

South Africa's industry preparedness to control COVID-19 transmission

D Brouwer¹, V Govender¹, M Hermanus²

1. School of Public Health, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

2. Wits Mining Institute, University of the Witwatersrand, Johannesburg, South Africa

Correspondence: Prof. Derk Brouwer, School of Public Health, Wits Education Campus, Parktown, 2193. e-mail: derk.brouwer@wits.ac.za

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INTRODUCTION

On 18 March 2020, regulations in terms of the Disaster Management Act were pronounced; subsequently, on 26 March 2020, South Africa went into a nationwide lockdown to prevent a total collapse of the healthcare system.¹ On 17 March 2020, the Department of Employment and Labour (DEL) published a COVID-19 planning guidance for employers² and, on 26 March 2020, the Department of Mineral Resources and Energy (DMRE) issued guiding principles on prevention and management of COVID-19 in the South African mining industry.³ On 20 March 2020, the DEL was also quick to respond with a notice on the compensation for occupationally-acquired novel coronavirus disease (COVID-19), which covers occupationally-acquired COVID-19 cases resulting from single or multiple exposures to confirmed cases of COVID-19 in the workplace, or after official trips to high-risk countries.⁴

The legislation governing non-mining industry workplaces in relation to COVID-19 is the Occupational Health and Safety (OHS) Act (Act No. 85 of 1993), as amended, read with the Hazardous Biological Agents Regulations, Section 8 (1) of the (OHS) Act.⁵ Specifically, Section 8 (2)(b) requires steps such as may be reasonably practicable to eliminate or mitigate any hazard or potential hazard before resorting to personal protective equipment (PPE). However, in the case of COVID-19, a combination of controls is required, although the main principle is to follow the hierarchy of controls.² The guidance is focused on the broader group – healthcare workers/health professionals.

The health and safety of miners is governed by the Mine Health and Safety Act (Act No. 29 of 1996)⁶ and the mining industry has well-organised and well-functioning occupational health and medical facilities. Guided by the Minerals Industry Risk Management Process⁷ and adopting the Minerals Council's COVID-19 Ten Point Plan of Action,⁸ it is well positioned to develop customised COVID-19 prevention strategies for its workforce, extending to the peri-mining communities. In addition to the healthcare sector, the energy (including relevant mining activities) and food sectors have been designated as essential services, thus putting pressure on these sectors to comply with high standards of hygiene, social distancing and use of effective PPE.

The global spread of the COVID-19 and measures to control the pandemic are developing rapidly, as is our knowledge on the effectiveness

ABSTRACT

South African industry needs to prepare for a long-term battle to control transmission of the 2019 novel coronavirus disease (COVID-19), guided by occupational health risk assessment and management. Knowledge of the exposure pathways is key to developing sustainable and effective control strategies. A starting point is the identification of exposure scenarios with enhanced transmission risk and high-risk persons who are predisposed to greater severity of COVID-19 illness. Workplace control options, according to the well-known hierarchy of controls, should be implemented. This will require that employers, together with their multidisciplinary teams and stakeholders, be decisive, weigh up the risks in context, and act in a manner commensurate with the magnitude of this threat.

of the measures; however, there are still many unknowns. Anticipating a post-lockdown situation in South Africa, industry should prepare for continuation of preventive measures for 'flattening the curve' of the expected follow-up infection waves, when operations are restarted or upscaled. In this paper, we discuss the transmission pathways in occupational settings in more general terms and explore the preparedness of South African industry to comply with the general recommendations regarding transmission control.

THE TRANSMISSION PATHWAYS

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (the virus that causes COVID-19) is, like other enveloped viruses, a protein molecule (ribonucleic acid (RNA)) covered by a protective layer of lipids (fat), which, when absorbed by the cells of the ocular, nasal or buccal mucosa, changes their genetic code (mutation) and converts them into aggressor and multiplier cells.⁹ Virus particles in the air and on fomites (surfaces and substrates that are likely to carry infection) are exposed to a range of environmental conditions that influence their persistence. Relative humidity, fomite material and air temperature can greatly impact enveloped virus inactivation rates.

In the publicly available information, e.g. the World Health Organization (WHO) scientific brief,¹⁰ the transmission pathways are, in general, well described, as well as standard precautionary measures to reduce the probability of transmission. However, there are still many unknowns, especially regarding COVID-19 virus viability, both in air and on surfaces under different environmental conditions.

The pathway resulting in intake by inhalation by a receptor-person is subdivided into the so-called direct and indirect routes⁹⁻¹³ (Figure 1).

The direct route is determined by the ability to inhale droplets emitted into the air by the infected (index) person. The droplets consist of a protein nucleus surrounded by liquid (mainly water). Both speech by the index person and, for example, coughing/sneezing, will generate droplets. However, the droplets differ, regarding size, composition and the number of infectious quanta per droplet. Expiration characteristics of speech and sneezing/coughing also affect the number of droplets generated, as well as their exhalation speed and the frequency and

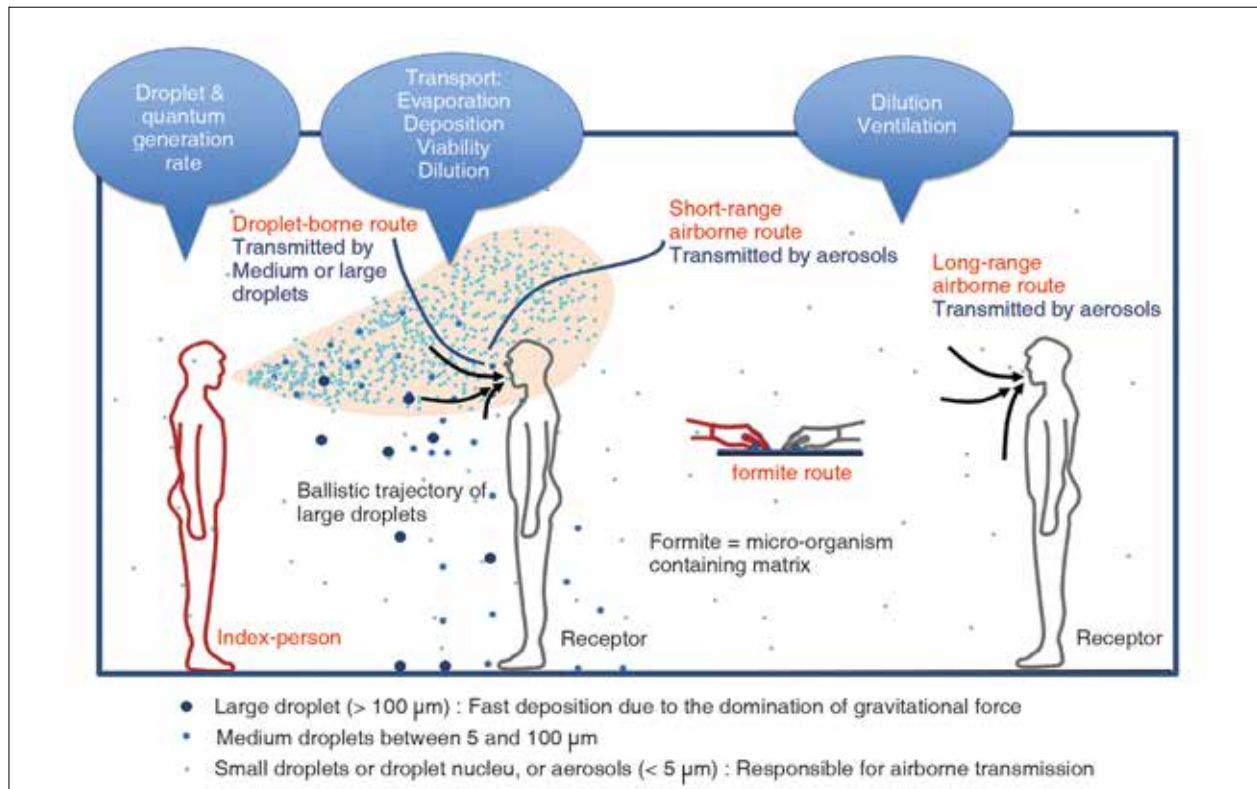


Figure 1. Illustration of different transmission pathways. Small droplets (< 5 µm), sometimes called aerosols, are responsible for the short-range airborne route, long-range airborne route, and indirect contact route; large droplets are responsible for the direct spray route and indirect contact route. The balloons illustrate the determinants of the processes. Figure adapted and modified from Wei and Li, 2016¹¹

duration of the droplet generation. Normal breathing generates droplets < 1 µm in size, whereas coughing can release droplets up to 100 µm. As a rule of thumb, at very close distances (up to 150–200 cm), even larger droplets (called aerosols) may reach the breathing zone of a receptor. Within this zone (between index and receptor persons), droplets are greatly affected by environmental conditions such as relative humidity and temperature which determine, in combination with the initial droplet size, their time of residence in the air. Smaller droplets of up to 5–10 µm, however, remain airborne for a longer period. With increasing index-receptor distance, the fate of the droplets (especially their time of residence in air) is affected by relative humidity and temperature. In general, low relative humidity and high temperature will enhance the evaporation of the water part of the aerosol, and the size of the aerosol will decrease rapidly to approximately 30% of its original size. These aerosols will be captured by air movement, may remain airborne for a long period, and may be inhaled by receptor-person(s) much further away from the index-person. Especially for indoor environments, this 'long-range airborne transport' might be (or become) an important pathway. Recent experimental studies provide evidence that the aerosols containing COVID-19 virus have a half-life of approximately 1.2 hours, and can be detected for up to three hours,¹⁶ indicating that this route of transmission cannot be excluded.¹³⁻¹⁵ However, currently, the WHO states that, only in specific clinical circumstances and settings in which procedures that generate aerosols are performed, may airborne transmission be possible, and that the detection of COVID-19 RNA in environmental samples, based on polymerase chain reaction (PCR)-based assays, is not indicative of viable viruses that could be transmissible. Thus, the current focus is very much on the 'droplet' route.

The indirect route is the fomite route. Droplets may have deposited on surfaces and substrates where the virus may survive for a while. Hand-contact with these surfaces (fomites), followed by hand-mouth/nose mucous contact, is considered an important transmission route. Specific information for the COVID-19 virus is presently scarce¹⁶ but is expected to be quite similar to other coronaviruses.¹⁸ Survival time shows huge variation, from a few hours on porous surfaces, e.g. cardboard, to three days on smooth, non-porous surfaces, e.g. stainless steel and plastic.^{16,18} However, the viability of the virus, indicated by the virus titre, rapidly declines, as shown by the reported half-lives of 5.6 hours on stainless steel and 6.8 hours on plastic.¹⁶ Usually, the survival time on the skin is much shorter compared to that on non-animate surfaces. The transfer efficacy of pathogens from surface to hand, and from hand to the perioral area or the nose, is highly variable but could be up to 30% or more.¹⁷⁻¹⁹ Observations from other studies show that the frequency of hand-to-face contact is eight times per hour, on average.^{22,23}

OCCUPATIONAL EXPOSURE SCENARIOS

There is consensus that high exposure risks are experienced by caring and protective service workers, e.g. healthcare workers, healthcare or laboratory personnel, medical transport workers, and morgue workers (broadly, those who may have contact with patients, patients' tissues, etc., including faecal shedding).^{2,15,24,25} Beyond these workers, there is a wide range of service economy workers who have frequent and close interaction with many people over the course of a shift, and who may therefore be at risk of respiratory infections like COVID-19. Shop workers in high-volume retail settings, taxi and bus drivers, cleaners, teachers, bank workers, hospitality and penitentiary workers, etc.

are among the many service-sector employees who are at risk. Many of these workers will have either physical contact with the public or indirect contact through exchange of goods and money.²⁶ In addition, all high-population-density work environments, such as labour centres, consulting rooms, points of entry for personnel, etc. can be considered as potential 'hot spots' for transmission. It is unknown, however, if specific workplace conditions, such as dust exposure, high air velocities, and hot and humid environments, may modify COVID-19 transmission. For example, similar to nanoparticles, the smaller droplets might be scavenged by, or adhere to, dust particles and be transported through the air over long distances.²⁷ However, it is also likely that adherence to dust will decrease the survival time of the virus.

Several sectors have been designated as 'essential services' during the lockdown, including medical care services, supply chains (e.g. energy and food), retail workers and public transport.²⁸ Thus, these sectors should remain in full operation; however, in many instances it will be a challenge to comply with the precautionary measures recommended to the general public, such as keeping a 'social or physical distancing' of 1.5 to 2 metres, and appropriate sanitation. Clearly, the currently allowed loading capacity of 70% for minibus taxis,²⁹ and the transfer of money, increase the potential to violate these general rules.²⁶ Specifically, for the energy-supply chain, the innate nature of mining operations lends itself to dense occupancy in living quarters, while commuting to workplaces, in change- and lamp-rooms, and in travelling to the stopes, whether it be in a vehicle or cage, or on foot. In addition, specific mining processes require teams whose members work in close proximity to each other, providing additional COVID-19 transmission points. However, surface mining operations and mechanised mining provide ample opportunities to enforce safe hygiene practices.

Food production involves one or more of the following processes: continuous or semi-continuous production, batch production, or craft or hand finishing. During production and transport to market, many people come into contact with each other and the food product, e.g. during harvesting, sorting and packing.³⁰ Although the Department of Health (DoH) COVID-19 hygiene protocol, which emphasises hand-washing and hygiene measures, would also apply to the food supply sector, circumstances encountered in the sector are not regulated. For this reason, lessons can be learned from the United Kingdom where the COVID-19 epidemic is ahead of South Africa. Here, the trade unions in the food sector are not convinced that the Food Standards Authority-issued guidelines to food manufacturers, aimed at keeping workers safe and preventing person-to-person transmission, are adequate, and have called for a 'mandatory imposition' by government of a 2 m social distancing rule.³¹

WORKPLACE EXPOSURE CONTROL OPTIONS

With COVID-19, it may not be possible to eliminate the hazard. The most effective exposure control measures are associated with prevention of transmission from infected persons and asymptomatic carriers; thus, the exposure pathways and the hierarchy of controls for COVID-19 are vital, i.e. engineering controls, administrative controls, safe work practices, behaviour risk management (a type of administrative control), and PPE. Thus, measures, at the source, to detect early infected and/or potentially infected persons, are key.

According to the National Institute for Communicable Diseases (NICD) case definition, persons under investigation (PUI) who should be tested for COVID-19 are those presenting with acute respiratory illness or a cough, sore throat, shortness of breath, fever ≥ 38 °C, or a history of fever.³² Initiatives to detect PUIs in workplace settings should

be governed by a workplace COVID-19 policy, and should include body temperature screening at points of entry as well as measures to reduce the emission of exhaled droplets, i.e. behavioural practices such as 'controlled-sneezing',³³ and wearing of face masks.³⁰⁻³² The latter has been proven to be effective in healthcare settings where infected patients wore masks. However, it is plausible that even home-made cloth face masks will reduce the emission of droplets into the air to a certain extent. Definitely, the larger droplets will be captured, and the swelling of the cotton fibres when moisturised may prevent even smaller droplets escaping.

Regarding the droplet transmission pathway, structural measures such as simple (face) screens and barriers used in some customer-facing roles, including those of taxi/bus drivers and banking staff, might offer some degree of protection from COVID-19, compared to the more open interactive style of work that teachers or general shop staff adopt. More drastic measures would be, for example, the transition to self-scanning of purchased goods, and replacement of traditional door handles with elbow-operating systems or automatic doors. Adequate room ventilation in combination with reduced occupancy of rooms are key factors to reduce the long-range transport of aerosols and shorten the associated transmission pathway, as demonstrated in tuberculosis transmission research.^{20,37} Furthermore, engineering controls to reduce the emission of dust should be extended as it is hypothesised that concurrent exposure to dust may affect exposure to COVID-19.

Adequate personal hygiene, including handwashing, will require that workers are well instructed and facilitated, and should be paired with cleaning procedures to provide frequent and adequate cleaning of surfaces, especially those that are frequently touched by different persons.³⁸ Personal protective equipment which includes gloves, goggles, face shields, face masks, aprons, overalls, hair and shoe covers, and respiratory protection, will only be effective if workers are adequately trained to use protective clothing and equipment, which includes instructions on how to correctly don, use/wear and doff it.

The effectiveness of the facemask type of respirator, or the so-called disposable filtering facepiece (FFP), is very much determined by the 'fit', i.e. the presence or absence of facial leakages, rather than the filtration efficacy.³⁹ In addition, it is quite often forgotten that 'disposable' implies replacement and not reuse. It will be interesting to determine whether adherence of viruses to dust particles will result in a Trojan horse effect if the particle size is close to the so-called most-penetrating particle sizes, which are in the range of 40 to 300 nm, depending on the filter material.⁴⁰ As research indicates, appropriate donning practices very much determine the fit of respirators,⁴¹ and inappropriate doffing of respirators and gloves enhances cross-contamination.^{15,42} Thus, the use of masks, i.e. non-medical masks for non-healthcare workers and the general public, must be accompanied by mask hygiene, and awareness and education.

OCCUPATIONAL HEALTH PREVENTION AND SURVEILLANCE

The general principles that play a major role in keeping workers healthy and safe, i.e. IDENTIFY, PREVENT, TRACE, TEST, TREAT, through early diagnosis, early treatment, and rehabilitation will also apply to the control of COVID-19, whilst maintaining workers' dignity.

Persons under investigation

COVID-19 symptom and fever screening at work and at home, to identify suspected cases and contacts early, should be given priority. Contacts should be actively and promptly traced, tested and treated. Infected

workers should be placed in isolation immediately. Contacts and workers with flu-like symptoms should remain self-quarantined at home or in specific quarantine accommodation. It may become necessary for employers to engage with local authorities to access specific COVID-19 quarantine facilities for their employees who are unable to self-isolate in their usual accommodations.

Identification of persons with high-risk profiles

As part of the risk management process, high-risk COVID-19 categories amongst the workforce should be actively identified and appropriately managed as they are predisposed to experiencing greater severity of COVID-19 illness. According to the Centres for Disease Control (CDC), older adults and people of any age who have serious underlying medical conditions might be at higher risk for severe illness from COVID-19.⁴³ Thus, employees with the following conditions should be identified and actively monitored:

- pre-existing lung diseases such as asthma, obstructive airways diseases, active/chronic/past tuberculosis, and pneumoconiosis, e.g. silicosis in mine workers;
- comorbid risk factors and pre-existing diseases such as cardiorespiratory disease, diabetes, hypertension, auto-immune disorders and cancers;
- human immunodeficiency virus (HIV)-infected employees with low cluster of differentiation 4 (CD4) cell counts or poorly managed HIV; and,
- smokers, who are at higher risk for more severe COVID-19.

The South African population has high tuberculosis and HIV rates. According to the WHO, tuberculosis patients who have lung damage from past episodes of tuberculosis or chronic obstructive pulmonary disease may suffer from more severe illness if they are infected with COVID-19.⁴⁴ There is thus a strong case for concurrent testing for both conditions in these individuals as the COVID-19 clinical picture could easily mimic that of tuberculosis. The WHO also emphasises that, while untreated HIV is an important risk factor for progression to tuberculosis or for poor outcomes in tuberculosis patients, the influence of HIV on the prognosis of COVID-19 patients remains unclear. This means that employers should take "additional precautions for all people with advanced HIV or poorly controlled HIV".⁴⁴ With regard to smoking and COVID-19, a systematic review noted that, despite the limited available data, evidence that smoking is associated with adverse outcomes of COVID-19 is increasing.⁴⁵

These high-risk workers and those at higher risk for severe illness should be fast-tracked to receive prophylaxis for the seasonal influenza (flu vaccine), pneumococcal pneumonia (pneumococcal vaccine) and tuberculosis (isoniazid preventive therapy), as advised by their doctors.

Customised COVID-19 workplace policies and procedures

COVID-19 policies must be integrated into strategic risk management frameworks and core business practices and be endorsed by top leadership and employees alike. In addition, employers should be acutely aware of the local community COVID-19 epidemiological patterns, and plan for community outbreak intervention strategies to provide support to communities.

Workplace policies must be clear about who is entitled to sick leave or quarantine sick leave, and explicit about how this should be implemented. Multidisciplinary teams, comprising human resources practitioners, labour representatives and occupational medicine practitioners, should prepare for determining how PUIs will be reintegrated into the workplace. Policies and procedures for post

lockdown, post COVID-19 illness or post COVID-19 quarantine must be developed and communicated to the workforce to educate and reassure workers. Medical incapacity policies should be reviewed and judiciously applied in suspected, infected and recovering COVID-19 cases.

Risk communications

The information must target specific behaviour modifications that prevent COVID-19. Existing peer-educator platforms, and health and safety committees, should be used effectively to educate and raise awareness on prevention of contracting and prevention of transmission of COVID-19. General health promotion materials, illustrating good cough hygiene, hand washing, respiratory etiquette, COVID-19 symptoms, quarantine/isolation methods, and information on available healthcare facilities, must be freely available, using multiple communication channels.

Other support mechanisms

Employers would do well to engage with the service providers of their employee assistance programmes to provide advice, stress management and psychosocial support to their workers. A COVID-19 hotline, managed by the company's occupational health staff, could assist with triaging workers. This would take a substantial burden off the public health systems and hotlines managed by the NICD and other agencies.

CONCLUSION

There is no doubt that the South African workforce is vulnerable to COVID-19. In the 1990s, when the mining sector was most impacted by HIV and tuberculosis, without life-saving antiretroviral drugs, it had to respond in a most decisive and unprecedented manner by applying multipronged, multidisciplinary and novel approaches to tackle the extraordinary burden of disease. Other sectors should take cognisance of the lessons learned and not reinvent the wheel. Leading practices that worked to contain the HIV and tuberculosis epidemics should be adopted and enhanced to contain and mitigate the impact of COVID-19 on the South African economy. For the various exposure scenarios, it is necessary to determine the most effective measure to limit COVID-19 transmission. Exposure science and occupational hygiene are important fields of expertise to assist in exposure-control decision making.

There is no time for complacency. Employers, together with their multidisciplinary teams and stakeholders, need to be decisive, weigh up the risks in context, and act in a manner commensurate with the magnitude of this threat. The COVID-19 workplace policies should not only be aligned to the prompt governmental response and progressive legislative frameworks, but, as outlined in this paper, go beyond this and be reflective of a relentless and tenacious fight against the impact of COVID-19.

DECLARATION

The authors declare that this is their own work; all the sources used in this paper have been duly acknowledged and there are no conflicts of interest.

AUTHOR CONTRIBUTIONS

Conception and design of the paper: DB

Drafting of the paper: all authors

Critical revision of the paper: all authors

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