Evidence Review Paper

HSE Workplace Health Expert Committee (WHEC)

SARS–CoV–2: testing and the workplace: Rapid review to 16th February 2021

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Workplace Health Expert Comittee

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Completed February 2021

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Foreword

The development of policy in HSE needs to be informed by the best available contemporary scientific evidence. In 2015, HSE formed the Workplace Health Expert Committee (WHEC) to provide independent expert advice to them on:

- New and emerging workplace health issues
- New and emerging evidence relating to existing workplace health issues
- The quality and relevance of the evidence base on workplace health issues

Questions about workplace health issues come to WHEC from many sources, which include HSE, trade unions, employers, interested individuals and members of WHEC. WHEC's responses to these questions are published online as reports to HSE, as position papers following investigation, or as a briefer response where the current evidence is insufficient to warrant further investigation. In cases where the evidence-base is limited WHEC will maintain a watching brief and undertake further investigation if new and sufficient evidence emerges.

In its formal considerations, WHEC aims to provide answers to the questions asked based on the available evidence. This will generally include review of the relevant scientific literature, identifying the sources of evidence relied on in coming to its conclusions, and the quality and limitations of these sources of evidence.

The purpose of WHEC reports is to analyse the relevant evidence to provide HSE with an informed opinion on which to base policy. Where there are gaps in the evidence, which mean that this is not possible, WHEC will identify these and, if appropriate, recommend how the gaps might be filled.

Key points

Testing for the workplace

- Appropriate testing cannot eliminate the risk but can play a part in reducing the risk of transmission of this disease within a workforce.
- It is not possible to specify a specific testing system and the approach needs to be tailored to the needs of the organisation.
- Careful selection of an appropriate test is required. The test will form part of an administrative control plan for the hazard.
- The screening is not primarily for the benefit of the individual being screened but for others, such as colleagues and/or the wider community.
- Testing achieves nothing without accompanying actions. Testing must therefore be viewed as part of a wider risk mitigation strategy
- There is a risk of unintended harm from a testing programme, particularly if implemented without adequate planning and preparation.
- Harm may arise if testing is viewed by either the organisation or individual workers as an alternative to the fundamental controls of distancing, hygiene and ventilation.
- False positives and false negatives can result in damage to both health and earnings and potentially damage faith in not just the testing programme but also in the employer/employee relationship.
- Testing must therefore be considered as part of an overall strategy for reducing the risk of disease transmission in which the behavioural consequences of the intervention become critical. This requires advice and guidance.

Types of test and the testing process

- There are many tests available. Selecting an appropriate test for a given work context is complex and may require professional advice.
- Tests can indicate evidence of "infection" but are poorer in indicating the degree of "infectivity" of the worker being tested. The delay between sampling and receiving results may be critical, as the infection can spread before the test results are available.
- The usefulness of the parameters of a test varies according to the frequency of disease in any given population.

Employer considerations

- Employers must consider all aspects of what they are trying to achieve before they introduce testing.
- The context in which testing is applied, the mechanism of implementation together with resultant actions and the outcomes intended must be clear to minimise potential risks of unintended harms.
- The likelihood of transmission will be determined by the nature of the work undertaken, the socio-demographic characteristics of the workforce and the levels of virus circulating in the community at that time
- Monitoring is best designed using an approach that is focused on indicators to identify when the intervention is not working, is too costly or is harmful.
- It is usually far easier to initiate a health intervention than it is to stop it.
- Employers need to be aware of the complexity involved in introducing testing. The context in which testing is applied, the mechanism of implementation together with resultant actions and the outcomes intended must be understood to minimise potential risks of unintended harms.
- An urgent requirement exists to undertake an education programme to promote better understanding of testing both for employers and employees.

Executive Summary

Background

WHEC has been asked to consider the role of SARS-CoV-2 testing as part of a risk mitigation strategy in a workplace setting. The main types of detection assay are described and the differences between evidence of "infection" and "infectivity" are highlighted. The issues of sensitivity, specificity and predictive values of tests are discussed together with the impact on those measures of sampling quality and levels of community transmission. The delay between sampling and receiving results is a significant practical issue in the workplace and, in general, there is a trade-off between speed and accuracy.

SARS-CoV-2 testing of asymptomatic workers is an intervention in a complex system, analogous in some ways to well-person screening for which there are well established principles. A critical difference in this context is that the screening is not, primarily, for the benefit of the individual being screened but for others - colleagues and/or the wider community. Testing must therefore be considered as part of an overall strategy for reducing the risk of disease transmission in which the behavioural consequences of the intervention become critical. Intervention research indicates that design, application and evaluation should consider the context in which testing is applied, the mechanism of implementation together with resultant actions and the outcomes intended. The potential risks of unintended harms also need to be considered, for example higher levels risk taking behaviour after receiving a negative test and negative impact on the employer/employee relationship if testing is perceived to have failed to prevent outbreaks.

Context

The drivers for testing are likely to be context specific. For employers, the likelihood of transmission will be determined by the nature of the work undertaken, the socio-demographic characteristics of the workforce and the levels of virus circulating in the community at that time. The impact on the safety of the workforce will be heavily influenced by the vulnerability of individual employees and the impact on the organisation by the sector in which it operates. Workers may be driven to seek testing by fears for their own safety or that of their families but there may be perverse incentives (e.g., zero hours contracts) in that those at the highest risk are often most dependent upon being able to work in order to maintain a basic level of subsistence.

Mechanisms

Testing achieves nothing without accompanying actions and is therefore reliant on appropriate behaviours from those initiating the test, undertaking it and using the results. The uncertain and complex context for SARS-CoV-2 testing means that it is important to consider aspects of decision-making and biases that might lead to inappropriate decisions and behaviours; these can, in turn, lead to unintended harms to individuals and to the employer/employee relationship. Achieving appropriate behaviour change also needs to be considered, including whether all involved have the capability, motivation and opportunity to adopt the relevant behaviours. Testing must therefore be viewed as part of a wider risk mitigation strategy and the way it is introduced should be informed by established behavioural theory and appropriate support.

Outcomes

It is essential that employers give proper consideration to all aspects of what they are trying to achieve before introducing testing. This requires advice and guidance to be provided. They should then ensure that they have appropriate indicators in place to determine whether the desired outcomes have been met or when they are failing. Monitoring is best designed using a disconfirmation approach; that is focused on indicators designed to identify when the intervention is NOT working, is too costly or is harmful. This needs to be tightly coupled with a course correction mechanism which usually has three distinct options of "stop", "redesign" or "scale". It is worth considering that it is usually far easier to commence a health intervention than it is to stop it.

Benefits & Drawbacks

Both benefits and disbenefits can accrue from workplace testing for SARS-CoV-2 to individual workers, managers/leaders, organisations and society as a whole. As part of a full risk management programme, appropriate testing can play a part in reducing the risk of transmission of this disease within a workforce. However, there is also a risk of unintended harm from a testing programme, particularly if implemented without adequate planning and preparation. Some of the underpinning concepts are complex and there is therefore scope for misunderstanding about the purpose and the consequences of testing. False positives and false negatives can result in damage to both health and earnings and at the same time potentially damage faith in not just the testing programme but also in the employer/employee relationship itself. Perhaps the greatest potential harm arises if testing is viewed by either the organisation or individual workers as an alternative to the fundamental controls of distancing, hygiene and ventilation.

Conclusion

Testing for SARS-CoV-2 in a workplace environment is a complex undertaking which should only be considered in the context of a multi-strand risk management strategy. Any decision to test should be made with a clear understanding of expected outcomes and how those will be monitored and communicated. The type of test selected will be dependent on a range of factors which include the trade-off between speed and accuracy. The behavioural impact of introducing this type of intervention should be carefully thought through if unintended consequences are to be avoided. These issues do not currently appear to be well understood by very many in society, including policy makers and some specialists advising them. There is therefore an urgent requirement to undertake an education programme to promote better understanding.

Aim

HSE has requested the Workplace Health Expert Committee (WHEC) to consider how various testing regimens can be used to prevent individuals with current SARS-CoV-2 from entering the workplace, particularly when they may be asymptomatic or pre-symptomatic.

In particular, they wish to know:

- could a particular testing regimen be used as a useful mitigation within a SARS-COV-2 secure risk assessment (considering the counterfactual as part of this consideration)?
- what are the benefits and disbenefits of particular approaches to testing?

Background

WHEC has been asked to consider the role of SARS-CoV-2 testing as part of a risk mitigation strategy for employers and workplaces. This requires a full consideration of how testing could or should be used be used to ***diagnose*** the disease, to ***contain*** it, to ***find*** cases and/or to ***enable*** other actions to occur.

The HSE brief to WHEC is, primarily, to consider an ***enabling*** function for tests and, specifically, how various testing regimens can be used to prevent individuals with current SARS-CoV-2 from entering the workplace, particularly when they may be asymptomatic or pre-symptomatic. "Preventing" exposure to this hazard implies that the risk can be eliminated through testing which is not possible; the brief has therefore been interpreted as how to reduce the risk of transmission by using testing as an administrative control measure.

Currently the regulator (i.e., MHRA) is trying to establish in what contexts such tests might be used and what criteria might be appropriate for matching a test to a specific workplace use. It is evident that, if we know the context of use, it becomes easier to consider what the performance (and the target product profile (TPP)) of an appropriate test might be. There are many tests available and are, broadly, of two sorts:

1. Those that test for evidence of current infection by identifying the presence of a fragment of the Covid virus. Note that 'infection' does not necessarily equate to 'infectiveness', an important distinction in this context (see Figure 1).
2. Those that test for evidence of immunity, usually through the identification of antibodies to the Covid virus. These tests are not widely used outside the research setting currently and are not discussed further here.

There are two categories of tests for evidence of current infection, Categories are based on the target that is being detected:

1. **Nucleic acid tests:** detect the presence of viral RNA. Typically, these use an amplification step based on RT-PCR (reverse transcription polymerase chain reaction). LAMP (which is an acronym for Loop-mediated Isothermal Amplification) is a single tube technique for the amplification of DNA. It provides a low-cost alternative to polymerase chain reaction (PCR) technology to detect COVID-19 and can be used at point of care.

2. **Antigen tests:** detect the presence of a viral antigen, typically part of a surface protein. These tests have attracted most attention in the context of workplace testing. In particular, the use of lateral flow tests has been seen by Government as an option for routine testing of staff in schools and in care homes (HM Gov, 2021 a & b) In both instances these interventions have proved contentious (Wise, 2020; BMJ 2021)

There is little direct evidence of the precise time course of the relationship between infection and infectivity for SARS-CoV-2. A theoretical model (see Figure 1) is helpful to illustrate the key variables involved (i.e., time, viral load, test sensitivity) and the likelihood of any given test showing a "positive" value (Mina et al, 2020.) This model also suggests that the relationship between the current "benchmark" PCR tests and infectivity still needs elaboration. For example, the PCR test may identify a positive that is no longer infectious or is pre-infectious stage. The science regarding PCR testing is complex and there is much debate in the literature regarding appropriate cycle threshold (Ct) cut-off levels with respect to disease status classification (Public Health England, 2020a).

Mina et al (2020) make assumptions about the period during which an individual may be infectious but do not address the challenge of testing asymptomatics, that may comprise up to 30% of all those infected (Buitrago-Garcia et al, 2020). Such cases could only be identified through a routine and regular screening programme. If current government guidelines are followed, the majority of those with symptoms will seek a nationally available PCR laboratory test. However, a proportion of these (pre-symptomatic) may spread the disease prior to developing any recognised COVID-19 symptoms.

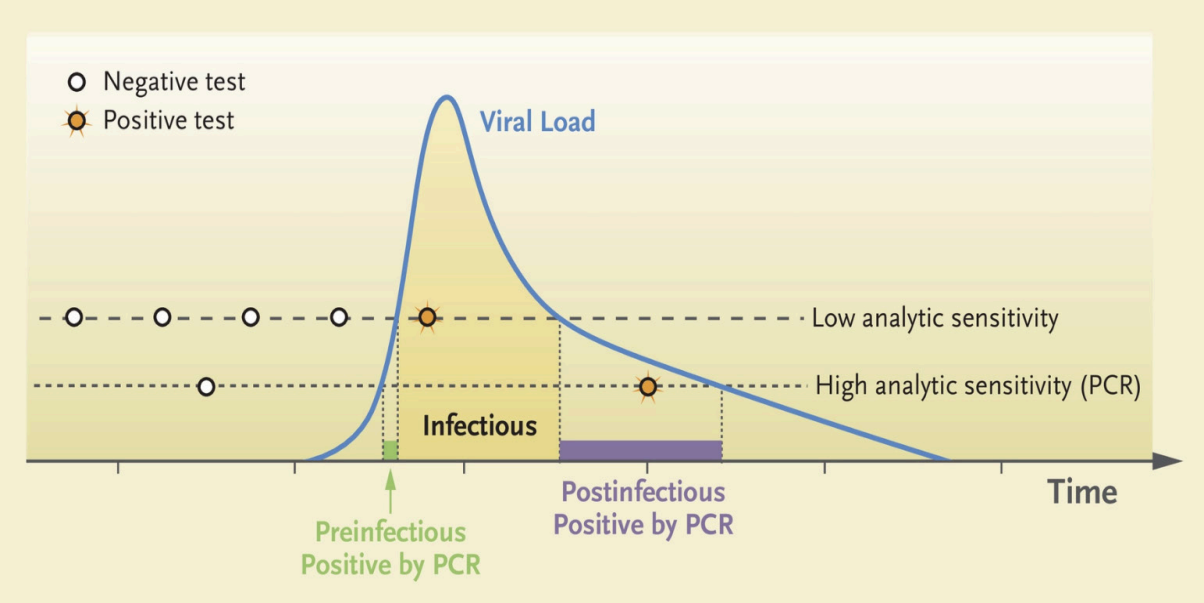

Figure 1. Model of time course of the relationship between infection and infectivity for SARS-COV-2 and testing (Mina et al., 2020)

Interpreting test results

No tests, of either sort, are 'perfect' and all produce falsely positive and falsely negative results in varying degrees. The efficacy of a test is often described by its sensitivity (its ability to detect a true case) and its specificity (its ability to detect a non-case), metrics that can be calculated after comparing the test's performance against that of a 'reference standard'. To date, most tests have been compared with reference to the results of RT-PCR assays of viral RNA from nasopharyngeal swabs. RT-PCR assays are exquisitely sensitive; for example, they may remain positive for many weeks after recovery from a COVID infection, and there is no evidence that detection of low levels of viral RNA by RT-PCR equates with infectivity. Thus, direct comparisons between tests designed primarily to detect only high viral loads (a correlate of infectivity) with tests that detect 'infection' may be misleading but are the source of the widespread claim that many tests are insensitive – that is, they fail to detect a proportion of true cases.

Sensitivity and specificity are critical, unvarying metrics that are intrinsic to a test. In the context of workplace testing,

however, it is more useful to consider two related but orthogonal measures which reflect the value of a test result, rather than the result of a reference test. A test's 'negative predictive value' (NPV) measures how likely a negative test result is to reflect a truly negative situation of infection/infectivity; conversely a test's 'positive predictive value' (PPV) measures the rate at which a positive test truly reflects infection or infectivity (see Table 1.)

Table 1. Illustration of how the positive (PPV) and negative (NPV) predictive values of a test vary by two levels of the community prevalence of a condition (i.e. 0.5% and 5%) & a test with sensitivity of 40% and specificity of 99%. In this example a 'population' of 1,000 has been chosen.

Community prevalence 0.5%						
		Reference test result				
		positive	negative		PPV	NPV
Test result	**positive**	2	10	12	2/12 = 17%	
	negative	3	980	986		980/986 = 99%
		5	990	1000		
Sensitivity		4/10= 40%				
Specificity			980/990 = 99%			

Community prevalence 5%						
		Reference test result				
		positive	negative		PPV	NPV
Test result	**positive**	20	19	39	51%	
	negative	30	931	961		97%
		50	950	1000		
Sensitivity		40%				
Specificity			99%			

NPV and PPV values varies according to the community prevalence of infection; as this rises so will the PPV, but the NPV will fall. When the community prevalence of infection is low then the NPV of COVID tests tends to be very high. In Liverpool for example, in a series of INNOVA antigen tests in which the rate of community infection was around 1%, the NPV was approximately 99%. Thus a negative test result, in that setting, was adjudged to rule out infection in 99 of 100 uninfected individuals.

Conversely, at low community rates of infection the PPV of any test will be commensurately low. The result of this is that an increasing proportion of positive test results will be false-positives, indeed most of them will be. This is illustrated below (see table 2) which display PPV and NPV values for tests with 40% and 70% sensitivity and specificities of 95% and 99%.

Table 2. NPV and PPV values at community prevalence infection rates of 1%, 2% and 5% for tests with sensitivity 40% & 70% and specificity 95% & 99%. Note: these levels of sensitivity and specificity have been chosen to reflect the use of some widely available antigen, lateral flow tests for SARS-CoV-2.

sensitivity 40%; specificity 99%				
		NPV	PPV	% of +test results that are expected to be false +
1% community prevalence				
size of workforce	1000	99%	39%	61%
	500	99%	38%	62%
	50	99%	31%	69%
2% community prevalence				
size of workforce	1000	99%	53%	47%
	500	99%	54%	46%
	50	99%	48%	52%
5% community prevalence				
size of workforce	1000	97%	71%	29%
	500	97%	71%	29%
	50	97%	69%	31%

sensitivity 70%; specificity 99%				
		NPV	PPV	% of +test results that are expected to be false +
1% community prevalence				
size of workforce	1000	100%	51%	49%
	500	100%	51%	49%
	50	100%	45%	55%
2% community prevalence				
size of workforce	1000	99%	65%	35%
	500	99%	65%	35%
	50	99%	61%	39%
5% community prevalence				
size of workforce	1000	99%	81%	19%
	500	99%	81%	19%
	50	99%	80%	20%

sensitivity 40%; specificity 95%				
		NPV	PPV	% of +test results that are expected to be false +
1% community prevalence				
size of workforce	1000	99%	8%	92%
	500	99%	7%	93%
	50	99%	7%	93%

2% community prevalence				
size of workforce	1000	99%	14%	86%
	500	99%	14%	86%
	50	99%	14%	86%
5% community prevalence				
size of workforce	1000	97%	29%	71%
	500	97%	29%	71%
	50	97%	29%	71%

sensitivity 70%; specificity 95%				
		NPV	PPV	% of +test results that are expected to be false +
1% community prevalence				
size of workforce	1000	100%	13%	87%
	500	100%	13%	87%
	50	100%	12%	88%
2% community prevalence				
size of workforce	1000	99%	22%	78%
	500	99%	22%	78%
	50	99%	22%	78%
5% community prevalence				
size of workforce	1000	98%	42%	58%
	500	98%	42%	58%
	50	98%	41%	59%

Under each condition above, the NPV of a test is very high indicating that a negative test result is 'correct' in 97%-100% of cases. Note that for a test with very high (99%) specificity and under conditions of low community prevalence, the PPV is expected to be a little lower in smaller workforces although the uncertainty about its estimate is greater.

Conveying the meaning of these test parameters to organisations that may wish to implement a testing regime as part of their administrative controls to reduce risk in the workplace appears to be a significant challenge. Interpreting test results requires the understanding of complex and at times nuanced concepts. Such concepts include changing values as disease prevalence varies both within the population and within the chosen testing group, the concept of confidence limits, variations arising with the size of the group being tested and the "risk" to any workplaces of false negatives and of false positives.

Biosafety issues

This addresses the safety of a test when used in its planned location and with the intended users. For example, non-propagative diagnostic laboratory work involving SARS-CoV-2 should be conducted at a facility using procedures equivalent to at least containment level 2 (HSE, 2019). Propagative work (virus culture, neutralisation assays) involving infectious SARS-CoV-2 should be conducted at a containment level 3 laboratory with air pressure negative to atmosphere (HSE,

2019). The location of a workplace testing facility would need to ensure that biosafety issues were met. Many current 'point of care' tests involve swabbing and then transferring the swab sample to a buffer before testing. The extent to which the buffer deactivates the virus or creates a 'hazardous material' must be considered. Disposal of tests can present further biosafety related risks and potentially hazardous environmental waste.

Skills and the training of test operators

Most currently available tests are only authorised for use by a trained operator. The sensitivity of some tests, such as the INNOVA lateral flow assay, is reported to vary substantially according to the skill of the individual administering it (Public Health England, 2020b). The quality of swab sampling, in particular, is likely related to varying levels of reported test sensitivity, as is the type of sample used (e.g., nasal, pharyngeal or saliva). For example, the PHE/Porton Down study of lateral flow tests found levels of sensitivity of a lateral flow test to be 78% when used by trained professionals but that this fell significantly when tests were conducted by other non-specialist users (PHE Porton Down & University of Oxford, 2020; Public Health England, 2020b) Similarly, the mass community testing of the public in Liverpool (Liverpool University, 2020) relied on the general population to self-swab whilst supervised by trained staff. This study found sensitivity levels of 40% for the lateral flow test. When used in Liverpool the test was self-administered under military supervision; we are not aware of studies that report on the performance of unsupervised, self-administered tests, although in settings of low community prevalence the NPV would be expected still to be high.

Errors in testing may arise from factors such as the ability to swab, manipulation of the sample, comprehension of the instructions and the reading and reporting of test results. Each has implications for the validity of tests when used in workplace settings and/or where workers are self-testing. Employers need to fully understand the complexity of both undertaking tests and in interpreting the results.

Adherence to testing

Any testing regime will necessarily depend on the adherence to the testing protocol by those being tested. The extent of adherence in any given workforce is not known. It may be anticipated that levels of adherence for repeated, frequent (e.g. 2 or more times per week) swabbing and testing may be low, particularly in poorly motivated groups. The act of swabbing is usually reported as unpleasant. The motivation to self-test may vary according to perceived likelihood of being infected. Hence, a high NPV when the prevalence of the disease is low, may lead to lower adherence in those being required to self-test. Recent research (Micocci et al, 2021) within care home staff suggests that workforce approaches to testing may vary from the guidance provided. This suggests that achieving appropriate adherence is a complex issue with many variables (e.g. need to work, requirement to travel to work to be tested even on days off, trust issues surrounding self-testing etc.) affecting outcomes. Understanding the motivation of the workforce in this regard and their adherence with testing regimes, reporting of test outcomes and resultant actions requires research.

Volume & speed of results

The number of tests that can be completed in a given time period is critical for many work situations, as disruption to other work activities can occur. There is a "trade-off" between speed of results, testing capacity and accuracy. The most sensitive tests (i.e., PCR) require laboratory analysis which, generally, gives rise to a delay (often of 24-48 hours) in receiving results. High sensitivity point of care tests (e.g., LAMP) have capacity issues which limit the number of workers that can be processed. Rapid self-administered point of care tests (e.g., lateral flow devices) currently seem to have a low sensitivity. Research (Micocci et al, 2021) has found each of these factors to be impediments to regular care home staff testing. Home

testing by employees may also be an option but is likely to suffer from a lack of quality control, supervision and advice from a trained specialist.

Availability of tests

Some tests have limited availability and insecure supply lines. The commercial supply of tests, often through online facilities, is becoming routine, yet many of these tests are unregulated for use in the UK.

Cost

The cost of administering and maintaining a workplace testing (and tracing) facility has not, to our knowledge, been reported nor has an appropriate value proposition paper been published. However, anecdotal evidence suggest that such evaluations are occurring within organisations.

Testing as an intervention: a question for public health, occupational health or workplace performance?

WHEC has considered SARS-CoV-2 testing as an intervention in a complex system.

It fits with a public health screening intervention where regular/routine testing is undertaken of those with no apparent disease symptoms/signs. (Note: this is consistent with the brief set to the committee by the HSE, namely that the focus is primarily on those workers who are pre-symptomatic/asymptomatic.)

If screening is the intended approach for SARS-CoV-2 testing, then the principles advanced by Wilson and Junger (1968) (see Table 3) should act as an appropriate guide to their use.

Table 3. Principles of Screening (Wilson and Junger,1968)

Box 1. Wilson & Jungner's principles of screening

1. The condition should be an important health problem.
2. There should be an accepted treatment for patients with recognized disease.
3. Facilities for diagnosis and treatment should be available.
4. There should be a recognizable latent or early symptomatic phase.
5. There should be a suitable test or examination.
6. The test should be acceptable to the population.
7. The natural history of the condition, including development from latent to declared disease, should be adequately understood.
8. There should be an agreed policy on whom to treat as patients.
9. The cost of case-finding (including a diagnosis and treatment of patients diagnosed) should be economically balanced in relation to possible expenditure on medical care as a whole.
10. Case-finding should be a continuous process and not a "once and for all" project.

The Workplace Health Expert Committee (WHEC) have reported on the evaluation of interventions for workplace health (HSE Workplace Health Expert Committee, 2020). However, this section on 'intervention' is distinct from the evaluation perspective, albeit that some elements of that report are helpful with regard to SARS-CoV-2 testing.

Whereas evaluation is focused upon identifying what has happened, the design and prototyping of a new intervention (i.e.,

testing) needs to make real time evidence-informed probabilistic decisions about what is likely to happen and then monitor to see if the indicators suggest that these probabilistic outcomes have been met or not. This is particularly necessary when rapid prototyping is required, as in this case. Monitoring is best designed using a disconfirmation approach, so focused on indicators designed to identify when the new prototype is NOT working, is too costly, or is harmful (i.e., a governance rather than a reporting approach) (Wilde, 2016). This needs to be tightly coupled with a course correction mechanism which usually has 3 distinct options; these are stop, redesign or scale.

Testing in this situation however, contrasts with most screening programmes for disease, where the focus is predominantly on intervening in the health of the individual tested, rather than the individual as a health risk to others. By contrast, the predominant focus for this question is **not** whether any individual needs health intervention, but rather what the overall transmission risk is from all people at work, both in the workplace and consequently outside of this workplace.
This means that any design of an intervention based on testing needs to be focused on transmission risk (with outbreaks as the disconfirmatory indicators) and not solely on managing positive test results. Given the issues with timeliness and accuracy of the tests outlined earlier, using testing to remove people from the workplace when they receive a positive test result may not significantly reduce workplace transmission risk. The transmission risk will be active in the pre-test situation, assuming that they were tested because they were in the workplace. Managing those who get positive test results is of course a management consideration for organisations using such an approach but may be a complex public and occupational health issue where professional guidance is required.

How does intervention research inform what is required to incorporate a SARS-CoV-2 testing strategy into workplace risk management?

The HSE is seeking to prevent individuals with current SARS-CoV-2 from entering the workplace, particularly when they may be asymptomatic or pre-symptomatic. However, as mentioned above, "preventing" exposure to this hazard implies that the risk can be eliminated through testing, which is not possible. Instead, what can be explored is how to reduce the risk of transmission by using testing as an administrative control measure. If testing is to be used in this way, it will be important to look at the complexities of the situation. Intervention research would suggest that intervention design, application and evaluation should consider the context in which an intervention is applied, the mechanism of implementation (in this case, not only of the testing itself but also of the actions that flow from test results) and the outcomes intended (Nielsen ref). In addition, there needs to be consideration of the potential risks of unintended harms.

Context

The drivers for testing are likely to be context specific and include those set out below.

Nature of the population to be screened/tested:

Socio-economic and demographic factors influence the risk of transmission. Prevalence of COVID-19 is consistently higher in those occupying large households and living in deprived areas as well as those in the 18-24 age group and people of black and Asian ethnicity (Riley et al, 2020; Dept Health and Social Care 2021). Demographic factors also impact on the risk of serious harm from the disease with a strong association with increasing age plus heightened risks for men, people of black and Asian ethnicity and a range of health conditions (Dept. Health and Social Care 2021; British Medical Association, 2020). Testing may therefore be considered a useful additional administrative control for workforces with these characteristics, especially when levels of community transmission are high. Perhaps counterintuitively, some of those

most at risk of becoming infected and suffering serious harm may be the least likely to take advantage of a voluntary screening programme.
Data from the Liverpool community study showed that uptake of public testing (the proportion of the population tested) occurred unevenly with lower uptake generally found in more disadvantaged groups. There is a danger that the same patterns may be reflected in workplace mass testing. Currently, it is thought by WHEC members that, where workplace testing is in place, it relies on a voluntary and not a mandatory approach. Research in how testing is seen and undertaken in workplaces should be reviewed as a matter of priority.

Nature of work carried out:
There is international consensus that work involving close proximity, prolonged contact, high frequency of contacts and confined shared environments are strongly associated with a higher risk of SARS-CoV-2 transmission. Public facing workers therefore experience higher infection rates with excesses reported in health and social care, transport and hospitality (Public Health England, 2020c).

The employer "drivers" to incorporate testing into a risk mitigation strategy are likely to be stronger in these environments, especially where primary controls cannot be applied because of the nature of the work (e.g., where close contact is integral to the task). Unusually in this context risk assessments, and the reliability of any tests deployed, need to not only consider the protection of workers but also customers and other members of the public with whom workers may come into contact.

The risks associated with a 'false negative' worker entering a care home full of vulnerable residents are significantly greater than that of a 'false negative' transport worker driving a truck from one location to another where few other contacts (and therefore transmission opportunities) are likely. Testing guidance is therefore highly context specific.

Nature of workplaces (including size of organisation):
The physical working environment affects the transmission risk of SARS-CoV-2 and strengthening controls (which may include testing) may be required where workplaces are unavoidably cramped, congested or poorly ventilated. Organisational size is also a consideration in that large companies are more likely to have the resources (financial and otherwise) to implement and sustain a testing programme than a small firm. Smaller organisations considering testing as a risk mitigation are consequently more likely to look to public health provision as a way of accessing services.

Complexity and multiple-level nature of workplaces/organisations:
Workplaces/organisations are complex adaptive systems, meaning that they are in constant flux and have multiple feedback loops operating and that multiple factors will be operating at different levels within and outside the system that will affect the way testing is implemented and the outcomes it delivers. The WHEC paper on psychosocial interventions has made good use of the IGLOO model (Nielsen et al, 2018) to illustrate the different levels that need to be considered when introducing psychosocial interventions. We believe this model could be used to identify individual, group, organisational and potentially societal factors that will ned to be addressed with regard to SARS-CoV-2 testing for workforces. It could also be used to identify potential unintended harm that might arise from testing, as set out later in this paper.

Mechanism

A critical factor for any test is that it should be seen as an additional way of reducing the risk of onward transmission by enhancing mitigation strategies that are already in place. Testing generates a piece of data at a given point in time that may

enable a safer course of action to be pursued (e.g., isolation & not going to a place of work, seeking treatment, enabling others to be warned and take action).

However, testing alone achieves nothing without accompanying actions. Actions resulting from a test are reliant on appropriate behaviours from those initiating the test, undertaking the test and implementing/using the results of the test. Alignment of motivation, use of results and subsequent compliance with best public health/occupational health practice is therefore essential as part of any testing strategy.

As indicated in the previous section, SARS-CoV-2 testing involves decision-making in a complex, dynamic and uncertain context. This means that it is worth bringing in the psychological evidence about decision-making under uncertainty and the associated behavioural consequences to help manage risk. For example, unhelpful decision-making heuristics such as attribute substitution can be triggered in these contexts (Tversky and Kahneman 1974; Kahneman and Frederick 2002). Where false negative test results occur, attribute substitution risks leading to errors (see table 4).

Table 4. Attribute Substitution

Attribute substitution	**How it manifests in this context**
Target attribute is inaccessible	Certainty of transmission risk (either for individual or workplace) is not available.
Associated attribute is accessible	Tests for infection are available (although none are perfect as set out above).
Associated attribute is substituted for target attribute and this substitution is not detected/recognised	Workplaces use testing as the means to identify transmission risk without clear recognition of the substitution of test result for transmission risk or its implications. Negative results are therefore assumed to mean no transmission risk is present, which could be highly problematic when there is incidence of false negative results.

If failures such as outbreaks of infection occur due to such heuristics, this can lead to problems within the employee/employer relationship such as switch to distrust (Searle et and Rice 2018). The Appendix uses the IGLOO model mentioned above to explore some of the behavioural science insights as they may apply to workplace testing for SARS-CoV-2.

There is also substantial evidence that, when under threat conditions (disease/financial), cognitive capacity becomes more constrained and more prone to stereotypical thinking, which tends to disrupt the capacity to check assumptions and can lead to decision-making biases and other problems (Kinderman el al 2016). Specific examples of problematic decision-making and biases that are of particular significance in the context of SARS-CoV-2 testing include: confirmatory bias, where people seek out information to confirm their point of view; and in-group trust which attenuates the perception of risk from others who are in our in-group (Cruwys et al 2021).

In addition, any successful introduction of SARS-CoV-2 testing to workplaces will require behavioural changes that should be informed by current behavioural theory. Models exist that may enable this e.g. Michie et al, 2011 who point out that behaviour change requires the individuals involved to have the capability, opportunity and motivation to change and provide pointers to the factors that can support this.

Motivation to participate in a testing programme may not be clear cut. The benefits of being tested for SARS-CoV-2 tend

not to accrue to the individual being tested but rather to others (work colleagues, customers, society in general). Social purpose can be a strong driver if the issue is framed carefully but enthusiasm and adherence may wane as a burdensome and perhaps unpleasant procedure continues for a prolonged period. In addition, there may be considerable disincentives to participation, especially for workers engaged on zero hours contracts or on a freelance basis who will not be paid if they do not work.

Outcomes

If testing is to contribute to a risk mitigation strategy it is critical that employers, workers and policy makers understand what they're trying to achieve before embarking on a programme. There is a widespread (if often unarticulated) belief that testing will allow for the creation of a SARS-CoV-2 -free environment (i.e., elimination of the risk) rather than seeing it as a potential additional control measure which, like all the others, should be considered on the basis of its effectiveness, cost and practicality. It is concerning that even some specialists in occupational medicine and public health cite testing for SARS-CoV-2 as an elimination method in the hierarchy of controls (Asanati et al, 2021).

Employers wish to continue operating while maintaining a workplace that is SARS-CoV-2 secure and a workforce that is healthy. The principal drivers for considering testing as part of a risk mitigation strategy include:

- To create a layer of defence as part of a process of building and sustaining a SARS-CoV-2 secure working environment
- To meet regulatory (e.g.travel) or customer requirements
- As a reassurance to workers
- As an adjunct to public health authorities in identifying asymptomatic cases

What are the benefits and potential disbenefits of workplace testing for SARS-CoV-2?

Testing is not a means for eliminating the hazard but is rather a control measure for reducing the likelihood of transmission. Reducing the risk of infection requires appropriate behaviours from all stakeholders and this then enables testing to be one part of a set of a control measures. These behaviours occur within complex social structures both at and away from the workplace. Understanding the potential benefits/disbenefits to all stakeholders is therefore important. Models of the potential benefits to employers may be of little help in real world contexts where factors outside of the workplace or the large variations in individual behaviours around testing might undermine the predicted benefits of a testing strategy. Table 5 identifies some of the potential benefits and disbenefits of a routine regular screening test for the workforce.

Table 5. Examples of Benefits and Disbenefits of Workplace Testing for SARS-CoV-2

	Benefits	Disbenefits	Comments
Individual	Income, safety, job security	Disruptive to daily life if repetitive testing required, which is unpleasant to undertake.	
		A positive result may affect income	A negative result may be sought as 'desirable'. May affect the undertaking of the test & hence its validity
	A positive test and appropriate actions may be seen as societally responsible.	A positive test that forces others to isolate may be seen in adverse way by work colleagues who may lose income etc.	
		A negative test may, wrongly, be seen as a benefit by the individual who might interpret is as giving licence to behave with less adherence with other SARS-CoV-2 measures.	
Managers/ Leaders	Can maintain workforce in place of work to allow production / service delivery	May be perceived as enforcing an undesired public health screening test on workforce	
	Can demonstrate responsible / caring approach to workforce, TU, Government, etc.	Positive tests impair productivity (individual and contacts) through enforced isolation	
	May allow rebalancing of other control measures that impact more on productivity		
Organisational	Workplace SARS-CoV-2 free and productivity maintained	May be perceived as enforcing an undesired public health screening test on workforce	
		May be costly (consumables & labour) if frequent repeat testing is required	
		Poor tests will result in false positives and false negatives resulting in reduced trust in organisation requiring such testing.	Test and trace and any additional support structures must be in place to effectively act on test results. This may be complex and expensive.
Societal	Economic, reduced transmission with related healthcare burden	Mistrust of poor screening tests (with wider public health implications)	Test and trace and any additional support structures must be in place to effectively act on test results. This may be complex and expensive.

Potential for unintended harm

Risk of confusion and misinformation:
Anecdotal evidence from occupational health professionals suggests that the issue and importance of false positives and false negatives and other epidemiologically based test statistics is poorly understood by employers & workers, especially in the context of different levels of community transmission. Further, there is much potential generally for confusion regarding the values found in laboratory evaluations compared to those found in real world settings.

Risk of prompting non-conformity with other measures:
Of particular concern has been the potential behavioural changes in those testing negative who may see this as enabling behaviour that does not conform with the current high SARS-CoV-2 security guidelines.

Risks posed by false negatives and false positives:
The risks associated with false negative results are self-evident i.e., asymptomatic individuals who are likely to consider themselves, "disease free" are less likely to apply other control measures assiduously. They may therefore present a greater risk to those around them than if they had not been tested and provided with false reassurance. False positives do not directly increase the safety risks in the workplace but the unnecessary removal of workers and the colleagues with whom they have been in contact impacts adversely on the organisation's ability to operate effectively. If the organisation is engaged in safety critical work or healthcare the absence of such workers may create a significant risk to society.

Risk of damage to employee-employer relationship:
Mayer et al (1995) identified three dimensions: competence, benevolence and integrity - if these are compromised then lowered trust may eventually lead to a switch to distrust in institutions (Searle and Rice 2018). There is a considerable literature on the preservation of trust in crisis conditions that may need further examination. Risk management approaches developed in conditions of relative certainty can be problematic in more uncertain conditions i.e., this pandemic (e.g., Reason, 2000.) The resultant issue is that the implied encouragement to rely on health and safety can contribute to the activation of a number of psychological factors which may, as a result, have negative consequences. Such factors include the difficulties surrounding decision-making in uncertainty, human threat responses, switching to distrust & also a perception of low justice where the complexity and difficulties of the situation suggest an abdication of organisational responsibility to off load difficulty (i.e., if a high demand, low control, low support approach is adopted by senior people/ regulator.) In the event of testing failing to control outbreaks of SARS-CoV-2, then many of these factors are likely to be activated.

Conclusions

Testing for SARS-CoV-2 in a workplace environment is a complex undertaking which should only be considered in the context of a multi-strand risk management strategy. It is not possible to specify a specific testing system and the approach needs to be tailored to the needs of the organisation. Any decision to test should be made with a clear understanding of expected outcomes and how those will be monitored and communicated. The type of test selected will be dependent on a range of factors which include the trade-off between speed and accuracy. There is no official guidance re. what are acceptable levels of sensitivity/specificity for workplace applications of testing for SARS-CoV-2. Such levels would, of course, be linked to the objectives of the testing programme and the context of use. It is reasonable to assume that HSE (with assistance from WHEC) might provide guidance based on the risks associated with a low performance tests and to provide details of how to mitigate risks in other ways should the sensitivity or specificity be unacceptably poor.

The behavioural impacts of introducing testing for SARS-CoV-2 as a workplace intervention have been discussed in this paper and the dangers of unintended, negative consequences highlighted. These issues do not currently appear to be well understood by very many in society, including policy makers and some specialists advising them. There is therefore an urgent requirement to undertake an education programme to promote better understanding.

Appendix

IGLOO model applied to intervention prototyping (design) stage – a thought experiment based on a false negative test result[1].

It appears that none of the various forms of testing (as outlined in this paper) give us both an accurate and a timely insight into whether any negative test outcome informs us about transmissibility risk (Rapid feedback LFTs maybe timely but have nearly 50% false negative (I understand) and the others maybe accurate but take 48 hours to deliver any result – (so someone can become a transmission risk between having a test and receiving a negative test result, as they can became infected in the interim).

This means that we cannot claim that someone having a negative test result is a certain enough indicator of low transmissibility risk. The potential harms from this high uncertainty coupled with a testing protocol that people are likely to assume is a 'normal' type of risk management approach is that the hazard is not controlled, but people act as if it is controlled. This 'attribute substitution' thereby increases the risk of outbreak and the associated harms (to health and trust).

The table below draws on behavioural science insights (Van Bavel et al forthcoming) and uses the IGLOO model to outline for each different level the cognition/bias issues, behavioural consequences and impact on trust[2] from highly probable false negative test result and how these heuristic decision-making mechanisms can lead to harm. It also references the literature on preservation of trust as potential mitigation.

[1] Positive test maybe an individual/group level financial risk – and this may make the likelihood of a false negative test greater - but this issue is not the focus of this table

[2] Factors relevant to institutional trust: competence, benevolence, integrity (Mayer et al 1995). Lowered trust if any of these compromised – and switch to distrust particular risk if benevolence -> malevolence (Searle forthcoming and Searle and Rice 2018). Factors relevant to interpersonal trust meta-cognitions - Warmth and competence (Fiske et al 2006) – meta-cognition about managers competence will be compromised by likely outcomes

[3] **Moral disengagement** key risk in conditions of uncertainty (Searle and Rice 2018) on badly manged change and insider threat) both manifests as a consequence of switch to distrust and as a compounding factors for the spread of distrust. Moral disengagement manifests in (1) **Justifying behaviour** such as Moral justifications, Euphemistic descriptions and Advantageous comparison (2) **Minimizing role in causing harm** such as Displacement of responsibility and Diffusion of responsibility (3) **Making other people deserving of wrongdoing** such as Dehumanisation and Victim blaming.

	Decision-making issues	Potential behaviour	Possible harms	Possible mitigation
Individual	Negative test result assumed as a long-term categorisation (confirmation bias). Consent issues	To take more individual transmissibility risk across contexts. If later tests different not take any test result seriously.	Increases transmissibility risk both in work and outside work. Outbreaks damage sense of informational justice and competence of workplace –> lowered trust (Colquitt&Rodell, 2011). Equity adjustments for workplace harm.	This content covers all levels in the IGLOO model. Careful and close monitoring and course correction – e.g., of care homes
Group (team/ family/ friends)	Negative test subject to confirmatory bias as less likely to see members of an in-group as a risk to health (in-group bias), Cruwys et al, 2021 - preprint).	To act as if everyone in close groups is always negative, regardless of later test outcome.	Increases transmissibility risk –> outbreaks lead to breach of Informational justice –> may contribute to 'switch to distrust' (Searle and Rice, 2018)	The importance of well-managed psychosocial hazards in the workplace using the HSE managerial standards as stress is implicated in the likelihood of lack of attention to compliance with risk management requirements. There is considerable literature on preserving trust in disruption (Gustafson 2020, Gillespie 2020) There is also a literature on the need for transparent communication about the complexity in decision-making with all involved (Jordan 2013). Key to this will be the need to answer the question – why is the workplace open if testing doesn't really help with most transmission risk? There is also info on strategic communications requirements for this (Martella et al, 2021)
Leader/ Manager	Attribute Substitution in understanding of risk management (Kahnemann & Fredrickson, 2002)	To act as if testing is a necessary and effective route for elimination in the required risk management protocols -> deflection from complexity of addressing transmission risk in the workplace.	Increases transmissibility -> workplace outbreaks evidenced -> Reduces interpersonal trust in managers and by managers. Increases managers stress and reduces quality of their decision making -> moral injury in managers (Roycroft et al, 2020)	
Organisation	Systemic Attribute Substitution	To invest in testing as the route for elimination in the required risk management protocols -> deflection from complexity of addressing transmission risk in the workplace. Moral disengagement from fact[3] of mortality/ morbidity impact of increased transmission/ outbreak. manifesting in tendency to blame individuals for any evidenced outbreak. (Fida et al 2018, van Beval et al forthcoming, Searle and Rice 2018, Searle forthcoming)	Increases transmissibility due to deflected attention from risk management -> outbreaks and increased absence etc. from work. 'Switch to distrust' as organisation intentions are assumed to be at best incompetent and at worst malevolent (ie using testing to stay open rather than caring for people's health). High cost for low benefit at best – likely harmful.	
Operating context/ Society	Systemic Attribute Substitution	To accept and advocate for testing as a key part of risk management. Moral disengagement from fact of mortality/ morbidity impact of increased transmission/ outbreak manifesting in tendency to blame individuals for any evidenced outbreak. Fida et al 2018, van Beval et al forthcoming, Searle and Rice 2018, Searle forthcoming)	Increases transmissibility due to deflected attention from risk management -> workplace outbreaks and increased work-related mortality and morbidity. Societal level 'switch to distrust' including broad assumptions of malevolence – on-going negative impact on the capacity to manage the overall society level transmission risk.	

References

Asanati, Majeed & Molokhia, 2021. Health and work during COVID-19. *Commentary.* Royal College of Physicians of London. 2021https://70b706f2.flowpaper.com/CommentaryJanuary2021/#page=16

BMJ (2021) Covid-19 INNOVA testing in schools: don't just test, evaluate https://blogs.bmj.com/bmj/2021/01/12/covid-19-innova-testing-in-schools-dont-just-test-evaluate/

British Medical Association (2020) https://www.bma.org.uk/media/2768/bma-covid-19-risk-assessment-tool-july2020.pdf

Buitrago-Garcia D, Egli-Gany D, Counotte MJ, Hossmann S, Imeri H, Ipekci AM, et al. (2020) Occurrence and transmission potential of asymptomatic and presymptomatic SARS-CoV-2 infections: A living systematic review and meta-analysis. *PLoS Med* 17(9): e1003346. https://doi.org/10.1371/journal.pmed.1003346

Colquitt, J A and Rodell J B (2012) Justice, Trust, and Trustworthiness: A Longitudinal Analysis Integrating Three Theoretical Perspectives. *Academy of Management Journal* 54(6) https://doi.org/10.5465/amj.2007.0572

Cruwys et al (Preprint 2021) Perceived SARS-COV-2 -19 risk is attenuated by ingroup trust: Evidence from three empirical studies. *TB & Outbreaks Week*, 2021=02-02 p221

Dept Health and Social Care (2021) https://www.gov.uk/government/publications/react-1-study-of-coronavirus-transmission-january-2021-final-results/react-1-real-time-assessment-of-community-transmission-of-coronavirus-covid-19-in-january-2021

Fida, R., Tramontano, C., Paciello, M., Guglielmetti, C., Gilardi, S., Probst, T. M., & Barbaranelli, C. (2018). 'First, Do No Harm': The Role of Negative Emotions and Moral Disengagement in Understanding the Relationship Between Workplace Aggression and Misbehavior. *Frontiers in Psychology,* 9(671), 1-17. doi:10.3389/fpsyg.2018.00671

Fiske, S.T., Cuddy, A.J. and Glick, P. (2007) Universal dimensions of social cognition: warmth and competence. *Trends in Cognitive Science*. 11(2) 77-83.

Gillespie, N. A., et al. (2020). Preserving employee trust during crisis. Behavioral Science & Policy. Retrieved from https://behavioralpolicy. org/journal_issue/covid-19/

HM Government (2021a) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/950192/Care_Home_Testing_Guidance_England_v06-01_3.pdf

HM Government (2021b) https://www.gov.uk/government/publications/coronavirus-covid-19-asymptomatic-testing-in-schools-and-colleges/coronavirus-covid-19-asymptomatic-testing-in-schools-and-colleges

HSE (2019) Management and operation of microbiological containment laboratories https://www.hse.gov.uk/biosafety/management-containment-labs.pdf

HSE Workplace Health Expert Committee (2020) Evaluating interventions in work-related ill health and disease https://webcommunities.hse.gov.uk/connect.ti/WHEC/view?objectId=703109

Gustafsson, S, et al. (2020). "Preserving organizational trust during disruption." *Organization Studies*: https://doi.org/10.1177/0170840620912705

Liverpool University, (2020) https://www.liverpool.ac.uk/media/livacuk/coronavirus/Liverpool,Community,Testing,Pilot,Interim,Evaluation.pdf

Jordan, J, et al. (2013). "Someone to Look Up To: Executive-Follower Ethical Reasoning and Perceptions of Ethical Leadership." *Journal of Management* 39(3): 660-683.

Kahneman, D and Frederick, S (2002) Representativeness revisited: attribute substitution in intuitive judgement. In Glovich et al (eds) *Heuristics and Biases: The psychology of intuitive judgement*. Cambridge: CUP

Kinderman, Murden and Scott (2016): https://www.bps.org.uk/sites/www.bps.org.uk/files/Policy/Policy%20-%20Files/Changing%20Behaviour%20-%20Making%20Better%20Decisions.pdf

Martella et al (2021). Motivating voluntary compliance to behavioural restrictions: Self-determination theory–based checklist of principles for COVID-19 and other emergency communications. *European Review of Social Psychology.* DOI: 10.1080/10463283.2020.1857082

Mayer et al (1995) An Integrative Model of Organizational Trust. *The Academy of Management Review.* 20(3): 709-734.

Michie S, van Stralen MM , West R (2011) The behaviour change wheel: a new method for characterising and designing behaviour change interventions*. Implement Sci* doi:10.1186/1748-5908-6-42

Micocci,M Gordon AL , Allen, AJ , Hicks, T Kierkegaard, P McLister, A Walne, S Buckle, P on behalf of the CONDOR study team, (2021) COVID-19 testing in English care homes and implications for staff and residents, *Age and Ageing*, 2021. afab015, https://doi.org/10.1093/ageing/afab015

Mina et al (2020) Rethinking Covid-19 Test Sensitivity — A Strategy for Containment *N Engl J Med* 2020; 383:e120 DOI: 10.1056/NEJMp2025631

Nielsen K, Yarker J, Munir F, Bültmann U. IGLOO: An integrated framework for sustainable return to work in workers with common mental disorders. *Work & Stress*. 2018;32(4):400-417.

Public Health England (2020a) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/926410/Understanding_Cycle_Threshold__Ct__in_SARS-CoV-2_RT-PCR_.pdf

Public Health England (2020b) https://www.ox.ac.uk/sites/files/oxford/media_wysiwyg/UK%20evaluation_PHE%20Porton%20Down%20%20University%20of%20Oxford_final.pdfref

Public Health England (2020c) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/945978/S0921_Factors_contributing_to_risk_of_SARS_18122020.pdf

PHE Porton Down and University of Oxford (2020) https://www.ox.ac.uk/sites/files/oxford/media_wysiwyg/UK%20evaluation_PHE%20Porton%20Down%20%20University%20of%20Oxford_final.pdf

Reason J. (2000) Human error: models and management. *BMJ.* 2000;320:768–70. doi: 10.1136/bmj.320.7237.768

Riley S et al, (2020) REACT-1 round 8 interim report: SARS-CoV-2 prevalence during the initial stages of the third national lockdown in England. https://doi.org/10.1101/2021.01.20.21250158

Roycroft et al (2020) (editorial) Limiting moral injury in health professionals during the COVID-19 pandemic. *Occupational Medicine* 70:312–314.

Searle, R. H. (forthcoming). Counterproductive Work Behaviours. In J. Peiró (Ed.), *Oxford Encyclopedia of Industrial and Organizational Psychology*. Oxford Oxford University Press.

Searle, R. H., & Rice, C. (2018). *Assessing and mitigating the impact of organisational change on counterproductive work behaviour: An operational (dis)trust based framework.* Retrieved from Centre for Research and Evidence on Security Threats (CREST): www.crestresearch.ac.uk/cwb

Tversky, A and Kahneman, D (1974) Judgment under Uncertainty: Heuristics and Biases. *Science* 27 Sep Vol. 185, Issue 4157, pp. 1124-1131. DOI: 10.1126/science.185.4157.1124

Van Bavel, J J, Baicker, K, Boggio, P S, Capraro, V, Cichocka, A et al (in print) Using social and behavioural science to support COVID-19 pandemic response *Nature Human Behavior*.

Wilson, JMG, Jungner, G. Principles and Practice of Screening for Disease, World Health Organization, 1968.

Wilde, J (2016) The Social Psychology of Organizations Diagnosing Toxicity and Intervening in the Workplace Routledge ISBN 9781138823235

Wise, J (2020) Covid-19: Safety of lateral flow tests questioned after they are found to miss half of cases https://www.bmj.com/content/371/bmj.m4744

What is WHEC?

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