THE ROLE OF RISK
With COVID-19 & Its Impac

By Bruce K. Lyon and Georgi Popov

UNCERTAINTY AND FEAR OF THE UNKNOWN are the real enemies. Investment strategist Jim Paulsen (as cited in Minkoff, 2020) described it this way: "Although the contemporary crisis is loaded with bad news, this has not been its primary problem. It is the 'unknown.' Give me bad news any day over complete uncertainty." Paulsen's point is that if we know what we are dealing with, we are better prepared to manage it, whether or not it is bad news.

From an enterprise and strategic perspective, "risk" is defined as "the effect of uncertainty on objectives" (ANSI/ASSP/ISO, 2018). When an organization is faced with significant uncertainty (or undefined risk), it is negatively affected in its ability to make decisions and successfully achieve its business objectives.

On a more tactical and operational level, risk is known as the likelihood of something occurring and the severity of its consequences. Hazard and operational risks present only negative effects such as harm to people and the environment, damage or loss of assets and property, interruption of business operations, and loss of income, market share and reputation, to mention a few. There are also those types of risk that can present opportunities such as business ventures, investments, acquisitions, expansions, and other financial and strategic risks that organizations decide to pursue and manage.

The risk management process outlined in ISO 31000 and 31010 (Figure 1) provides a road map to anticipating, identifying, assessing and managing risk. In this article, the authors describe this process to examine how it can be applied to pandemic situations such as COVID-19.

KEY TAKEAWAYS

- **The concept of using the risk management process is fundamental to assessing and managing all types of risk, including those created by pandemics. It is a universal approach designed to better understand risk and reduce uncertainty.**
- **This article presents the use of risk management and risk assessment from a business continuity standpoint on the impacts of COVID-19. The authors provide a risk-based perspective on the pandemic and its overall effects as it concerns OSH professionals and their organizations.**
- **This article presents the use of risk management and risk assessment from a business continuity standpoint on the impacts of COVID-19. The authors provide a risk-based perspective on the pandemic and its overall effects as it concerns OSH professionals and their organizations.**
- **The authors present a use of methods that incorporate risk summation to understand and communicate whole-system risk.**

Uncertainty

Uncertainty, strongly linked to probability, can occur in several different ways including a lack of relevant knowledge of the system (epistemic uncertainty), a random, unpredictable nature surrounding the system (aleatory uncertainty), a vagueness or ambiguity inherent in spoken languages (linguistic uncertainty), and uncertainty associated with value systems, professional judgment, company values and societal norms (decision uncertainty).

There will always be some degree of uncertainty and risk in everything we do. Organizations and individuals are now facing such uncertainty surrounding the COVID-19 pandemic. The actual impact of the pandemic goes far beyond the health risks to people. As we have witnessed, the effects of this pandemic have global implications that are unprecedented. Globally, businesses have been forced to shutter their operations leaving only those manufacturers, service providers and transportation operations that fulfill essential needs to the public. The surge of COVID-19 patients has caused an overload to our healthcare systems, with some countries in serious uncertain conditions. The economy has suffered as indicated by the financial markets and their reactions to this event, which cascades into other concerns such as job security, ability to pay mortgages and bills, and healthcare costs. The shortage of PPE such as N95 face masks and medical equipment such as ventilators adds to the global stress level. With many workplaces requiring employees to work from home using personal computers and company-owned laptops, the exposure to cyber threats such as phishing emails, ransomware and malware infections increases. Psychological stress from significant change in everyday life, social isolation and uncertainty about the future is also a risk that organizations must recognize and manage.

The Risk Continuum

Risk is dynamic and can be viewed as a continuum. It changes with the emergence of new conditions, changes in variables, risk drivers and exposures, degree of uncertainty, and effects of applied risk treatments. A continuum can be defined as a coherent whole characterized as a collection, sequence, or progression of values or elements varying by minute degrees. For example, the state of water within a range of temperatures from freezing to boiling represents a continuum; water is a solid when frozen, a liquid when at room temperature and a gas when boiled. In risk management, risk can be viewed as being in a continuum depending upon its point in the risk management cycle. For this reason, risk management must not only in-

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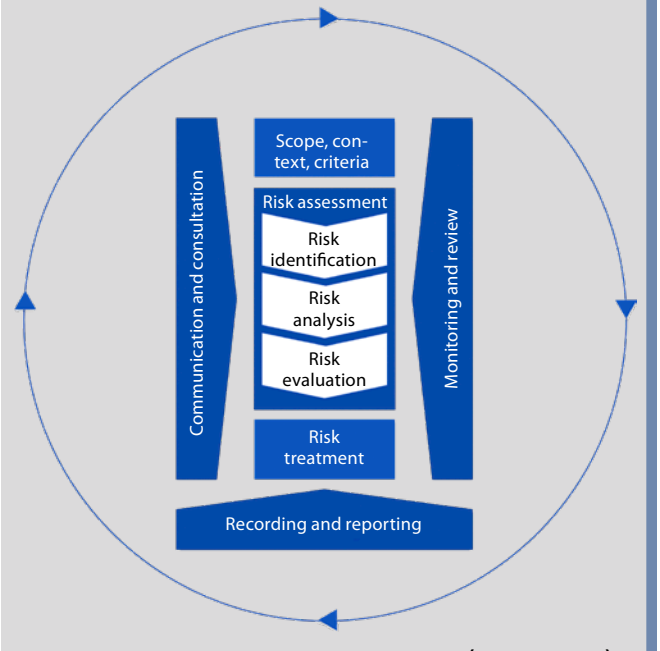
clude managing initial risks that have been identified, assessed and treated, but also anticipate potential unknown risk, detect emerging and developing risks, identify inherent risk and assess initial risk, as well as previously treated risks, residual risks and possible secondary risks created by risk treatments. This continuous and dynamic process of risk is expressed in Figure 2 (p. 34) as the risk continuum.

Risk is derived from its risk source (e.g., hazards, operations, financial and strategic) and influenced by risk drivers. Risk treatments are designed to maintain control of the risk and prevent exposure to assets or objectives. When a loss of control occurs from a trigger or cause, exposure to the risk source results in an incident or event that results in consequences and effects on the objectives. A simplified relationship of elements within the risk pathway is represented in Figure 3 (p. 34). Although the illustration is linear, risk is often multidimensional and must be considered as such.

FIGURE 1
THE RISK MANAGEMENT PROCESS



Note. Adapted from "Risk management: Guidelines (ISO 31000:2018)," by ISO, 2018.

Assessing Pandemic-Level Risk: COVID-19

Risk is dynamic and continuously evolving with changing conditions, risk drivers, risk treatments and other variables. The risk pathway for a pandemic such as COVID-19 begins with the risk source: a new virus (Figure 3, p. 34). In this case, the risk drivers (conditions that influence the risk source) may include global travel, social interactions, unknown vectors and environmental conditions. Exposures to the risk source might include the organization's employees and key personnel, its suppliers, customers and contractors, possibly healthcare providers and waste management. At this point, a trigger event causes the incident to occur such as loss of containment of infected persons unknowingly spreading the infection. Once the spread reaches pandemic levels, the consequences begin to be felt, including impacts on employees, operations, supply chains, financial conditions and overall survivability of the organization.

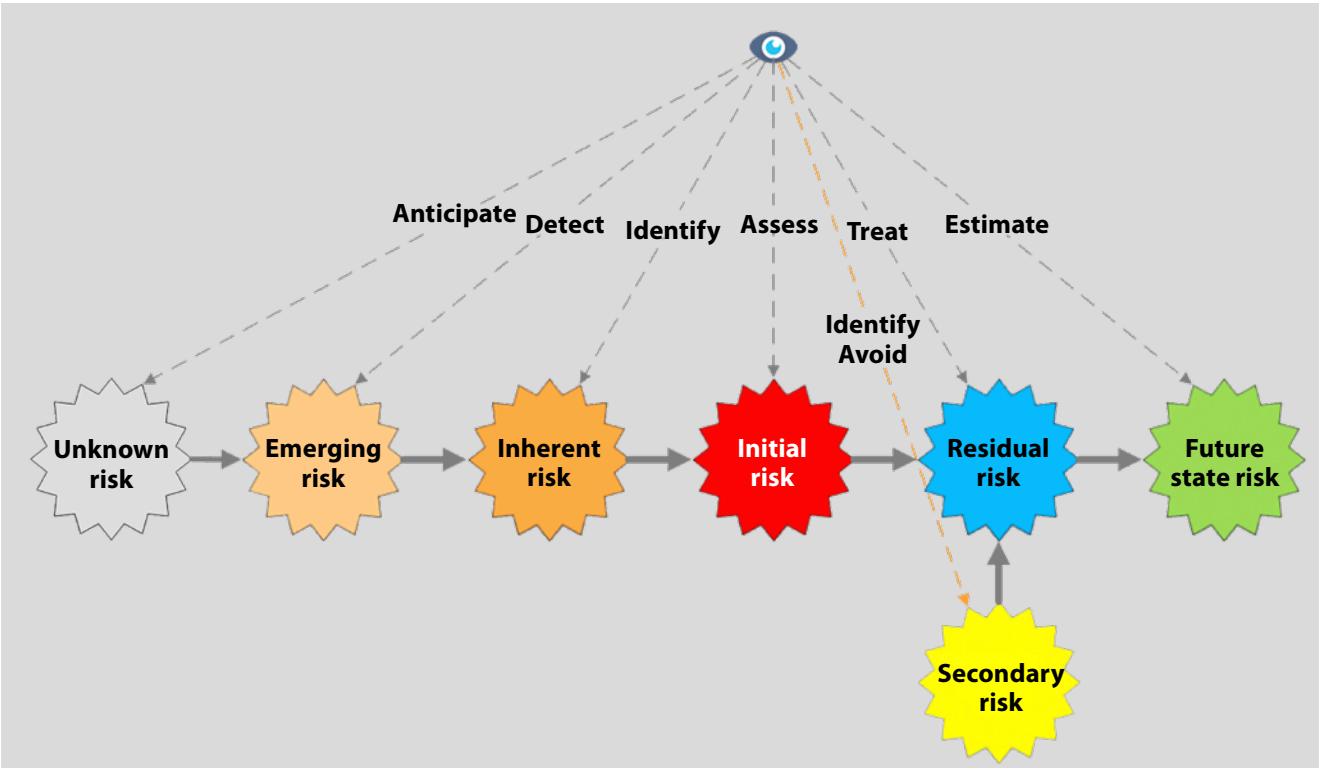
Before the event occurs as part of business continuity planning, the organization must establish its own risk criteria and context for managing risk. Its purpose is to customize the risk management process to the organization, enabling effective risk assessment and appropriate risk treatment. This involves defining the purpose and scope of the process, understanding the context, planning the approach to be taken and defining the criteria for evaluation.

Risk criteria are the basis for risk-based decision-making and action taken. Specifically, they are the criteria to determine 1. how risk is to be analyzed; 2. outputs required from the analysis; and 3. the most appropriate risk management techniques to be used. Risk criteria are the defined reference points and measurements used to evaluate and compare against the risk levels determined in the risk analysis. To help demonstrate how the risk management process can be applied to a pandemic scenario, the following case study is provided.

Case Study

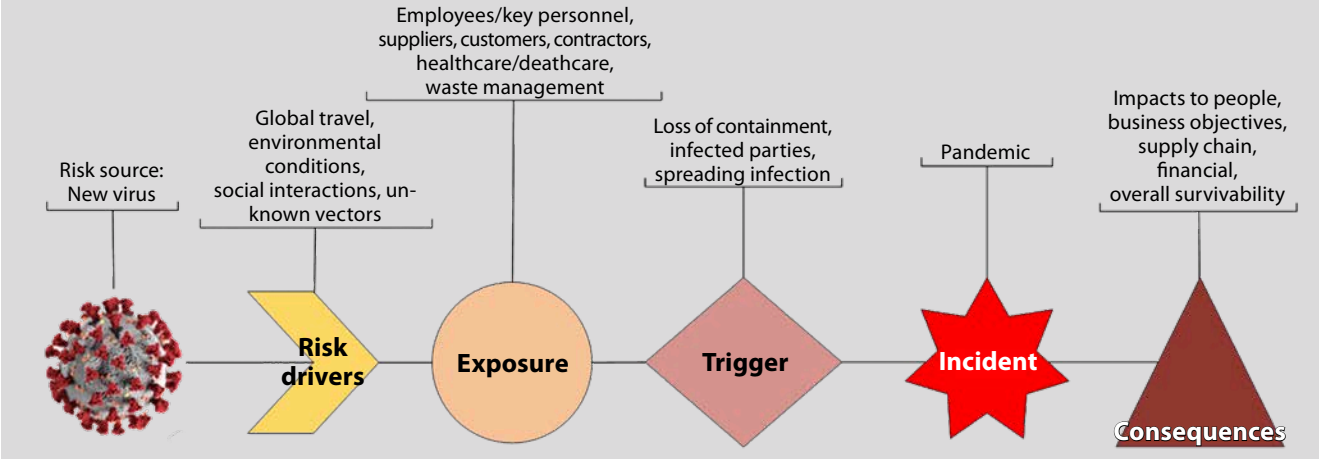
A U.S. company producing respirators and other supplies was concerned about rising production costs. As a result, the company considered outsourcing 50% of its production to a manufacturer in China. As part of the arrangement, the organization would need to send a team overseas to train the personnel in the Chinese facility. In light of the COVID-19 pandemic, the organization decided to send a team of experienced risk assessors to perform a risk assessment using established risk criteria including a 5x5 risk matrix (Figure 4, p. 35).

FIGURE 2
THE RISK CONTINUUM



Note. Adapted from "COVID-19: The Role of the Risk Management Process and Its Impact on Pandemics," by B.K. Lyon and G. Popov, 2020a.

FIGURE 3
THE RISK PATHWAY OF COVID-19



Note. Adapted from "COVID-19: The role of the risk management process and Its impact on pandemics," by B.K. Lyon and G. Popov, 2020a.

Considering the complexity and nature of the risks, the team reviewed the methods found in ISO 31010 and ASSP's TR-31010-2020 technical report, "Risk Management—Techniques for Safety Practitioners" (Figure 5) and decided upon a modified what-if method called structured what-if risk assessment (SWIFRA). SWIFRA expands the "what-if" questions to include "how" and "why," as well as incorporates risk estimations, evaluation and recommended risk treatments (Lyon & Popov, 2020c). A portion of the resulting risk assessment is shown in Figure 6 (p. 36).

One risk-reduction measure identified by the team was daily disinfection of surfaces. Because of its low cost and ready availability, bleach was initially suggested by the purchasing department as the disinfectant solution. Unfortunately, the purchasing manager did not consult with the production manager and was not aware that bleach may damage sensitive equipment. Also, under certain conditions bleach can create chlorine gas.

Other OSH risks were considered. A common complaint during the winter months was minor respiratory irritation due to low relative humidity. However, such minor issues were not considered a priority since relative humidity and temperature are not regulated and there are no OSHA standards related to indoor office temperature. Note: OSHA

FIGURE 4
RISK MATRIX

Incident outcomes				Likelihood of occurrence				
				1	2	3	4	5
Severity rating	Health effects (people)	Property damage	Environmental impact	Very unlikely	Unlikely	Possible	Likely	Very likely
5	Death or permanent total disability	Catastrophic damage	Significant impact	5	10	15	20	25
4	Permanent partial disability; hospitalizations of three or more people	Severe damage	Significant but reversible impact	4	8	12	16	20
3	Injury or occupational illness resulting in one or more days away from work	Significant damage	Moderate reversible impact	3	6	9	12	15
2	Injury or occupational illness not resulting in lost workdays	Moderate damage	Minimal impact	2	4	6	8	10
1	First aid only; no injuries or illnesses	Light damage	No impact	1	2	3	4	5
Very high risk = 15 or greater; high risk = 9 to 14; moderate risk = 5 to 8; low risk = 1 to 4								

Note. Reprinted from "Managing Risk Through Layers of Control," by B.K. Lyon and G. Popov, 2020, *Professional Safety, 65*(4), p. 30.

(n.d.) recommends that employers maintain workplace temperatures in the range of 68 to 76 °F and humidity control in the range of 20% to 60%. According to an OSHA (2003) interpretation letter, "office temperature and humidity conditions are generally a matter of human comfort rather than hazards that could cause death or serious physical harm. OSHA cannot cite the general duty clause for personal discomfort." Controls for worker exposure inside the facility concerning infectious diseases were evaluated using a simplified layers of protection analysis (Figure 7, p. 36).

A brainstorming session was conducted by a cross-functional team to consider the additive effects of lower-level risks. It was determined that using bleach presented a secondary risk since chlorine affects the respiratory system, weakening humans' natural defenses. In addition, low humidity (relative humidity = 11%) can dry out the mucus that normally coats the nose and airways, making it easier for the virus to enter the body and cause infection. Considering these additive effects, the team estimated that the combined risk to be "very high" (Figure 8, p. 37). To communicate the "big picture" to upper-level management, the team presented its findings in a striped bow-tie risk assessment (Figure 9, p. 37).

Managing the Risks of a Pandemic

As demonstrated in the case study, the potential effect of combined or whole-sys-

FIGURE 5
RISK MANAGEMENT PROCESS ASSOCIATED METHODS

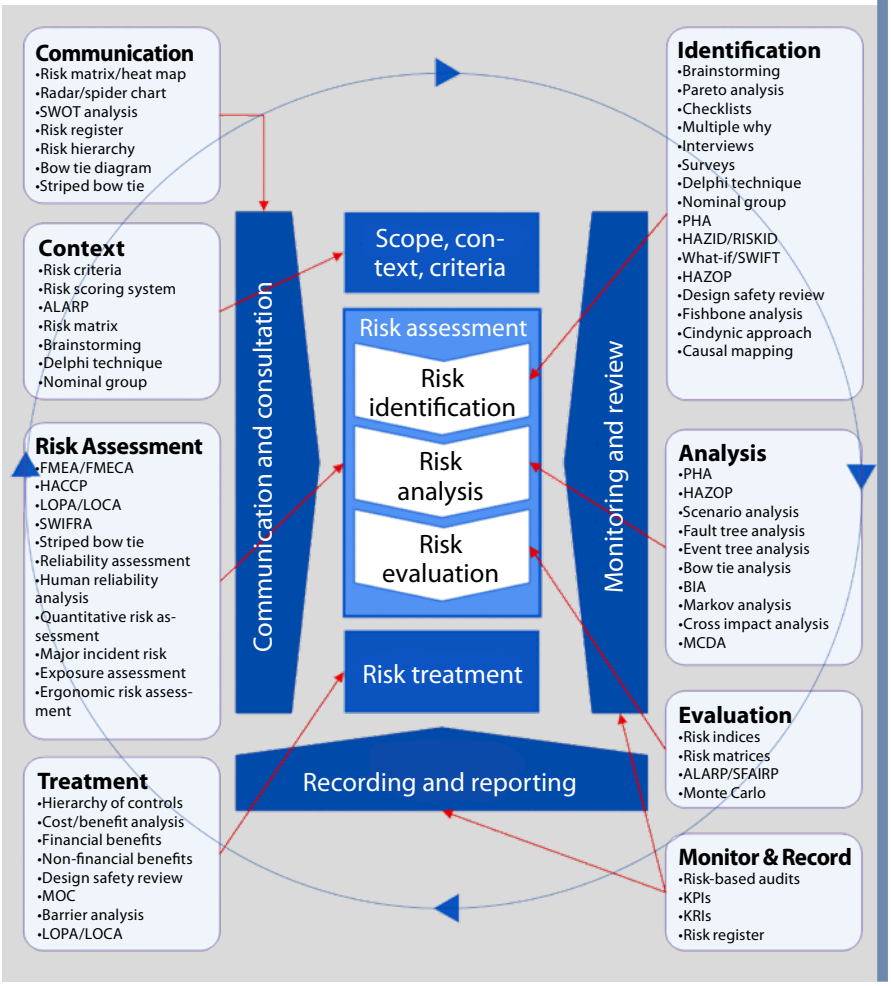


FIGURE 6

STRUCTURED WHAT-IF RISK ASSESSMENT (SWIFRA)

#	What if . . .	How can this occur?	Why can it occur?	Controls	L	S	Risk level	Risk level acceptable (Y/N)	Additional controls	L 2	S 2	Risk level 2	% RR
1	The operator is exposed to COVID-19? Answer: Probable severe illness	Operator travel to China (hot zone) to train operators	Operator does not take precautions while training workers	Hygiene and training	3	4	12	No	Physical distancing, face coverings, self-quarantine for 14 days and doctor's release before returning to work	1	4	4	67%
2	An infected operator returns to workplace undetected. Answer: Possible multiple exposures and illnesses	The median incubation period for COVID-19 is just over 5 days	No quarantine period; no temperature checks or testing	Hygiene and training	3	5	15	No	Physical distancing, face coverings, self-quarantine for 14 days and doctor's release before returning to work	1	5	5	67%
3	Multiple operators become ill due to COVID-19 exposure. Answer: Possible multiple fatalities and illnesses, business interruption	The median incubation period for COVID-19 is ignored; no quarantine	Emerging risk, organization is not fully aware of the need to quarantine potentially infected employees	Hygiene and training	3	5	15	No	Physical distancing, face coverings, self-quarantine for 14 days and doctor's release before returning to work; disinfect work surfaces daily	2	5	10	33%

Note. Reprinted from "COVID-19: The role of the risk management process and Its impact on pandemics," by B.K. Lyon and G. Popov, 2020a.

FIGURE 7

LAYERS OF PROTECTION ANALYSIS OF COVID-19

Event	Cause	Consequence	Current layers of protection (LOP)		Current state - existing LOP RL		
			1	2	Severity	Likelihood	Risk level
Potential COVID-19	COVID-19 exposed operator	Workers exposure	Admin (clean with bleach)		5	2	10
Low RH=11%	HVAC not properly operating	Minor respiratory irritation	None		2	1	2
Chlorine exposure	Cleaning with bleach	Minor respiratory irritation	None		3	1	3

Note. Adapted from "COVID-19: The role of the risk management process and Its impact on pandemics," by B.K. Lyon and G. Popov, 2020a.

tem risk is often greater than its individual risks. If risks are analyzed individually without considering additive (summation) effects, the whole-system risk can be underestimated.

A single control is rarely adequate. To effectively reduce risk, both preventive and mitigative measures must often be used (Lyon & Popov, 2020b). Using a hierarchy of risk treatment model such as the one shown in Figure 10 (p. 38), layers of control should be selected and applied to effectively reduce and maintain risk at an acceptable level.

In terms of a pandemic, layers of multiple control methods are necessary to adequately reduce the risk. This can be illustrated using the risk pathway model for the COVID-19 scenario presented in Figure 11 (p. 39). In the model, the risk control strategies are applied in layers to both 1. prevent exposure; and 2. mitigate the impact. The layers of control for the COVID-19 pandemic scenario in Figure 11 (p. 39) are briefly explained as follows:

1. Consider avoidance and elimination strategies such as eliminating travel to hot zones and temporarily relocating operations.

2. Substitution may be possible by substituting or replacing the exposure that occurs in office environments with remote or isolated work, use of teleconferencing for in-person meetings, and use of less toxic cleaning and disinfecting chemicals. In addition, the separation of critical personnel may be necessary to ensure business continuity.

3. Incorporate engineering controls to reduce the effects on the business from a pandemic such as COVID-19. Engineering controls might include robust informational technology systems to accommodate relocated workers and protect the organization's data and intellectual property (e.g., VPN, remote access to office files, laptops, antimalware). For healthcare and other essential operations that remain open, good ventilation systems equipped with high-efficiency particulate air filtering and 50% relative humidity, use of ultraviolet light systems to disinfect surfaces, and isolation of infected patients in controlled environments from the general population may be needed.

FIGURE 8

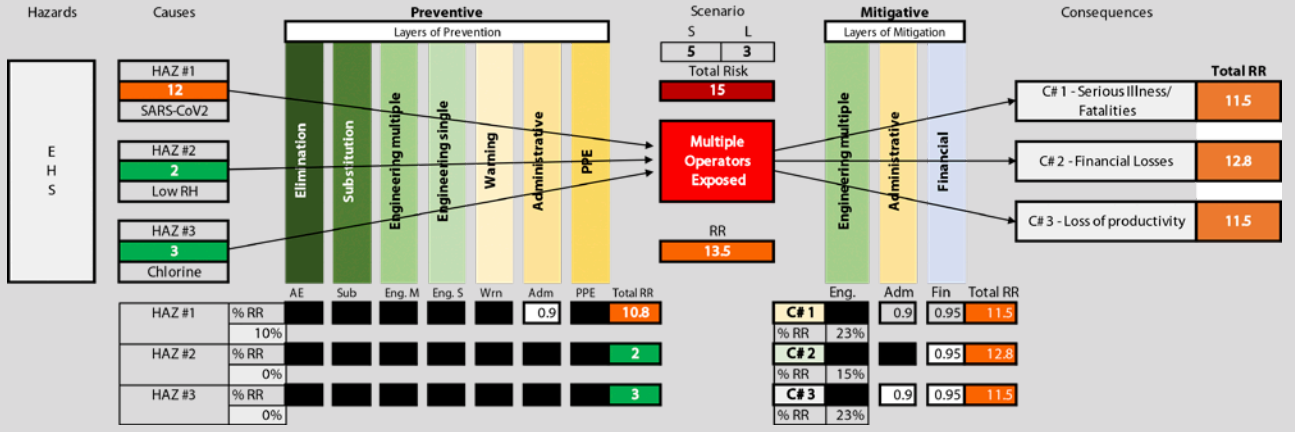
LAYERS OF PROTECTION RISK SUMMATION FOR COVID-19

Event	Cause	Consequences	Current layers of protection (LOP)		Current state - existing LOP RL			Combined consequences	Combined risks			RR
			1	2	Severity	Likelihood	Risk level	Top Event	S	L	Risk sum	CS C
Potential COVID-19	COVID-19 exposed operator	Workers exposure	Admin (clean with bleach)		5	2	10	Multiple operators exposed	5	3	15	14
Low RH=11%	HVAC not properly operating	Minor respiratory irritation	None		2	1	2					
Chlorine exposure	Cleaning with bleach	Minor respiratory irritation	None		3	1	3					

Note. Adapted from "COVID-19: The role of the risk management process and Its impact on pandemics," by B.K. Lyon and G. Popov, 2020a.

FIGURE 9

STRIPED BOW-TIE RISK ASSESSMENT CURRENT STATE



Note. Adapted from "COVID-19: The role of the risk management process and Its impact on pandemics," by B.K. Lyon and G. Popov, 2020a.

4. Consider administrative measures and procedures such as limiting public exposure, physical distancing, training in proper hygiene, use of thermal imaging cameras to detect elevated body temperatures and frequent cleaning of surfaces.

5. PPE such as N95 face masks, eye protection and impermeable gloves for those who have a potential of exposure to infection is required.

From a mitigative standpoint, plans developed well in advance of an event should be activated during the pandemic to reduce the impact of consequences. These include business continuity plans, communication and employee assistance plans, crisis management plans, and access to emergency funds. These layers of control work in concert to reduce the overall impact to the organization and help ensure resiliency.

These layers of control can be entered into the layers of control analysis, which includes a risk assessment of preventive and mitigative risk reduction. An example is presented in Figure 12.

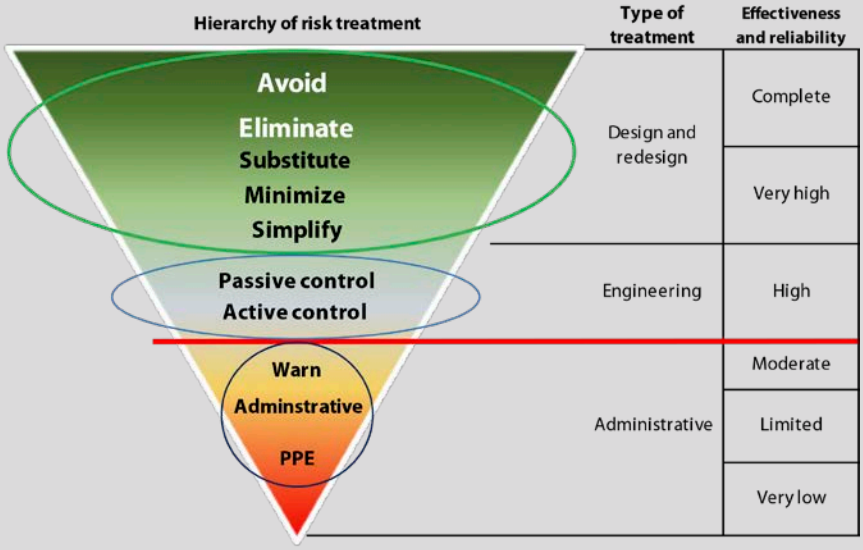
With this information, the risk management team can provide more details in their risk treatment plans. For example, by increasing the relative humidity, a reduction of respiratory system dryness and irritation is achieved leading to less coughing in the workplace. Nasal systems and mucous membranes are more sensitive to infections at very low relative humidity of 10% to 20% and, therefore, additional humidification in winter seasons is sometimes suggested. In fact, recent studies state that low humidity "prevented cilia, which are hairlike structures in airways cells, from removing viral particles and mucus. It also reduced the ability of airway cells to repair damage caused by the virus in the lungs" (Yale University, 2019).

Lessons can also be learned from environmental remediation companies regarding the substitution of bleach with less toxic and equally or more effective disinfectants. In fact, EPA-registered products often used in mold remediation are proven to be effective against human coronaviruses. By substituting bleach with EPA-registered fungicides or disinfectants, the potential for chlorine exposure is eliminated, leading to less respiratory irritation and less coughing.

Better filtration, physical distancing, separation of critical personnel and operations using two shifts instead of one, and PPE should be considered. Having two shifts will

FIGURE 10

HIERARCHY OF RISK TREATMENT MODEL



Note. Reprinted from "Moving Risk Assessment Upstream to the Design Phase," by B.K. Lyon and G. Popov, 2019, *Professional Safety, 64*(11), 32.

enable sufficient distance between workers (having more space) and business continuity. If one shift becomes infected and quarantined, the other can continue to produce critical supplies.

Infectious Disease Preparedness & Response

The risk of an infectious disease outbreak, epidemic or pandemic in the workplace must be managed so that an organization can continue to protect its employees, operate safely and achieve its objectives. This requires that the organization develop an infectious disease preparedness and response plan ahead of time with internal trigger points for implementation and response. Such a plan should be developed in accordance with guidance from CDC and OSHA as well as state and local agencies, medical experts and key personnel (e.g., legal, human resources, insurance, customers, distributors, suppliers, other key stakeholders). In addition, the plan should be integrated into the organization's safety and health management system, and business continuity, crisis management and communication plans.

Key elements in an infectious disease preparedness and response plan might include roles and responsibilities, exposure assessment, infectious disease task force, safety protocols, exposure response actions, recordkeeping and reporting, and plan review.

Roles & Responsibilities

Both managers and employees have important roles in providing and maintaining a safe workplace during infectious disease outbreaks. A breakdown of the responsibilities for leadership and employees concerning infectious disease prevention, communication and action plans should be defined and effectively communicated.

Exposure Assessment

OSHA (2020) outlines steps employers should take to protect the safety and health of their workforces including the development of an infectious disease preparedness and response plan. The plan should consider and address the level of risk associated with various work sites and tasks workers perform by the organization (Figure 13, p. 40). The following risk category classifications should be used to guide the details of the response plan (OSHA, 2020):

- Very high exposure risk groups include healthcare workers (e.g., doctors, nurses, dentists, paramedics, emergency medical technicians) performing aerosol-generating procedures (e.g., intubation, cough induction procedures, bronchoscopies, some dental procedures and exams, invasive specimen collection) on known or suspected COVID-19 patients, and healthcare or laboratory personnel collecting or handling specimens from known or suspected COVID-19 patients.
- High exposure risk jobs include healthcare delivery and support staff (e.g., doctors, nurses, hospital staff who must enter patients' rooms) exposed to known or suspected COVID-19 patients, and medical transport workers moving known or suspected COVID-19 patients in enclosed vehicles.
- Medium exposure risk jobs include those that require frequent or close contact (i.e., within 6 ft) with people who may be infected with COVID-19 but who are not known or suspected COVID-19 patients. In areas where the COVID-19 virus has been identified, this may include workers who come in contact with the public, including in schools or retail settings.
- Lower exposure risk jobs are those that do not require contact with people known to be or suspected of being infected with COVID-19 nor frequent close contact with the general public.

In addition to consideration of workers' risks, the plan should take into account contingencies that may arise during outbreaks, including:

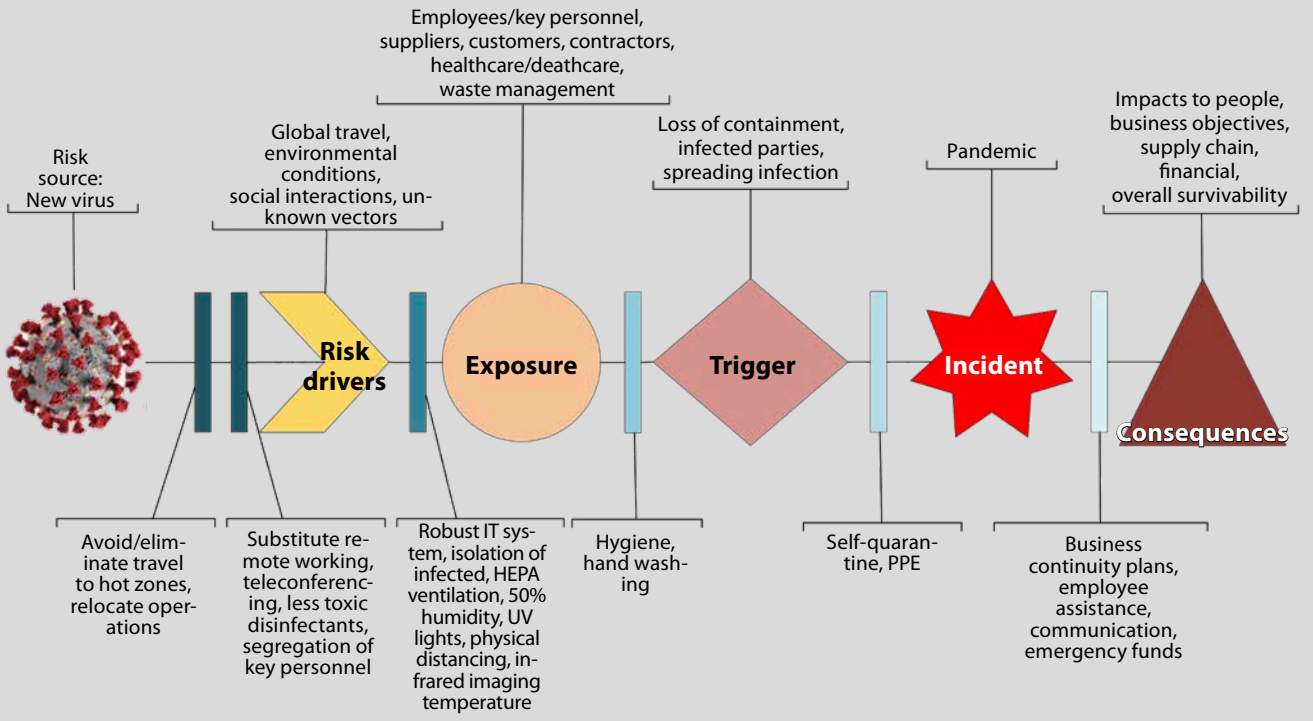
- increased rates of worker absenteeism
- the need for social distancing, staggered work shifts, downsizing operations, delivering services remotely and other exposure-reducing measures
- options for conducting essential operations with a reduced workforce, including cross-training workers across different jobs to continue operations or deliver surge services
- interrupted supply chains or delayed deliveries

Infectious Disease Task Force Team

The plan should establish a cross-functional team responsible for guiding and overseeing workplace protocols to control the spread of infectious diseases such as COVID-19. The team should include key members from senior management, human resources, legal, facilities, operations, key employees and other

FIGURE 11

THE RISK PATHWAY OF COVID-19



Note. Adapted from "COVID-19: The role of the risk management process and Its impact on pandemics," by B.K. Lyon and G. Popov, 2020a.

FIGURE 12

LAYERS OF CONTROL ANALYSIS OF COVID-19

Event	Cause	Consequence	Additional LOP 2	3	4	5	6	7	Combined risks FS S	L	Risk sum	LOMA Engineering layers	Admin layers	Financial layers	Consequence	Risk reduction LOMA E RM	A RM	F RM	Residual risk
Potential COVID-19	COVID-19 exposed operator	Workers' exposure	TI camera: Temp check	Social distancing/ warning	Ventilation with MERV 16	Separation two teams/two shifts	Deep clean between shifts	PPE				Isolation	Quarantine and return to work	First layer $100K retention	Serious illness and/or fatalities	0.7	0.9	0.95	**2.99**
Low RH=11%	HVAC not properly operating	Minor respiratory irritation		Increase RH to 50-55%					5	1	**5**		Business continuity plan	Second layer $500K to primary	Financial losses		0.9	0.95	**4.28**
Chlorine exposure	Cleaning with bleach	Minor respiratory irritation	Substitute less toxic cleaner										Temporary workers	First layer $1M to excess carrier	Loss of productivity		0.9	0.95	**4.28**

Note. Adapted from "COVID-19: The role of the risk management process and Its impact on pandemics," by B.K. Lyon and G. Popov, 2020a.

stakeholders. The team should consider and select appropriate control measures to prevent and reduce the risk of infectious disease exposures in the workplace as outlined by OSHA. These options include:

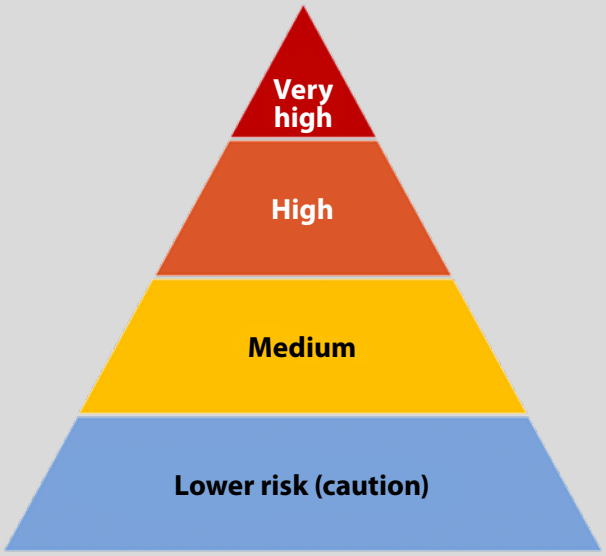
1. avoidance and elimination such as avoiding travel to high-risk areas and eliminating face-to-face meetings
2. substitution of less harmful substances or methods such as replacing chlorine bleach cleaner with an EPA-registered disinfectant and teleconferencing rather than in-person meetings
3. engineering controls such as air filters, increased ventilation and physical barriers
4. administrative controls such as requiring sick workers to stay home, minimizing contact among workers by avoiding face-to-face meetings, discontinuing nonessential travel and creating emergency communication plans
5. safe work practices such as promoting personal hygiene practices (handwashing)
6. PPE such as gloves, face masks, goggles and respiratory protection, when appropriate

Safety & Health Protocols

An important part of the plan are formal safety and health protocols for employees, as well as contractors, customers and other third parties to be implemented in the event of an outbreak. These protocols should incorporate the layers of control using the hierarchy of risk treatment. Such protocols include general safety and health practices

FIGURE 13

OSHA's OCCUPATIONAL RISK PYRAMID FOR COVID-19



Note. Adapted from "Guidance on Preparing Workforces for COVID-19 (Publication No. 3990-03-2020)," by OSHA, 2020.

Because the uncertainty from a global pandemic can significantly affect organizations, it is critical to be prepared for such risks in advance.

(as outlined by CDC, OSHA and this article); policies for avoiding exposure (e.g., travel bans, remote work); sanitation, disinfection and hygiene; facility and workstation physical modifications and engineering controls; administrative policies; PPE supplies and use; policies for managing contractors, visitors and third parties; training and monitoring; and other related protocols.

Exposure Response, Recordkeeping & Reporting

The plan should outline guidance for how the organization will respond to employee exposure and infection, and establish protocols for quarantine, medical testing and return-to-work procedures. Recording and reporting work-related exposures should be included in the plan, adhering to federal, state and local requirements.

Conclusion

Because the uncertainty from a global pandemic can significantly affect organizations, it is critical to be prepared for such risks in advance. As part of an organization's business continuity planning, risk assessment and risk management methods should be used to address pandemic level risks such as COVID-19.

Rarely is one control method adequate in preventing or protecting people, property or environment from harm. The layering of controls and defenses has been used throughout the years and has proven to be effective in reducing the risk from multiple threats. OSH professionals should consider this approach for the workplace when analyzing and designing risk reduction measures by including both preventive and mitigating controls. Using methods such as what-if analysis, SWIFRA, bow-tie diagraming, and layers of control analysis to analyze control effectiveness and estimate risk summation can help OSH professionals identify weaknesses and needs for building additional layers of control. **PSJ**

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