Recommendations for screening tools used as part of COVID-19 health surveillance for health workers

EB Mphaphuli[1,2], C Whyte [1,2], DJ Kocks[1,2]

[1]School of Health Systems and Public Health, Department of Public Health Medicine, University of Pretoria, Pretoria, South Africa
[2] Steve Biko Academic Hospital, Pretoria, South Africa

Correspondence: Prof. Daniel J Kocks, Public Health Medicine, University of Pretoria, Department of Public Health Medicine, PO Box 667, Pretoria, 0001, South Africa
e-mail: daniel.kocks@up.ac.za

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ABSTRACT

Background: The coronavirus disease 2019 (COVID-19) pandemic has created the need for electronic screening tools for occupational health surveillance in South Africa. This is to ensure that the surveillance systems pick up symptomatic COVID-19 suspected cases early so that testing can be carried out, and cases isolated expeditiously, to facilitate control of transmission. Electronic screening tools are being used as part of the decision-making process to support referral for testing. The screening tools consist of a brief history and questions about selected signs and symptoms.

Objective: To make recommendations on the choice of signs and symptoms and the numerical score that should be attached to each, in a screening tool.

Methods: A rapid review of open source COVID-19 literature was undertaken to identify commonly reported presenting signs and symptoms of COVID-19 in healthcare workers.

Results: The literature reviewed supported the recommendation that each of the six symptoms of cough, fever, sore throat, shortness of breath, fatigue and myalgia be prioritised in a screening tool, and provided a basis for assigning a predictive numerical score. A numerical score can be allocated to each sign or symptom based on its frequency of occurrence in cases diagnosed with COVID-19, and used in conjunction with personal and occupational risk ratings. The higher the cumulative score, the more likely that a healthcare worker has COVID-19 and requires urgent follow-up for appropriate evaluation and testing.

Conclusion: A screening tool using a scoring system for COVID-19 health surveillance could support persons working in the field of occupational health with decision making on whether to test an employee for COVID-19.

INTRODUCTION

The number of coronavirus disease (COVID-19) cases continues to rise despite most countries, including South Africa, having reached a peak; some are now experiencing a second wave of the pandemic.[1] As the lockdown regulations are being lifted and the economy is gradually opening, employers need to assess employees daily for symptoms of COVID-19. This is an essential part of addressing the public health crisis of the pandemic under the National State of Disaster.[2] According to the definition of the International Labour Organization (ILO), occupational health surveillance is "the ongoing systematic collection, analysis, interpretation and dissemination of data for the purpose of prevention".[3] Screening of health workers, defined as high-risk workers, as part of surveillance, enables occupational medical practitioners to detect and reduce transmission of disease at an early stage. We know that health workers are a vulnerable group because they work closely with COVID-19 positive patients for long hours at a time, in sometimes poorly resourced settings.[4] In such circumstances, a screening scoring system could assist in the clinical decision-making of non-COVID-19-related symptomology.

Clinical applications have been shown, in other countries, to help in setting up an epidemic prevention system and preventing widespread panic.[5] Some South African workplaces have, as part of their health surveillance for COVID-19, developed electronic or web-based surveillance applications to ensure daily employee self-assessment and reporting of COVID-19 symptoms.[6-8] The main purpose of the application is to identify employees who develop respiratory symptoms to be referred for appropriate evaluation and testing, and to link them up to the occupational health services that have recorded individuals' personal and occupational risks. Employees register on the application and then complete a 'screening' questionnaire daily regarding clinical symptoms such as fever, chills, cough, sore throat, shortness of breath, myalgia/body pains, anosmia, dysgeusia and diarrhoea.

In some workplaces, if an employee reports one or more symptoms, he/she is followed up telephonically by an occupational health practitioner (OHP) or, in prescribed cases such as those with comorbidities, by an occupational medicine practitioner (OMP), for further clinical assessment and verification of symptoms. Once assessed and verified, additional symptoms are recorded and each symptom can be allocated a score; the total screening score is then calculated. The score would generally not be shown to the employee but be used to support follow-up decisions in conjunction with the history and personal risk factors for each individual.

The scoring system applied to health workers aids in deciding who could be advised to seek medical care, who requires follow-up by the OHP/OMP, and who should get tested in view of the limited availability of testing.

Healthcare workers are constantly at risk for COVID-19 because

of their daily exposure to infected patients. They are, however, also exposed to other infectious agents that may cause similar signs and symptoms to those associated with SARS-CoV-2, and it is important that these diseases are differentiated and managed appropriately. If healthcare workers repeatedly present with symptoms that are not COVID-19 related, they may be subjected to multiple unnecessary tests in an already strained testing system. As a rule, an employee with an exposure history or a symptom score above a predetermined value, in conjunction with telephonic clinical assessment, is referred for COVID-19 testing. Those sent for testing receive treatment recommendations and quarantine instructions in line with the latest national guidelines from the National Institute for Communicable Diseases (NICD) of South Africa.[9] Those with a score below the predetermined value are monitored via the COVID-19 application for worsening or resolution of symptoms, and receive relevant advice, if needed, from the OHP or the OMP.

Decision support tools are commonly underpinned by clinical prediction models.[10] Ideally, if a model is used to facilitate decisions, such as whether an employee should be tested for COVID-19 or not, it should be robustly developed and be as accurate as possible. However, in the current urgent context of COVID-19, one can argue that the development of a tool in conjunction with some form of clinical assessment can be made rapidly available to support decision-making. Nevertheless, this should be done on condition that the tools are updated as new evidence arises. In order to evaluate and make recommendations on the choice of signs and symptoms for an application and the numerical score that should be attached to each, evidence needs to be garnered from proven cases of COVID-19.

METHODS

A rapid review of open source COVID-19 literature, published from 1 December 2019 to 22 April 2020, was undertaken to identify commonly reported presenting signs and symptoms of COVID-19. For ease of access to COVID-19 articles, Google Scholar has provided links to a collection of journals with open access to the COVID-19 literature produced to date. Studies that described the presenting symptoms of confirmed COVID-19 cases were reviewed. Using the links on Google Scholar, the following were searched: The New England Journal of Medicine, the Journal of the American Medical Association, The Lancet, the British Medical Journal, Nature Coronavirus Collection; Elsevier

Table 1. Summary of signs and symptoms reported in reviewed studies

	Study (first author, year)												
	Guan, 2020[11]	Bhatraju, 2020[12]	Zhou, 2020[13]	Chang, 2020[14]	Wang, 2020[15]	Arentz, 2020[16]	Spellberg, 2020[17]	Wu, 2020[18]	Chow, 2020[19]	Xu, 2020[20]	Chen, 2020[21]	Burrer, 2020[22]	
Sample size	1 099	24	191	18	138	21	7	38	48	62	274	4 707	
Weight (%)	16.6	0.40	2.9	0.3	2.1	0.3	0.1	0.6	0.7	0.9	4.1	71.0	
Setting	Hospital	ICU	Hospital	Hospital	Hospital	ICU	Community	Hospital	Community	Hospital	Hospital	Hospital and community	
Country	China	USA	China	Singapore	China	USA	USA	China	USA	China	China	USA	
Symptom (%)													Weighted average
Cough	67.8	88.0	79.0	83.0	59.4	47.6	14.3	0.0	50.0	81.0	68.0	78.0	74.9
Fever	88.7	50.0	94.0	72.0	98.6	52.4	85.7	0.0	41.7	77.0	91.0	68.0	73.2
Fatigue	0.0	0.0	23.0	0.0	69.6	0.0	0.0	0.0	0.0	0.0	50.0	68.0	52.5
Headache	0.0	0.0	0.0	0.0	6.5	0.0	0.0	0.0	16.7	34.0	11.0	65.0	47.2
Shortness of breath	0.0	0.0	0.0	11.0	31.2	76.0	0.0	0.0	10.4	3.0	44.0	41.0	32.0
Sore throat	0.0	0.0	0.0	11.0	17.4	0.0	0.0	0.0	14.6	0.0	12.0	38.0	28.0
Diarrhoea	3.8	0.0	5.0	3.0	10.1	0.0	0.0	0.0	6.3	8.0	28.0	32.0	25.0
Nausea and vomiting	5.0	0.0	5.0	0.0	10.1	0.0	0.0	0.0	2.1	0.0	9.0	20.0	15.8
Loss of smell or taste	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.0	11.4
Abdominal pain	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0	13.0	9.5
Rhinorrhoea	0.0	0.0	0.0	0.0	9.4	0.0	0.0	0.0	0.0	0.0	0.0	12.0	8.7
Myalgia	0.0	0.0	15.0	0.0	34.8	0.0	71.4	0.0	35.0	52.0	22.0	0.0	2.9
Anorexia	0.0	0.0	0.0	0.0	39.9	0.0	0.0	0.0	2.1	0.0	24.0	0.0	1.8
Dizziness	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	0.0	0.3
Conjunctivitis	0.0	0.0	0.0	6.0	0.0	0.0	0.0	31.6	0.0	0.0	0.0	0.0	0.2
Haemoptysis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.1
Chills	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.6	0.0	0.0	0.0	0.1
Nasal congestion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.1
Hoarseness	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.03

Novel Coronavirus Information Center, and Oxford University Press. We included both published articles and research letters in our review, but only included those articles that reported on presenting signs and symptoms of COVID-19 in their results.

The sample sizes used in the studies that we included varied greatly. To determine the most common symptoms, we calculated the weighted average of each symptom from the different studies. First, the weight of each study was calculated by dividing the sample size by the sum of the sample sizes in all the studies. The weighted average for each symptom was then calculated by multiplying the percentage of participants in each study with that symptom by the weight of the study, then adding up all these products and dividing the sum of the products by the sum of the weights of all the studies. The formula used was: weighted average $\sum_{i=1}^{n} X_i W_i / \sum_{i=1}^{n} W_i$, where X_i represents the symptom (%) and W_i represents the weight (%).

RESULTS

More than 300 articles and research letters were evaluated; 12 articles and research letters where included in the final review. The limitations of most of these studies included small sample sizes, inconsistent signs and symptoms, and short study timeframes.

Table 1 summarises the findings from the publications that were reviewed. The different studies reported a range of one to 16 presenting symptoms; 22 different symptoms were identified.[11-22] Only 19 of the symptoms are included in the table. The omitted symptoms were dry cough, sputum production or expectoration, which can be considered as a variation of cough, and tightness of chest, which can be viewed as shortness of breath.

The sample sizes in the studies ranged from six to 4 707; the largest study was conducted in the USA.[17,22] Cough (74.9%) was the most common symptom, followed by fever (73.2%), fatigue (52.5%), headache, (47.2%), shortness of breath (32.0%), and sore throat (28.0%). Loss of taste and/or smell occurred in 11.4% of the participants but it is important to consider as it is more specific for upper respiratory symptoms than are headache, diarrhoea, and nausea and vomiting, although all these symptoms were found to occur more frequently.

An interesting symptom that was reported in only one of the 12 studies was conjunctivitis.[18] In that study, one-third (12 of 38) of patients with COVID-19 had ocular manifestations consistent with conjunctivitis or increased secretions, which frequently occurred in patients with more severe COVID-19.[18]

DISCUSSION

According to the South African Occupational Health and Safety Act, 1993, Regulations for Hazardous Biological Agents,[23] SARS-CoV-2 can be classified as a group 4 hazardous biological agent (HBA), thus necessitating rapid, innovative approaches to health surveillance. From the largest study reviewed, which included reports of symptoms from 4 707 cases, 92% of those who tested positive for COVID-19 had fever, cough, or shortness of breath.[22] The remaining 8% did not report any of these symptoms and, if not tested because they did not present with the three most common symptoms, they could have unknowingly spread the virus in their workplaces.[22] Important to note is that four of the six studies from China [11,13,15,21] consistently reported fever as the most common symptom, compared to two of five from the USA.[16,17] The prominence of fever as a symptom in China might be because self-temperature monitoring was more widespread in the Chinese community and therefore more commonly reported. The less frequent symptoms should not be ignored. The significance of the report that a third of patients with COVID-19 had conjunctivitis is to avoid overlooking conjunctivitis as a symptom.[18] Furthermore, although only two patients (5.2%) tested positive for COVID-19 from a conjunctival swab in the study, it shows that it is possible to transmit the virus via ocular secretions.[11,18] The limitations of most of the studies included in the review encompassed small sample sizes, inconsistent signs and symptoms, and short study timeframes. Consequently, symptoms may be underestimated as being atypical since, for this report, the calculations for the most common symptoms were based on a weighted average of each study.

This rapid review suggests that it is important for anyone developing a screening tool scoring system to consider giving a high score for each of the six most common symptoms that necessitate testing. In other words, any employee who presents with one of the six symptoms of cough, fever, sore throat, shortness of breath, fatigue or myalgia should be sent for testing. This is especially important for 'frontline workers' who are at a much higher occupational risk for COVID-19 than the general public, particularly if they have personal risk factors e.g. comorbidities. By including a wider range of signs and symptoms in the scoring system, fewer cases would be missed.

A scoring system was developed from the findings of the rapid review, as shown in Table 2. This scoring system will ensure that the surveillance screening tool is sufficiently sensitive. Since South African health workers have an ongoing likelihood of exposure to patients with COVID-19, it would be prudent to monitor and test as many symptomatic workers as possible.

The need for a highly sensitive screening tool was well demonstrated in the USA study from King County, Washington, in which they assessed a screening tool that included only fever and respiratory symptoms (cough, shortness of breath, or sore throat), with clinical discretion for evaluation for other symptoms (e.g. myalgia).[19] If the worker had any of the respiratory symptoms or fever, he/she qualified for testing. Screening for only fever, cough, shortness of breath, or sore throat might have resulted in 17% of symptomatic workers not being identified at the time of illness onset. Expanding the criteria for symptom screening to include myalgia and chills may still have missed 10%.[19]

There is sufficient evidence that increasing age and comorbidity are associated with a higher prevalence of severe outcomes.[22] Therefore it will be important, in addition to the scoring system, to consider the age and presence of comorbid conditions of the employee, as well as

Table 2. Suggested scoring system

Symptom	Score
Cough	5
Fever	5
Fatigue	5
Shortness of breath	5
Sore throat	5
Loss of smell or taste	5
Headache*	3
Diarrhoea	2
Nausea and Vomiting	2
Abdominal pain	2
Rhinorrhoea	2
Conjunctivitis	2
Any other upper respiratory symptoms	5

** A score of 5 or more requires referral for clinical evaluation*

the degree of occupational risk and exposure history to aid the decision of whether or not to prioritise testing.

Most electronic screening questionnaires are yes or no answers and do not quantify the likelihood of infection. The proposed tool provides a numerical value in the form of a score that highlights, to the practitioner, the urgency to respond and prioritise screening. Infected health workers present a hazard to their colleagues and patients; thus, screening is carried out to protect others, as well as to identify the support needed for medical diagnostic follow-up and employee fitness definition. Workplace screening for health workers offers better access to testing than non-health workplaces because tests from health workers are prioritised at all laboratories throughout the country. The screening tool should be evaluated by using it concurrently with a strategy of testing all symptomatic health workers to validate and estimate the sensitivity of the tool, so that the tool could be considered for use later to decide who should be tested or not.

Ultimately, the most effective screening tool for testing is one that promotes a healthy, COVID-19-free workforce and reduces transmission, as every worker is an asset to the prolonged response to the COVID-19 crisis.[24]

CONCLUSION

A screening tool scoring system for COVID-19 disease surveillance needs to ensure that an employee presenting with any one of the six symptoms of cough, fever, sore throat, shortness of breath, fatigue or myalgia is referred for evaluation and testing for COVID-19. At the least, the scoring system for testing should be in line with the most current South African person under investigation (PUI) definition, and should be updated as new evidence comes to light. Although a screening tool with a scoring system is important in view of the limited access to testing, for some workplaces, such as the healthcare industry, universal testing for all healthcare workers might be the ideal but is not always possible. With COVID-19, a remaining problem both for occupational and public health is the asymptomatic cases which symptom screening cannot currently identify.

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 study: EBM, DJK, CW
Data acquisition: EBM
Data analysis: EBM
Interpretation of the data: EBM, DJK, CW
Drafting of the paper: EBM
Critical revision of the paper: DJK, CW

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