hygiene, economics, and a range of construction trades. The interviewees had diverse and valuable experiences working in academia, private industry, industry associations, and government. They provided a range of insights in relation to the project's overarching research questions.

Emerging and re-emerging occupational illnesses and diseases

The following categories of emerging and re-emerging illnesses and diseases were highlighted by participants (not in order of priority).

Communicable/Infectious diseases

- Several participants mentioned that there were a range of communicable diseases of relevance to this research.
- They highlighted that we should not lose focus on a range of respiratory illnesses, while also paying closer attention to emerging zoonotic infections.

Respiratory illnesses and diseases

- Silicosis, pneumoconiosis, occupational asthma, and lung cancer were frequently mentioned by both participants who have specialist knowledge of respiratory health and non-specialists alike.

Illnesses and diseases related to chemical/nanoparticle exposures

- Hairdressers and similar high-turnover professions with high levels of chemical exposure were mentioned as a key cohort for surveillance.
- One participant expressed concern about our currently lack of knowledge about the risks of some nanoparticles.
- Another mentioned that moving towards a circular economy may expose workers to previously unknown chemical exposure risks through re-processing of materials.

Dermatological issues

- Contact dermatitis was mentioned by several participants.
- One participant noted that dermatological conditions may often not be linked to working conditions by their general practitioners.

Mental health conditions

- Mental health conditions were mentioned by nearly all participants. They mentioned that workers in professions perceived to be high stress, as well as those in other professions, were at risk.
- Participants felt that changes in both workplace arrangements and norms about acceptable behaviours following the COVID-19 pandemic are likely contributing to this.

Surveillance and monitoring

- The surveillance and monitoring approaches to better identify emerging and re-emerging illnesses and diseases highlighted by participants were as follows:

Data linkage and better utilisation of existing data sets

- Several participants felt that there are growing opportunities to link data sets, for instance by connecting data about workplace illness and climate.
- Several participants also felt that better use of existing data sets was merited, noting that we could better capitalise on the nuance present in large administrative datasets (e.g., the PBS).
- They also highlighted several ethics and access issues related to compiling large data sets containing sensitive data.

Cohort studies and registries

- Several participants underlined the value of well-supported cohort studies and registries, but that the value of these tools can usually only be realised with sufficient resourcing.

Health assessment in key exposure settings/industries

- Health assessments at regular intervals in high-risk industries and exposure locations were also mentioned as a strategy that should be used more frequently. This approach could possibly be accomplished through regulation in some cases.

Human intelligence

- Multiple participants felt that networks of knowledgeable health practitioners and workers could be better developed and utilised to know what is going on “on the ground”.

Artificial intelligence techniques

- Artificial intelligence was mentioned less frequently than anticipated, and when it was, it was usually mentioned as a validated tool to support diagnostics in some fields.

New monitoring devices, including wearables

- Multiple participants mentioned exposure monitoring devices or bio-monitoring devices but indicated that many are only mature enough to be used as supplements to more validated tools.

Changes to workplaces and the workforce

- A few changes to workplaces and workforce dynamics were mentioned by participants.
- Working from home has reshaped people’s risks for musculoskeletal diseases, mental health conditions, cohesiveness of the workforce, and work-home conflict.
- AI and automation raise a number of workplace-specific risks, for instance the impacts of automated or remote control of some machinery in mining. One participant indicated that some of the risks related to these concerns have not been fully assessed for workers directly and indirectly affected.
- Older people remaining in the workforce past traditional retirement age may mean that, due to cognitive, psychological or physical circumstances, their safety and risk of injury and illness needs additional consideration.

Key risk mitigation strategies

Product life cycle assessment and understanding

- Multiple participants felt that better understanding of the whole lifecycles of products/substances used by workers should be better understood and considered.
- These comments were often framed in relation to learnings from engineered stone.
- A range of issues pertaining to the emerging circular economy, for instance the implications for re-using a number of types of plastics, are not well understood.

Considering how return to work can be included in holistic health considerations

- One participant mentioned that for some injured workers, a staged return to work may help to prevent secondary injuries, like mental health injuries.

Training workers in occupational hygiene

- One participant made a strong argument for more workers to be trained in occupational hygiene to better identify emerging illnesses and diseases, as well as better protect their personal right to a safe and healthy workplace.

ILLNESS AND DISEASES PROFILE FINDINGS

Profile 1: Chemical exposure and miscarriages in healthcare workers

- Endocrine-disrupting chemicals (EDCs) like pesticides, BPA, and phthalates in healthcare settings contribute to reproductive issues such as endometriosis, ovarian failure, and infertility among healthcare workers.
- Dental professionals exposed to mercury, disinfectants, anaesthetic gases, and acrylate compounds face increased risk of miscarriage and other reproductive health issues.
- Healthcare workers exposed to ionising radiation, anaesthetic gases, chemotherapy drugs and other hazardous chemicals face a heightened risk of adverse pregnancy outcomes.
- Female surgeons have more than double the pregnancy loss rate compared to the general population.
- Frequent risk assessments, proper training, workload management, and biomarker monitoring are critical to ensuring workplace safety and reducing chemical exposure risks for healthcare workers.

Profile 2: Mosquito-borne encephalitis (with a focus on the impact of climate change)

- Encephalitis is an inflammation of the brain caused by various pathogens, such as viruses, bacteria, and parasites. Mosquito-borne encephalitis is a global health issue, with over 700,000 annual deaths linked to these illnesses.
- Climate change is influencing zoonotic infectious diseases, including encephalitis, by altering the environment for disease carriers like mosquitoes, impacting the timing and spread of outbreaks.
- Emerging diseases like Japanese encephalitis (JE) and Murray Valley encephalitis virus (MVEV), are increasingly being found in new areas due to climate and land use changes.
- In Australia, encephalitis outbreaks, particularly of JE, have been linked to climate change, and regions like rural Victoria now face greater infection risks.
- Current diagnostic tools for encephalitis are limited, with surveillance in Australia only documenting laboratory-confirmed cases, leaving gaps in tracking to prevent outbreaks.
- New technologies, such as geospatial analysis using graphical information systems, remote sensing, and machine learning, are helping predict the spread of diseases like JE, with climate and public health data integration improving disease monitoring and early detection.
- The severity of Murray Valley encephalitis outbreaks underscores the importance of integrated surveillance and public health measures to mitigate future outbreaks.

Profile 3: Malaria (with a focus on the impact of climate change)

- Malaria is a mosquito-borne disease, caused by Plasmodium parasites, and transmitted by mosquitoes of the Anopheles species.
- Although malaria remains a global public health concern with over 200 million cases per year, there has been a reduction in the morbidity of malaria over the past decade.
- In Australia, trends in malaria fluctuate due to its geographic location, traveller demographics, destination choices, and migrant source countries. Most reported cases are imported, primarily from Sub-Saharan Africa, Oceania, and Southern and Central Asia.

- Studies suggested that vector-borne diseases including malaria are most commonly reported among outdoor workers and frequent travellers such as soldiers, migrant workers, miners, farmers, and forest workers.
- Australia would benefit from a surveillance system for workers who frequently travel to endemic areas, especially to prevent imported cases.
- Across the globe, innovations for malaria surveillance strategies and vector control have been developed using technologies such as web-based platforms, mobile applications, and drone technology.

Profile 4: Occupational asthma

- Occupational asthma (OA) results from specific workplace exposures, while work-exacerbated asthma (WEA) involves worsening of pre-existing asthma due to work conditions.
- In the manufacturing industry, exposure to chemicals, metals, and wood dust are common triggers for OA/WEA, while in the agriculture industry, exposure to organic dust, gases, and pesticides poses significant risks.
- Parental occupational exposure, particularly during the postnatal period, can increase the risk of asthma in children, emphasising the need for preventive measures and protective practices.
- Primary prevention through process modifications and material substitutions, such as replacing hazardous chemicals and materials, is crucial for reducing OA/WEA risk.
- When full elimination of hazards isn't possible, strategies including improved ventilation, engineering controls, and partial segregation of work areas can limit exposure, with personal protective equipment (PPE) considered a last resort.
- For those with OA/WEA, management involves pharmacologic treatments, immunotherapy, and biologic therapies, alongside robust health surveillance and early detection measures.
- Delays in diagnosis, often due to lack of awareness and inadequate screening, highlights the need for enhanced education and awareness among healthcare professionals, employers, and workers.

Profile 5: Occupational heat stress

- Climate change is increasing the risk of heat stress in workplaces, particularly in high-temperature environments, impacting worker health, productivity, and economic stability.
- Heat-related illnesses, such as heat exhaustion and heat stroke, can be fatal and are influenced by environmental and physiological factors. Long-term risks include kidney dysfunction, cardiovascular issues, and musculoskeletal damage.
- Heat stress also raises the risk of workplace injuries (e.g., slips, falls, burns), with notable incidents recorded in construction and manufacturing sectors.
- Emerging technologies, such as wearable sensors and hybrid cooling vests, provide advanced monitoring and mitigation strategies for heat stress.
- Smart systems, like sensor-based safety helmets and digital skin, enhance real-time monitoring and worker protection.
- Education on heat exposure risks, hydration, and symptom recognition is essential, along with prevention strategies that use tools like Wet Bulb Globe Temperature and heat indices.

Profile 6: Poor air quality resulting from bushfires and risk controls for the workplace

- Exposure to bushfire smoke, particularly PM2.5 and ozone, poses significant health risks to outdoor workers, leading to both acute and long-term respiratory and cardiovascular issues.

- Both volunteer and career forest firefighters are particularly at risk due to their exposure to harmful pollutants, inadequate PPE, and a lack of proper decontamination facilities for themselves and their PPE, all of which can result in declines in lung function and respiratory symptoms.
- Bushfires can produce transboundary air pollution, affecting populations far from the fire's origin and necessitating international cooperation and policies to mitigate health impacts.
- Enhanced monitoring infrastructure, including portable sensors and satellite-based methods, is essential for accurate real-time data, especially in rural and remote areas prone to bushfires.
- Regular health surveillance programmes for outdoor workers should incorporate medical assessments to detect early signs of respiratory and cardiovascular issues, helping to mitigate long-term health impacts.
- The integration of digital technologies, such as smartphone apps for air quality monitoring, can empower individuals to make informed health decisions during bushfire events.
- The exposure risk among forest firefighters, many of whom are volunteers, is seasonal which, in turn, complicates the tracking of health outcomes. This highlights the need for innovative research methodologies to assess long-term impacts.
- Comprehensive global regulations and workplace policies are crucial for protecting outdoor workers from bushfire-related health risks, including implementing protective measures and addressing health equity issues.

Profile 7: Ross River Virus

- Ross River virus (RRV) is a mosquito-borne disease and the most prevalent arboviral disease in Australia.
- RRV infection is often asymptomatic and not fatal, but can generate symptoms such as rash, fever, and joint pain. When left untreated, chronic joint pain can persist for years, contributing to a 108% increase in disability-adjusted life years between 2003 - 2015.
- RRV transmission is highly influenced by the rise in temperature and change in climate. The incidence rates of RRV infection vary between seasons and areas, with peak incidence between February and May.
- People who work or live in humid climates, wetlands, as well as rural and peri urban areas where mosquito density is high, have a higher risk of getting RRV infection.
- Currently, prevention strategies mainly focus on mosquito control. However, early warning systems based on climate and weather factors can predict epidemics with reasonable precision (sensitivity 63%, specificity 93%).
- In Victoria, surveillance systems utilising more readily available data such as oceanic variables, hydrological determinants, and evapotranspiration and precipitation have also been implemented.

Profile 8: Secondary mental injury as a result of occupational injury

- Secondary mental injury is a psychological condition that develops following primary work-related physical injury or illness.
- Emerging evidence suggests that the prevalence of secondary mental injuries is increasing, with 30-50% of people meeting screening criteria for depression following a workplace injury.
- Secondary mental injury can be monitored through psychological reporting scales during their recovery from a physical injury, often conducted as part of risk screening practices.
- Studies have mentioned that perceived unfair claiming processes for physical injury have been found to contribute to secondary mental injury.

- Studies suggest that utilisation of mental health services tends to increase following occupational injury, with higher prevalence later in a claim when conditions begin to become chronic.
- When workplace injury happens, comprehensive rehabilitation approaches that integrate physical and psychological care need to be implemented.
- Effective workplace and claim management of a work-related injury is necessary to prevent secondary mental injury, including better communication between claimants, supervisors, colleagues, case managers, and health providers.

Profile 9: Silicosis outside of construction, manufacturing and mining

- Silicosis, a preventable occupational lung disease caused by inhaling respirable crystalline silica (RCS) dust, remains a persistent issue, particularly in industries like mining, construction, engineered stone fabrication, and newer industries such as denim manufacturing, and artistic fields like sculpting and jewellery making.
- There has been a resurgence of silicosis, especially among younger workers in the engineered stone sector. Recent epidemiological data from Australia indicates a rise in silicosis cases, growing from approximately 350 in 2019 to over 500 by 2022.
- Emerging technologies, such as portable real-time RCS dust monitors and AI-enabled radiology tools, are being explored for the early detection and monitoring of silicosis.
- Advances in diagnostic methods, such as high-resolution computed tomography (HRCT) and biomarkers in exhaled breath condensate (EBC), show promise for detecting early-stage silicosis.
- The 2024 ban on the use, supply, and manufacture of engineered stone, along with the establishment of the National Occupational Respiratory Disease Registry in Australia, are significant developments in reducing and managing the risk of silicosis.
- Ongoing collaboration between industry stakeholders, government agencies, and public health organisations is vital for protecting workers and preventing the devastating effects of silicosis.

Profile 10: Work-related chronic obstructive pulmonary disease

- Chronic Obstructive Pulmonary Disease (COPD) is a chronic respiratory condition that develops from prolonged exposure to inhalable inflammatory substances such as tobacco, fumes, dust, and many more.
- COPD is one of the leading causes of death worldwide (fifth in Australia) with rates of 42 deaths per 100,000 people. It is caused by prolonged exposure to inflammatory substances such as vapour, gas, dusts, and fumes.
- COPD is a highly preventable disease by reducing exposure to risk factors or using personal protective equipment such as gas masks and respirators, as well as conducting surveillance methods to identify high-risk workers and give them early interventions.
- Surveillance can be done by symptom tracking, lung function testing, as well as utilising AI technologies to identify, classify, and make decisions about work-related COPD.

SUMMARY OF RAPID REVIEW KEY FINDINGS

The rapid review identified 3 reviews and 6 primary studies that find promising evidence of the following:

Machine learning is being used to better predict zoonotic disease dynamics that may be relevant to the workplace

- One review indicated that machine learning is useful for working with a wide range of data types and predict risk factors for specific types of workers.
- One primary study suggested that machine learning can be used to predict the emergence of poultry diseases (e.g. avian influenza or Newcastle disease).

Machine learning and big data are being used to support better prevention of zoonotic disease spread in settings relevant to many workers

- One review indicated that the risk factors identified with machine learning techniques can be used to design prevention efforts in occupational settings.
- Three primary studies showed that compiling large datasets and analysing them using machine learning can result in a range of valuable prevention insights, for instance, how and why zoonotic diseases are emerging due to changes in host species populations, geographic spread of hosts, or emergence of new pathogens; refine authorities' understanding of key exposure pathways for illnesses like Q fever; and determine which helminths are most likely to pose an unknown risk to humans.

Machine learning and big data can be used to personalise insights for individuals

- One review found that processing data related to social characteristics, lifestyle factors, lifetime events, and interaction between determinants can be used to predict susceptibility to mental health problems. Moreover, these data can be used in conjunction with data about exposures to agents or environments to quantify individuals' risks of developing occupational illnesses.

Participatory approaches can enhance the quality of surveillance

- Two primary studies underlined the critical role of human experts and practitioners in collecting, managing, and analysing data and insights resulting from big data and AI. One study described how a global surveillance program was strengthened by involving a network of experts to validate and analyse the outputs from the database. Moreover, these experts provided critical jurisdiction-specific insights based on the surveillance data. Another demonstrated that involving a number of on-the-ground stakeholders was of great value for building a large surveillance dataset that can detect issues early and navigate cross-sectoral prevention and management issues.

The review uncovered some key risks, limitations and challenges:

- As with other quantitative approaches, insights are only as good as the data on which they are based, and issues can be magnified when compiling large datasets.
- Linking datasets come with legal and privacy concerns.
- Making linkages between zoonotic surveillance and occupational settings may require changing how some data are collected and structured to effectively link data.
- Building the infrastructure for using these tools well may require significant up-front investments.

CROSS-CUTTING THEMES & POTENTIAL IMPLICATIONS FOR PRACTICE

Based on the three methods of data collection undertaken, a few cross-cutting themes emerged:

- Key emerging and re-emerging illnesses, diseases, and issues included contact dermatitis, occupational asthma, welding fumes exposure, zoonotic diseases, and mental health issues.
    - ***Potential implications for practice:*** Regulators, unions, peak bodies, or other workers groups could fund, organise, and/or implement tailored occupational hygiene trainings for workers in high-risk sectors or in sectors where emerging issues may likely be present.
    - Moreover, regulators could develop awareness-raising materials, guides for occupational history taking, or other outreach approaches for general practitioners and other relevant health professionals in an effort to better link work conditions with symptoms and to identify emerging and re-emerging occupational illnesses and diseases identified in this report earlier.
    - Regulators and researchers collaborating to ensure that linkages between existing health-related databases and those from other relevant topics (e.g. climate) are being used maximally to identify emerging and re-emerging occupational illnesses and diseases, may be a useful near-term step.
    - Regulators, medical providers, unions, peak bodies, and other workers' groups could develop knowledge exchange activities to consolidate learning about the growing burden of mental health conditions caused by occupational factors, as well as how the changing nature of work may be affecting this emerging issue.
- Climate change is going to shape a number of occupational illnesses and diseases in complex ways.
    - ***Potential implications for practice:*** regulators and researchers collaborating to ensure that linkages between existing climate and health-related databases are being used maximally to identify emerging and re-emerging occupational illnesses and diseases may be a useful near-term step.
- Big data and machine learning are creating several new opportunities for surveillance.
    - ***Potential implications for practice:*** Regulators could maintain awareness of the capabilities of AI tools for data processes and the development of insights and deploy them where appropriate within a well-designed ethical/responsible AI framework.
    - Additionally, data stewards assessing and implementing identifiers or other information/structures to ensure that datasets can be optimally used my emerging AI techniques and tools.
    - Moreover, regulators, researchers, and other stewards and stakeholders of data can explore partnership opportunities to exchange knowledge about valuable data sets, develop ways to increase the value of data linkage where possible, and/or consider using open data approaches where appropriate and feasible. One practical example of these types of approaches would be, regulators could develop a closer understanding of if and how pharmaceutical benefits scheme data could support their role in the community may be an action easily realised in the near term.
- Long-term planning, engagement, and support is required.
    - ***Potential implications for practice:*** Regulators, government research funding schemes, private businesses, and/or universities could develop funding opportunities and research infrastructure that ensures on-going and/or long-term research is possible. For instance, if a cohort study is

initiated through government funding, ensuring that the funding is allocated for a sufficiently long period for the cohort study to realise its value to the community.

- Sensing and monitoring technology are getting a lot better, but still need further improvement and validation in many cases.
    - ***Potential implications for practice:*** Researchers or regulators regularly undertaking monitoring for updates on potential uses and validity of data from new sensors could support the process of integrating them into health and safety practices more efficiently.
- Collaboration across sectors and disciplines is key.
    - ***Potential implications for practice:*** In relation to illnesses that may require substantial cross sectorial collaboration, for example in relation to mosquito-borne infectious diseases, developing or bolstering systems for knowledge sharing, coordination, and shared action between all potentially relevant actors could help to support early identification of emerging issues and holistic mitigation and response efforts. Systems-thinking-related methods like stakeholder mapping could be used to ensure that all relevant actors are identified and engaged.
- Greater awareness of occupational illnesses and diseases among workers and healthcare providers would help identify problems while they are still modest in size.
    - ***Potential implications for practice:*** Regulators, unions, peak bodies, or other workers groups could fund, organise, and/or implement tailored occupational hygiene trainings for workers in high-risk sectors or in sectors where emerging issues may be present (e.g. outdoor workers in relation to mosquito-borne illnesses, high stress office environments in relation to mental health disorders, or specific areas of the building sector in relation to exposure to new materials).
    - Moreover, regulators could develop awareness-raising materials, guides for occupational history taking, or other outreach approaches for general practitioners and other relevant health professionals in an effort to identify emerging and re-emerging occupational illnesses and diseases identified in this report earlier.

SUMMARY OF REGULATOR TAKE AWAYS

- There is a need to investigate opportunities for data compilation and harmonisation and data linkage, and the possibility of harnessing the power and value or AI/machine learning to better monitor emerging illnesses.
- Adequate funding of longitudinal cohort studies or high-risk workers is necessary to monitor illnesses, both in terms of their prevalence and their outcomes.
- Education of both healthcare professionals and workers on the link between work conditions and illness and occupational hygiene would be valuable for managing risks and monitoring emerging illnesses.
- emerging technologies such as wearable devices should be considered as tools that can support workers safety.