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Behavioral strategies for reducing disease transmission in the workplace

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The coronavirus pandemic highlighted that workplaces may serve as a hub of disease transmission if proper precautions are not enacted. The Centers for Disease Control recommends several strategies for decreasing the spread of illnesses in the workplace, including a) promoting proper hand hygiene, b) cleaning and sanitizing the work area, c) encouraging sick employees to stay home, d) personal protective equipment, and, e) social distancing. Research suggests that instructions are often not sufficient to change work behaviors, and behavioral interventions may be needed. Thus, the present paper reviews existing research that informs the implementation of behavioral strategies to reduce the spread of disease in the workplace, and makes recommendations for organizations to protect employees, clients, and customers. Intervention components such as training, prompts, the reduction of response effort, clear workplace policies, feedback, and consequences are discussed, and practical recommendations and suggestions for future research are provided.

Key words: infectious diseases, personal protective equipment, social distancing, hand hygiene, cleaning

Infectious diseases are a major public health concern and economic burden, accounting for $128 billion in healthcare expenditures in the United States (Bureau of Economic Analysis, 2020). Infectious diseases also place an economic burden on organizations, reducing productivity, increasing costs, reducing sales, and in some cases, disrupting business sectors such as food production or tourism (Smith et al., 2019). Moreover, outbreaks of infectious disease are associated with disproportionate effects on vulnerable populations, exacerbating the existing health disparities impacting individuals across racial, ethnic, geographic, and socioeconomic groups (Quinn & Kumar, 2014).

Although the burden of infectious diseases has been present for centuries, the 2020 Coronavirus Disease of 2019 (COVID-19) pandemic marked a turning point in modern history. Citizens, scientists, and policy makers across the world sought to address the rising death toll and the overwhelming burden on healthcare facilities by limiting transmission of COVID-19 as much as possible. During that time, organizations that provided essential services such as hospitals, grocery stores, residential care facilities, nursing homes, and gas stations remained open and needed to quickly adopt new practices to reduce the spread of COVID-19. Other organizations offering nonessential services were initially forced to adjust to remote work arrangements or close provisionally to limit the spread of the disease. Reopening plans required that organizations change the way they conduct business to keep their employees, clients, and customers safe. The COVID-19 pandemic fostered an increased awareness of the role organizations play in reducing the spread of infectious diseases, and while the pandemic is still present as we write this, the need to reduce the spread of infectious disease will continue after the pandemic subsides.

Infectious diseases can spread through direct contact (e.g., skin to skin contact, contact with

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bodily fluids), droplets (e.g.., coughing or sneezing), or via an indirect transmission (e.g., suspended air particles, contact with inanimate objects or vectors; Dicker et al., 2006; Hall, 2007; McNamara, 2018; Taqaddas, 2020). In many cases, asymptomatic people can still spread illnesses, and so visible signs of illness should not be considered the only time precautions are necessary (Li et al., 2020). To decrease the spread of infectious diseases in the community, the Centers for Disease Control and Prevention (CDC, 2020a) recommend the following strategies: frequent hand washing, keeping areas clean and sanitized, staying home when sick and, when risk of infection is high, wearing protective equipment such as face masks or gloves, and social distancing. Employees must adhere to these guidelines to prevent disease transmission, protect vulnerable populations, continue providing important services, and contribute to reducing the personal and economic burden of disease on the organization and our society.

Workplaces present unique challenges (e.g., managing the behavior of customers and clients) and unique opportunities (e.g., influencing a large group of people to follow CDC guidelines) for reducing the spread of infectious diseases. In this paper, we describe evidence-based interventions to promote each CDC guideline in the workplace and conclude with a call for behavior analysis research on reducing disease transmission. We conducted a comprehensive search of the behavior analysis literature and searched the literature in healthcare, infection control, and on each specific topic, to write this paper. The recommendations in this paper are not meant to replace the advice of public health and medical experts, rather, they should assist readers in implementing their advice.

Hand Hygiene

Proper hand hygiene (i.e., consistent with CDC guidelines) is one of the most important preventative measures impacting disease transmission (CDC, 2020b). The CDC (2020c) recommends the following handwashing procedure: wet hands with clean running water, apply soap and work into a lather across all surfaces of the hands, then scrub for at least 20 s, rinse hands under clean running water, and finally dry hands with a clean towel or air dry. Hand sanitizer can be used if hands are not visibly dirty but must contain at least 60% alcohol to be effective and should be applied to all surfaces of the hands and rubbed until dry. Individuals who do not comply with proper hand hygiene procedures can transfer harmful pathogens to food items, fomites (e.g., objects or materials such as doorknobs), and other people, thus increasing the risk of spreading infectious diseases such as pneumonia, influenza, and COVID-19 (CDC, 2020b; Freeman et al., 2014).

Previous research suggests that there is poor hand hygiene compliance across industries, including those involving healthcare professionals, food workers, and human service employees (Bowman et al., 2019; Erasmus et al., 2010; Green et al., 2006). For example, a review of hand hygiene compliance among healthcare workers found a median compliance rate of 40% (Erasmus et al., 2010). Similarly, research conducted with food workers indicated that they were only compliant with hand hygiene procedures during 26% of observed opportunities (i.e., before food preparation, after coughing, sneezing, or using a tissue; Green et al., 2006). Bowman et al. (2019) reported that handwashing adherence averaged 11% during baseline in a large human service organization. Proper handwashing or use of hand sanitizer can effectively reduce the presence of germs and pathogens, thus improving hand hygiene compliance in the workplace may be paramount in preventing the spread of infectious diseases. Therefore, we reviewed the existing evidence for strategies to improve hand hygiene compliance in the workplace.

Instructions and Prompts

One variable impacting the level of hand hygiene compliance in organizational settings may be that employees have not been exposed to relevant verbal instructions. Although the practice of washing one's hands after using the restroom or before meals is an established social norm in most cultures, some employees may not engage in the *proper* hand hygiene procedures described by the CDC and organizational guidelines because they have not been taught the relevant relations between hand washing and health consequences. The CDC and the World Health Organization provide a variety of free signage resources for organizations (e.g., https://www.cdc.gov/handwashing/pdf/hand-sanitizer-factsheet.pdf; CDC, 2020d); thus, employers could post or distribute these materials to improve hand hygiene compliance caused by inadequate instructions. Employers might also consider integrating hand hygiene procedures into work schedules by instituting policies that require all employees to wash or sanitize their hands upon entering or exiting the workplace, or during other occasions where transmission is more likely to occur. These policies could also offer additional opportunities to measure hand hygiene compliance (e.g., use of hand sanitizer in a public area after entering or going to the bathroom to wash their hands). However, mere exposure to verbal instructions about hand hygiene is not sufficient to improve compliance and should be combined with additional environmental strategies outlined below.

Organizations can also use prompts to increase the probability of hand hygiene compliance by employees, clients, and customers. The results of Ford et al. (2014) showed increased use of hand hygiene materials (i.e., consumption of soap and hand towels) by automating the provision of hand towels when users passed the sink compared to waving their hand in front of the dispenser, suggesting that the automatic provision of hand towels served as a discriminative stimulus for handwashing. Many workplaces have automated hand towel dispensers already installed and may be able to change the existing settings on those dispensers from user-activated to motion-activated. Cruz et al. (2019) demonstrated that the provision of hand sanitizer alone did not improve compliance in two of three direct care staff until combined with email prompts. Despite the addition of email prompts, compliance was variable, and two participants required supplemental supports to maintain improvements in hand-hygiene compliance. Similarly, a study conducted by Choi et al. (2018) demonstrated that prompts alone were insufficient at improving hand hygiene compliance in university restrooms before proceeding to more intrusive intervention procedures. These data suggest that verbal instructions and prompts may be necessary, in some cases, but are insufficient to increase hand hygiene compliance, and additional intervention components might be warranted.

Reduced Response Effort

Individuals are more likely to engage in proper hand hygiene when compliance requires relatively low response effort. Additionally, if soap or hand sanitizers are unavailable, difficult to access, or depleted, employees do not have the opportunity to complete hand hygiene procedures as needed. For example, Fournier and Berry (2012) showed that the availability and placement of a hand hygiene dispenser in a multifaceted treatment package improved hand hygiene compliance among university students. It is noteworthy that sanitizer use was approximately 60% when the prompt and change agent was present but was just 18% when the change agent was absent. Although the independent treatment effects of product placement could not be assessed, one might speculate that using hand sanitizer increases when a dispenser is in sight and nearby. Therefore, employers should consider providing portable sanitizer to employees or placing multiple sanitizer dispensers

in locations where direct contact occurs most frequently (e.g., bathroom, waiting area, communal tool storage). Other environmental manipulations that reduce response effort and minimize the transfer of pathogens to fomites can be employed, such as replacing hand door latches with foot latches and contactless badge readers (Cambridge Center for Behavioral Studies [CCBS], 2020). Of course, some environmental manipulations may require significant financial investment, so organizations will have to determine if the change will produce a worthy reduction in the spread of disease.

Feedback and Consequences

Previous research indicates that feedback may be the most effective strategy to improve hand hygiene compliance across organizational settings (Choi et al., 2018; Geller et al., 1980; Luke & Alavosius, 2011; Rosenthal et al., 2005; Stephens & Ludwig, 2005). Geller et al. (1980) increased the frequency of handwashing by food workers through an intervention that included observation, training, and presenting individual feedback on the percentage of times handwashing followed critical opportunities based on 3-hr observations from the preceding work day. Observations and sanitation training appeared to have modest effects on compliance; by contrast, the delivery of feedback increased the mean number of handwashing instances per day by 56% across groups. Choi et al. (2018) found that the provision of publicly posted feedback on the percentage of hand hygiene compliance in a university restroom increased hand hygiene compliance by 20% from baseline. Stephens and Ludwig (2005) increased hand hygiene compliance by 41% from baseline using goal setting and publicly posted graphic feedback, but compliance decreased to a gain of 28% from baseline when the intervention was withdrawn. Bowman et al. (2019) found antecedent strategies insufficient at improving hand hygiene compliance (M = 17% adherence), but the use of a group lottery (i.e., an interdependent group reinforcement contingency) successfully improved hand hygiene compliance to an average of 72% of opportunities after schedule thinning procedures were employed. Thus, feedback and consequence interventions, although sometimes time consuming, might be necessary to achieve high levels of hand hygiene compliance. Table 1 provides a summary of hand hygiene interventions.

Importantly, reactivity to measurement has been observed across studies evaluating hand hygiene compliance (Bowman et al., 2019; Gould et al., 2017; Hagel et al., 2015). For example, Bowman et al. (2019) found that

Table 1

Hand Hygiene Recommendations

Recommendations	Supporting References
Materials to wash or sanitize hands should be readily available at the point where the behavior is expected to occur, and hand hygiene should occur at designated time points in the day (e.g., upon entering and exiting).	Fournier & Berry (2012) CCBS (2020)
Provide feedback on measured compliance with hand hygiene policies (e.g., record employee compliance upon entering or exiting the workplace or during handwashing breaks).	Geller et al. (1980) Luke & Alvosius (2011) Rosenthal et al. (2005) Stephens & Ludwig (2005)
Promote organization-wide accountability by suggesting that peers provide feedback when hand hygiene opportunities are missed, or procedural compliance is poor and provide recognition contingent on compliance.	Bowman et al. (2019) Gould et al. (2017) Hagel et al. (2015)
Deliver verbal, email, or automated prompts in combination with consequence-based strategies.	Choi et al. (2018) Cruz et al. (2019) Ford et al. (2014) Gould et al. (2017) Midturi et al. (2015)

compliance was lower during covert observations than when a familiar experimenter observed. Therefore, employers may also need to consider whether covert observation is appropriate for monitoring hand hygiene, in order to gather more accurate data and deliver more accurate feedback.

Cleaning and Disinfection

Infectious diseases can survive on surfaces long after initial contact and may persist if decontamination procedures are insufficient (Otter et al., 2013). For example, researchers detected viable pathogens causing COVID-19 on environmental surfaces for 4 hr and up to 9 days, depending on the surface type, after initial contact (Kampf et al., 2020; Van Doremalen et al., 2020). Similarly, pathogens causing respiratory infections such as pneumonia persist on surfaces for multiple days, and gastrointestinal viruses can survive for over a week (Bright et al., 2010; Kramer et al., 2006). Adherence to recommended cleaning and disinfectant procedures can prevent the transmission of harmful pathogens and reduce illness in the workplace (Rutala & Weber, 2019). Therefore, the CDC (2020e) recommends routine cleaning with soap and water or Environmental Protection Agency approved disinfectants to reduce the risk of exposure. Cleaning and disinfectant procedures should be conducted before and after using frequently touched objects and surfaces (e.g., workstations, keyboards, handrails, doorknobs; CDC, 2020e); thus, employers should identify communal surfaces and objects and enact cleaning and disinfectant procedures accordingly. Once high-risk surfaces have been identified, organizations may employ several interventions to increase and maintain adherence to cleaning and disinfectant procedures outlined below.

Task Clarification and Checklists

Cleaning and disinfecting the work area does not guarantee reductions in disease transmission if cleaning procedures are insufficient or not followed. For example, research has found that disinfecting wipes may transfer pathogens across surfaces, and spray cleaners and paper towels should be used instead (Ramm et al., 2015). Furthermore, cleaning quality is reduced if there is not enough contact time between surfaces and disinfecting cleaners, or if the cleaner mixture does not meet Environmental Protection Agency standards (Boyce et al., 2016; Rutala & Weber 2015). Research has found that more time spent cleaning does not mean the cleaning was more effective (Rupp et al., 2015); instead, specific procedures must be followed. A number of studies found that using specially trained cleaning staff or supervisors to ensure proper procedures were followed improved cleaning and reduced infections in healthcare settings (Dancer et al., 2009; Falk et al., 2000; Goebel et al., 2016; Grabsch et al., 2012; Wilson et al. 2011). Therefore, employers may consider hiring specially trained cleaning staff when feasible.

If hiring trained cleaning staff is not feasible, organizations should teach existing employees how to clean and disinfect the workplace, provide well-designed cleaning tools, and designate sufficient time to complete cleaning procedures in addition to existing job requirements (Rock et al., 2016). Specifically, employees should be informed of the type of surfaces to be cleaned, when and how cleaning should be completed, the order in which to clean items, and the materials required to conduct cleaning and disinfectant procedures appropriately (Rutula & Weber, 2019).

Checklists can be used in combination with other interventions to improve and maintain compliance with procedures (Russ et al., 2013; Seligson Petscher & Bailey, 2013). Indeed, researchers have used checklists as part of a package intervention to improve a variety of workplace behaviors (Degani & Wiener, 1993; Winters et al., 2009), including cleaning behaviors, across different settings

(Anderson et al., 1988; Austin et al. 2005; Doll et al., 2007; Pampino et al., 2004. For example, Doll et al. (2007) increased cleaning task completion an average of 50% by using a package intervention that included task clarification, checklists, and graphic feedback depicting the prior week's performance. Organizations should develop checklists that correspond with cleaning procedures unique to the workplace setting and provide time to complete them. Critical items should be listed first, checklists should be short or divided into meaningful chunks, and checklists should be tested in the reality of the work environment (Winters et al., 2009). Furthermore, organizations could require that designated cleaning personnel self-monitor cleaning task completion using the checklist and turn completed forms in to supervisors to increase accountability and add an additional measure of task completion (Seligson Petscher & Bailey, 2013). Although checklists can clarify expectations and remind employees about required cleaning steps, they are often not sufficient to change behavior without ongoing monitoring and feedback (Bosk et al., 2009).

Table 2

Cleaning and Disinfection Recommendations

Recommendations	Supporting References
Develop appropriate cleaning and disinfectant procedures and processes specific to the workplace setting.	Rutala et al. (2019) CDC (2020e) Dancer et al. (2009) Falk et al. (2000)
Hire specially trained staff for cleaning, if feasible.	Goebel et al. (2016) Grabsch et al. (2012) Wilson et al. (2011)
Clarify training procedures and train staff.	Ramm et al. (2015) Rutala & Weber (2015) Boyce (2016) Goebel et al. (2016) Rutala & Weber (2019)
Provide checklists that are simple yet precise and easy to complete.	Anderson et al. (1988) Austin et al. (2005) Doll et al. (2007) Pampino et al. (2004) Winters et al. (2009)
Monitor adherence to cleaning and disinfectant procedures via direct observation or technology and provide ongoing feedback.	Anderson et al. (1988) Ceriale et al. (2015) Grabsch et al. (2012) Hayden et al. (2006) Tršan et al. (2020)

Monitoring and Feedback

Once employees are sufficiently informed and materials made available, organizations should continue monitoring compliance and deliver feedback contingent on both sufficient and insufficient adherence to those procedures. Previous research indicates that visual assessment of cleanliness is a poor indicator of true cleanliness (i.e., reductions in bacterial load) and cleaning efficacy (Cooper et al., 2007); therefore, organizations should consider employing additional monitoring and feedback procedures in place of postcleaning visual inspection, when feasible (Grabsch et al., 2012; Hayden et al., 2006). For example, supervisors or peers may be asked to observe cleaning procedures and provide feedback (e.g., "You completed 95% of the tasks correctly") or prompts (e.g., "Don't forget to wipe the doorknobs too") in response. Alternatively, fluorescent markers or adenosine triphosphate (ATP) bioluminescence assay can be used to periodically assess surface contamination following cleaning and disinfectant procedures (Ceriale et al., 2015; Datta et al., 2011; Tršan et al., 2020). If objective assessment indicates poor cleaning efficiency, supervisors should discuss the findings with relevant cleaning personnel and deliver corrective feedback, as needed. Conversely, sufficient cleaning should be positively recognized on an ongoing basis. Of course, time will need to be designated not only for performing cleaning tasks, but also monitoring performance and providing feedback. See Table 2 for a summary of interventions for cleaning and disinfection.

Staying Home When Sick

Another vital strategy for reducing the spread of infectious diseases is having individuals stay home when they are sick (CDC, 2019). The Institute for Women's Policy Research (2010)

estimated that people who showed up sick to work caused up to 7 million coworker infections of the H1N1 virus. A survey conducted by the staffing firm Accountemps (2019) found that 90% of employees surveyed admitted to going to work when they felt sick. The most common reasons employees cited for going to work sick were that they had too much work they needed to do (54%), did not want to use a sick day or did not have a sick day available (40%), and felt pressured by their employer (34%). Behavior analysis research on attendance has primarily focused on increasing attendance with limited consideration for whether the employees were ill or provided advanced notice at each absence (e.g., Berkovits et al., 2012; Camden & Ludwig, 2013). Although work attendance is important, interventions designed to promote attendance should be focused on attending only when healthy, and this can be accomplished through careful design of workplace policies and procedures.

Reduced Response Effort for Calling in When Sick

To start, employers who provide paid sick leave enable employees to call in sick as needed. Research indicates that offering paid sick leave can reduce the spread of influenza-like illnesses in the workplace (Ahmed et al., 2020; Asfaw et al., 2017; Kumar et al., 2012; Noh et al., 2020; Piper et al., 2017; Zhai et al., 2018). A recent report observed that low wage and part-time workers, who are disproportionately women and people of color, are less likely to have access to paid sick leave (Gould & Schieder, 2017). Furthermore, people of color are more likely to work in jobs with higher exposure risks (Bambino et al., 2020; Hawkins, 2020). A few days of lost wages can total the amount of money needed to purchase gas to commute to work or buy groceries, creating a negative reinforcement contingency that encourages attending work while sick. A 2017 study by Piper et al. (2017) found that access to paid sick leave was associated with an increase in employees staying home when ill. Offering paid sick days allows employees to base their decision to come to work on their health rather than their finances. Although paid sick leave is a cost to organizations, research suggests that the costs are neutralized or savings are realized through lower medical costs and lower overall absences (Asfaw et al., 2017; DeRigne et al., 2016; Hansen et al., 2018). Furthermore, employees who have access to paid sick leave may be 20-30% less likely to leave their jobs, reducing turnover costs for organizations (Hill, 2013).

Alternative Work Arrangements for Sick Employees

If employees are symptomatic but feel well enough to work, they can be offered the opportunity to complete tasks remotely, when feasible. Allowing employees to choose to telework occasionally could enable them to complete work and earn wages (i.e., access reinforcers) without infecting others. A survey conducted by Ahmed et al. (2020) found that 15% of workers reported access to telework. Employees with access to telework were more likely to be encouraged by their employer to stay home when sick and were more likely to still complete work when sick. Thus, access to telework may result in less productivity loss. If employees are attending work while sick because they do not want to forego income or increase their workload upon return, telework could assuage this financial and workload concern. In other words, offering telework weakens the negative reinforcement contingency for attending work while sick. Of course, even if an employee feels well enough to work, working from home may not be feasible for all types of jobs. In that case, alternative arrangements such as isolating the employee in their workspace or using personal protective

equipment (described in more detail in the next section) could prevent the spread of infectious diseases. Offering both alternative work arrangements and paid sick leave are two strategies that may attenuate the contingencies of reinforcement that encourage attending work sick, thereby reducing the spread of illnesses in the workplace.

Instructions and Modeling

Because some employees report feeling pressured to come to work sick, employers should set clear expectations with employees, emphasizing that they should stay home when showing specific illness symptoms. Establishing clear and fair attendance policies and consistently following them is crucial for managing absenteeism effectively (Scott et al., 1987). Managers who attend work while sick are more likely to have employees who do so, as well, so managers should model the health behaviors they expect of employees (Dietz et al., 2020). Finally, when employees report to work showing significant signs of illness (e.g., fever, cough, rash), they should be asked to leave until their symptoms subside or a physician gives them clearance, thereby arranging an extinction schedule for attending work while sick. These same recommendations extend to clients, who also need clear policies guiding when they should stay home, and management must follow through with those expectations.

Attendance Policies

Organizations should carefully examine their attendance policies to ensure that they do not inadvertently reward attending work while sick, thereby spreading illness among employees. Attendance programs with set criteria (e.g., three absences within 90 days) for disciplinary action promote attending work while sick (Grinyer & Singleton, 2000; Munir et al., 2007). If employees are required to make up missed work time, they are also more likely to attend work while ill (Aronsson & Gustafsson, 2005; Aronsson et al., 2000). Furthermore, ensuring adequate staffing and coverage of work tasks can reduce pressure to come to work ill (Caverley et al. 2007; Widera et al., 2010). Attendance reward programs should avoid offering rewards for "perfect attendance" and should instead reward compliance with workplace attendance and absence notification policies. Organizations should similarly examine their attendance policies and work coverage plans, ensuring that they do not favor attending work while sick (Johns, 2010).

If attendance is an ongoing organizational issue, organizations should consider four factors that could contribute to poor attendance. First, poor attendance could indicate high levels of illness in the organization and that more measures to reduce the spread of illness are needed. Research conducted in schools has demonstrated a significant improvement in attendance following handwashing (Bowen et al., 2007) and hand sanitizing (Azor-Martinez et al., 2014) interventions. Second, personal factors such as childcare or providing caregiving to family members can result in more absences, which could be alleviated by flexible work arrangements or emergency childcare assistance programs (Hansen & Anderson, 2008). Third, organizations should consider whether poor attendance is a symptom of other workplace issues like stress (Haswell, 2003), poor supervisor support (Dellve et al., 2007; Nyberg et al., 2008) or low morale (Saksvik, 1996), and design interventions to correct those issues such as offering employee assistance and wellness programs (Truman, 2003) and supervisor training. Finally, organizations should examine work practices to determine if they can be changed to mitigate productivity loss when employees are out sick. For example, cross-training employees can improve coverage during short-term absences (Olivella & Nembhard, 2016). Table 3 summarizes the interventions that increase the likelihood that employees will stay home when sick.

Table 3

Sick Leave and Attendance Policy Recommendations

Recommendations	Supporting References
Offer paid sick leave for employees.	Ahmed et al. (2020) Asfaw et al. (2017) Kumar et al. (2012) Noh et al. (2020) Piper et al. (2017) Zhai et al. (2018)
Offer telework arrangements, when feasible.	Ahmed et al. (2020) Scott et al. (1987)
Provide clear sick policies and follow through.	Johns (2010) Grinyer & Singleton (2000)
Design attendance programs that encourage compliance with policies and not reporting to work while sick.	Munir et al. (2007) Aronsson & Gustafsson (2005) Aronsson et al. (2000) Bowen et al. (2007)
Consider and resolve other organizational issues that may lead to poor attendance before adding attendance award programs.	Azor-Martinez et al. (2014) Dellve et al. (2007) Hansen & Andersen (2008) Haswell (2003) Nyberg et al. (2008) Olivella & Nembhard (2016) Truman (2003)

Additional Protective Strategies

Each of the above recommendations can be consistently followed by organizations to reduce the spread of infectious diseases. When the risk of infection is high, as in the case of the COVID-19 pandemic or in high-risk jobs, organizations may choose or be mandated to employ additional strategies to protect their employees, customers, and clients. Two standard procedures used to reduce the spread of infection in high-risk situations are the use of personal protective equipment and social distancing. Organizations should seek guidance from local and national public health agencies to determine when these strategies should be employed.

Wearing Protective Equipment

Personal protective equipment (PPE) is clothing and equipment worn to protect employees, used in jobs that involve exposure to hazards, including infectious materials (Lau et al., 2004). PPE for infection control includes gloves, masks, respirators, face and eye protection, gowns, and shoe and head covers (Doll et al., 2017). For example, a physician might wear a mask, eye protection, and a gown when examining a patient to protect their face and clothing from exposure to infection. PPE does not replace other preventative strategies; rather, it serves as an additional layer of protection in high-risk environments.

Organizations should work with a safety or infection control professional to identify the specific PPE required to protect their workforce and establish proper use (World Health Organization [WHO], 2020). For example, equipment may need to be cleaned or discarded after each new person-to-person contact. Specific standards exist for correctly wearing, removing, and cleaning various types of PPE used for infection control, and small errors can lead to a dramatic increase in the spread of infectious diseases (Lau et al., 2004). Even in healthcare, a business sector familiar with the use of infection-control PPE, compliance with PPE use and procedures is often lacking (Doll et al., 2017; Mumma et al., 2018; Schumacher et al., 2015; Tomas et al., 2015). Phan et al. (2019) observed that 90% of observed PPE doffing was completed incorrectly by healthcare workers. Similarly, Kuzu et al. (2005) found that baseline compliance with glove use at a university-affiliated hospital was just 58.8%. Zellmer et al. (2015) observed that less than half (43%) of healthcare workers removed their PPE in the correct order, and even fewer (17%) disposed of the PPE correctly. Therefore, once qualified professionals establish PPE needs and procedures, behavioral interventions should be employed to ensure correct and consistent compliance.

Task Clarification and Training

Because PPE infection control procedures can be complicated, and precisely following them is essential, employees need clear instructions and training (Doll et al., 2017; Kwon et al., 2017).

However, a traditional training approach may not be sufficient to support the appropriate donning, wearing, and doffing of equipment without committing a critical error (Northington et al., 2008). Therefore, when a knowledge or skill deficit is identified, behavioral skills training (BST) may be the best approach for ensuring appropriate use of PPE. BST incorporates instruction, modeling, rehearsal, and feedback to train a skill to a prespecified criterion (e.g., Miltenberger et al., 2004). When appropriate, the feedback component of BST can be enhanced by including fluorescence-based feedback during simulations, which simulates infectious materials and can be seen with ultraviolet light, to make the impact of mistakes more salient (Poller et al., 2018). Although task clarification and training may be useful, it is important to note that demonstration of knowledge or skill does not guarantee compliance. Instead, we recommend these methods be used in combination with additional strategies impacting the contingencies that produce or maintain PPE compliance outlined below.

Response Effort

PPE clothing and equipment should be well-placed and easily accessible (Casella et al., 2010; Harrod et al., 2020; WHO, 2020). Casella et al. (2010) found that manipulating the proximity of latex gloves influenced staff compliance. Staff were more likely to comply with glove wearing when the gloves were in close or medium proximity than when they were far away, which required a higher-effort response (Casella et al., 2010). Employers should also ensure disposal bins are well-placed, available in multiple locations, and regularly emptied (CCBS, 2020). Furthermore, selecting PPE that fits comfortably and adequately can increase appropriate use and compliance (Holland et al. 2020; McPherson, 2008). Finally, employers should consider how competing job responsibilities and other environmental variables compete with PPE usage and compliance (Nichol et al., 2008). For example, healthcare workers have reported that PPE use can be time-consuming, impair mobility, and that they are less likely to use PPE when the perceived risk of the work activity is low (Castle et al., 2010; Flaishon et al., 2004; Harrod et al., 2020; Kang et al., 2017). Variables impacting the effort and time required to use PPE likely differ across workplace settings, thus employers should evaluate the unique barriers impacting PPE compliance and limit the response effort required to complete those procedures whenever possible.

Peer Observations and Feedback

Correct PPE use can also be enhanced through feedback. Research has demonstrated that peer observations and feedback are vital behavioral-safety intervention components for improving safety performance in organizations, including proper use of PPE (e.g., Geller, 1996; McSween, 2003; Sulzer-Azaroff & Austin, 2000). During a peer observation, an employee can use a checklist to observe their peer while they work and scores their safety performance as safe or at-risk (McSween, 2003). Following the observations, the peer provides the observed employee with feedback on their performance. The data gathered are then aggregated and can be used to identify safe performance and opportunities for improvement (McSween, 2003). For example, if peer observers find that PPE is removed in the incorrect order, retraining may be required. The data gathered during peer observations can serve as leading indicators, identifying a potential source of infection spread before the spread occurs.

Several behavioral safety studies have evaluated the use of peer observations and feedback for improving PPE use. For example, Martinez-Onstott et al. (2016) used graphic feedback to increase proper PPE use by landscaping employees. Participants never wore PPE items correctly during baseline, and performance increased to 75-100% for all three participants

Table 4

Personal Protective Equipment Recommendations

Recommendations	Supporting References
Establish which PPE is necessary and the standards the PPE must satisfy.	Lau et al. (2004)
Use a BST approach to train employees to correctly wear and remove PPE.	Kwon et al. (2017) Miltenberger et al. (2004) Northington et al. (2008)
Ensure PPE fits properly and is readily accessible for employees.	Casella et al. (2010) Holland et al. (2020) McPherson (2008)
Conduct peer observations and provide feedback on PPE use and removal.	DeVries et al. (1991) Geller (1996) Martinez-Onstott et al. (2016) McSween (2003) Myers et al. (2010) Sulzer-Azaroff & Austin (2000)

following the intervention. DeVries et al. (1991) used task clarification and individual, graphic feedback to improve appropriate glove use by nurses during all the types of opportunities observed (e.g., giving injections, cleaning lacerations, transporting specimens; DeVries et al., 1991). Myers et al. (2010) implemented peer observations, peer-to peer feedback, monthly verbal feedback, and recognition to improve PPE use and other safety targets in a petroleum refinery. The packaged intervention produced a sizable decrease in injuries with a downward trend spanning multiple years, below the industry average. However, there are barriers to using peer observations that are noteworthy. Such observations require time away from job duties to observe peers, and employees may need training to collect accurate data and provide effective feedback. Table 4 summarizes the interventions for encouraging appropriate use of protective equipment.

Social Distancing

When the risk of spreading infection is high, another tool that can be employed to protect employees, clients, and customers is social distancing. The CDC defines social distancing as staying at least 6 ft apart from other people and avoiding gathering in groups. Staying physically distant from others can reduce inhalation of airborne droplets or contact with the mouth and eyes and reduce the likelihood of contact with contaminated surfaces (CDC, 2020f). In the workplace, employees often spend time in proximity with each other, clients, and customers. Workplace social distancing measures can include remote work arrangements, spacing work areas farther apart, and staggered scheduling (CCBS, 2020; Fong et al., 2020; Qualls et al., 2017). Statistical modeling studies have predicted that workplaces represent 20-25% of all weekly contacts and that influenza in the workplace represents 16% (range, 9-33%) of all transmissions (Edwards et al., 2016). Additionally, some research has suggested that workplace social distancing alone was responsible for a 23% reduction in the spread of influenza A (H1N1) in the population and that it delayed the peak of the influenza attack rate (Ahmed et al., 2018). Although social distancing appears to be effective, social interaction is reinforcing for many people. Promoting distancing, therefore, requires changes in work routines and behavioral interventions that include reinforcement (and possibly punishment for deviation) to support those changes.

Workplace Social Contact Identification and Reduction

Before imposing social distancing measures, organizations should determine points of person-to-person contact in the workplace by examining a process map (Rummler & Brache, 1995) or analyzing employees' weekly work calendars. Once points of contact are identified, the physical environment can be modified to reduce or eliminate contacts (i.e., response prevention), when feasible. Some contacts can be eliminated completely (e.g., remote work arrangements, moving in-person meetings to online meetings, avoiding handshakes, having

customers preorder products for no-contact pickup) while others can be reduced (e.g., limiting number of staff who interact directly with customers; Cirrincione, et al., 2020). Each person-to-person contact modification can reduce the risk of illness for employees, clients, and customers, especially when the rate of transmission is fairly low (e.g., $R_0 < 2$) and measures are enacted soon after the first infections occur (Ahmed et al., 2018).

Physical Environment and Prompts

Antecedent manipulation of the workplace environment may promote social distancing in instances where employees are required to work on-site (CCBS, 2020). For example, Hayes and Cone (1977) rearranged the environment by adding benches, chained pathways, and signs to decrease destructive lawn-walking at a university. Similarly, Leland et al. (1986) decreased destructive lawn walking by creating clearly visible, hard-surfaced pathways. Organizations can create clear, one-way walk paths that reduce the likelihood that people will walk past each other (CCBS, 2020). Furthermore, organizations can arrange the work environment so that employees can complete work and interact with clients and customers while keeping a safe distance apart. For example, workstations can be placed 6 ft apart with furniture or ropes separating the stations and waiting room seating can be spaced apart. Organizations can add signage and other physical prompts (e.g., place tape on the floor indicating a 6 ft distance) on the ground or rearrange the furniture to signal appropriate distances. When people cannot work 6 ft apart, clear wall dividers can reduce the spread of droplets and contamination.

Organizations can also rely on the use of technology to promote social distancing. For instance, organizations can allow employees to clock-in and out from an app or their personal workstation to avoid conglomerations at a clock-in/out machine. Customer transactions can be moved online, and clients can be served through video conferencing. Additionally, organizations can use technology to prompt employees when they are too close to others and monitor if people are engaging in social distancing (Buro Happold, 2020; Nguyen et al., 2020). Further advances in technology could promote social distancing by signaling when the behavior should occur and providing automated feedback (e.g., Berger and Ludwig, 2007; Moon & Oah, 2013), although it may be cost-prohibitive for some organizations.

Work Scheduling

When employees must still report to work during high infection risk periods, scheduling interventions can be employed to limit person-to-person contacts. For example, staggering arrival and departure times and breaks may limit the number of in-person contacts and allow people to maintain at least 6 ft of distance while traveling to their designated work area (Hollingsworth, 2020). When people are at work, employers should seek to limit the number of people that interact throughout the day. This can be accomplished by designating small work teams who only interact with each

Table 5

Social Distancing Recommendations and Supporting References

Recommendations	Supporting References
Conduct an assessment to identify all points of person-to-person contact for employees/jobs and determine ways to eliminate, reduce, or modify them to limit exposure.	Rummler & Brache (1995)
Use technology to reduce in-person contacts.	Berger & Ludwig (2007) Buro Happold (2020) Nguyen et al. (2020)
Arrange the physical environment to prompt and require maintaining safe distances.	Hayes & Cone (1977) Leland et al. (1986)
Use flexible work arrangements, staggered scheduling, and small teams to limit person-to-person contacts.	Almer & Kaplan (2002) Baltes et al. (1999) Cirrincione et al. (2020)

other during the day. If employees work with clients or patients, a small group of employees can be assigned to one client or patient, limiting everyone's exposure (Kluger et al., 2020). Finally, work schedules can be compressed to more on-site hours in fewer days with fewer employees on site, limiting days of potential exposure (Cirrincionne, et al., 2020). Adjustments in work scheduling may not be feasible for all organizations, in which case, other measures for promoting social distancing should be enacted. Table 5 provides a summary of interventions to promote social distancing.

Conclusion

In conclusion, organizations can play a critical role in reducing the spread of illnesses in communities by employing interventions that help keep employees, clients, and customers healthy. Behavior analysts know that simply informing employees about recommendations to reduce the transmission of illnesses in not sufficient to encourage the appropriate behaviors (Bowman et al., 2019; Geller et al., 1980.) Instead, employers must design interventions to support ongoing practices that reduce the spread of infectious diseases. The interventions described above share several common features across strategies. Employees should be provided clear instructions and training per CDC guidelines. Environmental prompts can serve as additional discriminative stimuli to increase desirable behavior. Employers should also reduce the response effort for engaging in desirable behavior by making materials like hand sanitizers, cleaners, and PPE readily available. In some cases, organizations may consider changes to workplace procedures and policies to reduce the risk of transmission as much as possible (e.g., creating designated times to clean and offering sick pay). Finally, measuring and providing feedback and consequences can help sustain adherence to procedures for disease prevention long-term. Although implementing these interventions may require time and cost investment, they are important for ensuring that CDC guidelines are followed consistently.

Although behavior analysis research offers evidence-based interventions to promote CDC guidelines on reducing disease transmission, an immense opportunity still exists to expand our research contributions. To start, although behavior analysts have researched compliance with basic prevention procedures (e.g., handwashing, cleaning and disinfecting, wearing PPE; Bowman et al., 2019; Casella et al., 2010; Choi et al., 2018; Cruz et al., 2019; Doll et al., 2007; Fournier & Berry, 2012; Geller et al., 1980; Luke & Alavosius, 2011; Martinez-Onstott et al., 2016; Myers et al. 2010; Stephens & Ludwig, 2005), limited research exists demonstrating that interventions have achieved sufficient reduction of pathogens (e.g., using objective measures of cleanliness, doffing PPE safely). Thus, behavior analysts can extend their work by using objective measures like pathogen cultures or optic markers and by evaluating the subsequent impact on reported illnesses and attendance.

Behavior analysts could also expand current research to address more nuanced and complex behaviors, such as appropriately donning and doffing PPE in a medical environment or encouraging mask use by an entire community. Research on attendance should observe whether employees attend work while sick and evaluate procedures aimed at complying with attendance policies, including staying home when specific symptoms are present. Attendance discipline and award programs can be refined to promote healthy attendance by employees and clients, patients, or customers. Predictors of poor attendance and attending while sick, including work coverage issues, supervisory behaviors, and sick pay, could also be evaluated. Finally, our search yielded few studies that evaluated interventions to improve adherence to social distancing guidelines to reduce disease transmission when the risk of infection is high. Behavior analysis

has a significant opportunity to contribute to developing interventions to improve social distancing in workplaces, the community, and schools. Social distance is a readily observable behavior and amenable to a variety of environmental manipulations. We hope this paper spurs research on these topics.

The COVID-19 pandemic has brought increased awareness to the role organizations play in reducing the spread of illnesses. Just as many organizations have programs, procedures, and job roles designed to improve workplace safety practices, we recommend that organizations design programs and procedures for reducing the transmission of infectious diseases. Responsible workplaces will take proactive, reasonable steps to protect employees, customers, and clients from harm, including contracting preventable diseases. Behavior analysis can help reduce the spread of infection by conducting research to promote these and other guidelines for creating safe and healthy workplaces. We hope this paper offers a starting point.

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