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A Framework for Sustainable Contact Tracing and Exposure Investigation for Large Health Systems

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Abstract

Contact tracing is a cornerstone of communicable disease containment and involves identifying, quarantining, and monitoring contacts of infected people. Although contact tracing is a known evidence-based strategy in the community setting, the COVID-19 pandemic highlighted the challenges to implementing labor-intensive contact tracing in the occupational setting of large health care systems and hospitals, the epicenter of the pandemic. We present a framework for feasible, scalable COVID-19 contact tracing in a large multistate health system in the United States employing approximately 69,000 health care personnel. The framework is shared with sufficient details to allow adoption or adaptation by other health systems. Continuous enhancement, optimization, and evaluation of the framework are ongoing.

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Contact tracing, a cornerstone of communicable disease containment, involves identifying, quarantining, and monitoring contacts of infected people.¹ Although contact tracing can be resource- and time-intensive, it is also recognized as critical to keeping communities safe and operational.²⁻⁴ Modelling studies suggest that because COVID-19 transmission can occur before symptoms become apparent, contact tracing and quarantining exposed individuals can control a COVID-19 outbreak within 3 months in most cases.⁵ Without immediate contact tracing, transmission in group settings can be widespread. An example is a call center with more than 40% of exposed staff developing COVID-19.⁶ Furthermore, some countries that stopped contact tracing due to high prevalence are now resuming this strategy to reduce the impact of an anticipated second wave of COVID-19.⁷

Despite its utility in containing outbreaks, many health care professionals (HCPs) are not familiar with the principles

of contact tracing or how to effectively implement it. One study showed that more than half of HCPs were not familiar with the contact tracing process early in the Ebola response.⁸ Another study of urgent care providers in Utah and southern Idaho also has shown the majority not knowing the prevention and control measures performed by public health practitioners after reporting occurs, including contact tracing.⁹ In addition, although contact tracing in the community is a clear and evidence-based strategy in times of epidemics, it can be challenging to apply this strategy efficiently in the occupational setting of large and complex health care organizations. In the United States, there are large health systems with hospitals that employ tens of thousands of HCPs. It is extremely resource-intensive to implement contact tracing in these settings, yet it is a critical issue because these hospitals have become the epicenter of the fight against the COVID-19 pandemic. Even the Centers for Disease Control and Prevention has acknowledged that some facilities may lack

the resources necessary to maintain contact tracing of HCPs.¹⁰ Therefore, we present a framework for COVID-19 contact tracing that was implemented in a large multistate health system in the United States. The framework is shared with sufficient detail to allow timely adaptation and adoption by other health systems.

METHODS

We developed the new contact tracing approach following quality improvement principles. The approach consisted of describing the current state, identifying relevant stakeholders, and applying continuous cycles of improvement in which the intervention was modified based on stakeholder feedback.

Setting

Mayo Clinic is comprised of three major campuses located in Rochester, Minnesota; Jacksonville, Florida; and Phoenix, Arizona; as well as multiple Mayo Clinic Health System hospitals and clinics throughout the Midwest in Minnesota and Wisconsin employing approximately 69,000 HCPs. Greater than 1,200,000 patients are seen per year from all 50 states and 138 countries. The employee Occupational Health Service (OHS) is structured so that each of the three main campuses and each of the four Mayo Clinic Health System regions provide occupational services and programming tailored to their local needs with collaborative administrative support and a single unified occupational health database.

The Existing Process Before the Pandemic

Accurate and thorough occupational contact tracing is labor intensive. With prior contact tracing and exposure investigations, processes were largely focused on patient-to-HCP exposures. In this scenario, most exposed HCP could be identified by reviewing the electronic medical record (EMR) and using its integrated tracing tool. With community spread of COVID-19, approximately 50% of occupational exposures involved a coworker as the source. With relatively mild symptoms and absence of fever being

common, COVID-19–positive individuals may be unaware that they are possibly infected.

Our existing contact tracing process relied upon detailed interviews performed by OHS to identify HCPs who may have had contact with an infected individual during the communicable period. Applying this process to COVID-19, OHS staff spent up to 45 min interviewing a COVID-19–infected individual to obtain details of their activities at work and a list of HCPs with whom they had close contact. It became readily apparent that employees have numerous interactions with coworkers throughout the day, many in close proximity (<6 ft) for extended periods.

Contact tracing was not only lengthy and labor-intensive for HCP-to-HCP exposures, but also for patient-to-HCP exposures. Because the EMR captures only personnel who documented their interaction with a patient, the EMR may miss many individuals exposed to a patient such as students, residents, techs, or others who did not document on the patient's chart. For exposures that do not involve a patient as the source, contact tracing tools in the EMR cannot be used at all as interactions outside of patient care are not documented in the EMR. For both patient and HCPs who were communicable for COVID-19, interviews with the supervisor of a work area such as a nurse manager often uncovered additional HCP who were potentially exposed.

Once the list of potential contacts of a COVID-19–infected person was obtained, a small team of OHS staff would begin making calls to potentially exposed HCPs. Each call took approximately 15 to 20 minutes to establish contact, explain the cause for concern of exposure, obtain information on proximity of interaction, duration of contact, and whether personal protective equipment (PPE) such as a surgical mask and/or face shield was worn, determine the risk level of the exposure, and counsel the employee accordingly. Following the phone call, additional tasks are needed depending upon the findings of the interview. These may include recommending quarantine, enforcing it through work restrictions, and enrolling

the exposed HCP in an ongoing monitoring program of self-monitoring or active monitoring depending upon the exposure risk level. With self-monitoring, HCPs monitor for fever or symptoms twice daily, reporting to OHS if symptoms occur; active monitoring involves twice-daily communication with OHS verifying the presence or absence of fever or symptoms. For a team of two OHS staff members, an exposure incident with 30 potentially exposed HCP would take more than 5 hours to obtain the contact list, call all potentially exposed HCP, and perform appropriate follow-up. This does not include additional time spent in communication with supervisors and department managers or responding to calls from unexposed but concerned coworkers. Thus, with COVID-19, it quickly became apparent that existing processes developed to perform contact tracing for exposures to HCPs would not be scalable.

Resources and Principles

To identify a scalable and sustainable solution, Mayo Clinic mobilized a large team to bring programming, project management, and administrative expertise to collaborate with OHS to address contact tracing needs.

Clinical guidance and recommended precautions are based upon input from Mayo Clinic Infection Prevention and Control, State and Local Health Departments, institutional policy, and applicable employment law. Throughout this evolving pandemic, occupational health professionals have been fully engaged in the institution's pandemic response planning to ensure that exposure mitigation strategies applied to personnel are aligned with current best practices and institutional priorities. We believe these efforts are critical to flattening the curve of COVID-19-positive cases as well as ensuring the safety and health of both patients and employees.

Because of an exponential increase in COVID-19 cases predicted by epidemiologic modeling, the team identified a need for advanced tools to enable timely and scalable occupational contact tracing. Tools developed for community contact tracing were

reviewed, and although these tools may be useful in the community setting, they were not adopted because they do not capture the complexity of the health care environment. Contact tracing in the health care setting must be:

- Proactive — Employers cannot rely on HCPs to adopt technology and self-report exposures.
- Rapid — OHS must notify potentially exposed HCP quickly at any time of the day or night. COVID-19's incubation period may be as short as 1 day, so HCP must be assessed before their next shift.
- Thorough — Facilities must be able to identify exposed HCPs in any area of the hospital/clinic/campus regardless of whether they documented their encounter in the EMR.
- Specific — Although electronic community tracing technology can identify physical proximity, this tracking is typically two-dimensional; multistory buildings such as health care centers require the ability to identify proximity in three dimensions.
- Uniform — The process should support contact tracing whether the source is a patient or an HCP.
- Simultaneous — For efficiency, the process must allow different team members (non-clinical staff, providers, and nurses) to work in parallel on different steps in the exposure assessment and contact tracing process.
- Integrated — Engagement with Infection Prevention and Control and use of all available resources, including any available EMR tracing tools for COVID-19-positive patients, is important.

The New Approach (Mayo Clinic Contact Tracing Process 2.0)

Following the identification of an employee or patient who is found to be COVID-19-positive, Mayo Clinic now uses a uniform process to perform contact tracing at all sites, with some core components centralized in Rochester, Minnesota, for efficiency. The framework developed for this approach is presented in

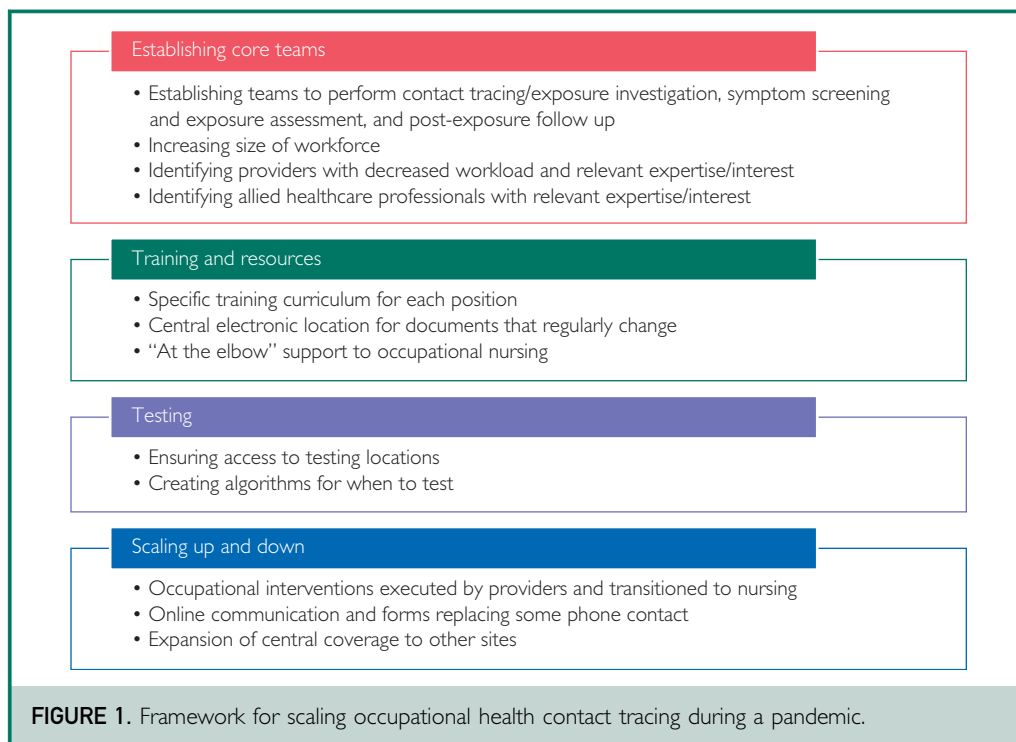


Figure 1. This process starts with identification of the source patient or HCP, and interactions to ascertain the potential for contact with other HCPs. A Rochester-based OHS clinician serves as an Exposure Triage Provider (ETP) whose role is to evaluate each potential exposure and initiate the contact tracing process. Contact tracing is partially delegated to responsible parties at the site of the exposure by sending electronic contact logs to appropriate supervisors, unit managers, or onsite Occupational Health and Infection Prevention and Control (IPAC) Partners. Timely completion of electronic contact logs is monitored and facilitated by a Non-Clinical Call Center (NCCC) in Rochester. Risk assessment of exposed HCPs is performed by a Rochester-based Exposure Investigation Team (EIT) consisting of physicians and advance-practice providers. These centralized teams (the ETP, EIT, and NCCC) operate 24 hours/7 days a week to ensure efficient and timely contact tracing and exposure assessment.

After the individual’s exposure has been assessed, occupational health nursing teams issue and manage work restrictions, arrange

testing for any symptomatic personnel, initiate active monitoring when indicated, and provide additional education. A toll-free Employee COVID-19 Help Line staffed by nurses has been created to help employees at all sites address COVID-19 occupational health concerns.

COVID-19—POSITIVE PATIENT PROCESS

Whether the source individual is a patient or an HCP, the local OHS team and the Rochester-based ETP collaborate to investigate potential exposures. When the source individual is a patient, OHS leaders partner with their local IPAC colleagues to assess exposure and identify potentially exposed HCP. The EMR is reviewed to create an initial list of employees who have documented in the patient’s record. The local OHS team works with IPAC to populate the electronic contact log, or may delegate completion of the log to a nurse manager at their site. Names of additionally exposed HCP identified by nurse managers and the patient care team are added to the log when applicable. Completed contact logs are submitted electronically and received centrally in Rochester,

which initiates the process of notifying and assessing potentially exposed HCPs.

COVID-19—Positive HCP Process

OHS is notified of a COVID-19—positive lab result by notification from IPAC, public health partners, or by self-reporting on the part of the infected worker. The ETP must then ascertain the communicable period of the HCP and the potential for coworker exposures. Two options exist for this function: the ETP may personally interview the individual, or may opt to trigger an email containing instructions for the individual to complete a secure online self-assessment form with pertinent details including symptom onset and dates worked. If the second option is chosen, the NCCC calls the employee to alert them to the form and assists in filling out the form if the employee is too unwell or has difficulty accessing their email from home. If the employee is well enough and willing to assist in identifying potentially exposed coworkers, the ETP may send them a contact log as well.

Work restrictions are then issued for the source HCP by the Nursing Exposure Follow-up team consistent with guidelines developed by OHS providers in collaboration with state public health departments.

Identification and Notification of Exposed HCP

When it appears that an exposure may have occurred, the ETP creates a new exposure event in the occupational health database including dates that the index case was infectious. A notice is sent to designees such as nurse managers as described above who populate a contact log with a list of HCPs who may have had close contact with the source individual during their communicable period. Population of the list is facilitated by integration with the institution's human resources database so that HCPs can be found using a search feature.

Submitted logs are reviewed for quality purposes by the ETP, who then triggers notification of all potentially exposed HCP on the contact log. These individuals are sent a link to a secure online Exposed Employee Assessment form in which they can verify and clarify

the contact they had with the source individual, note any PPE they wore during the encounter, and report any symptoms they may be experiencing. The benefit to this system is that all potentially exposed employees are notified quickly and simultaneously. The NCCC calls each exposed employee to request completion of the digital form as quickly as possible so that an exposure risk assessment can be performed and work restrictions determined. NCCC staff members are able to populate the assessment form on behalf of the exposed employee if the exposed employee has technical difficulties or requests help. The responses are immediately reviewed by an EIT provider who then calls the exposed employee and determines if their risk of exposure is high, medium, low, or none (Figures 2 and 3). The EIT provider counsels the employee on quarantine, work restrictions, and/or testing as needed, and notifies the Nursing Exposure Team. The Nursing Exposure Team issues work restrictions, sends education, initiates active monitoring, and coordinates testing as indicated based on the EIT provider's assessment.

Completion

During the contact tracing process and exposure investigation, the centralized OHS exposure team remains in contact with the local OHS site. Upon completion of the exposure investigation, OHS sends a summary of the exposure event to the site OHS team for review, which they disseminate to any requesting public health authority. Local OHS providers have access to the occupational health database to monitor progress of an exposure. An overview of the process is summarized in Figure 4.

Groups Involved in Contact Tracing and Exposure Investigation

Four groups are involved in the contact tracing process:

OHS Exposure Triage Provider Team.-

Comprised of physicians and nurse practitioners with expertise in occupational medicine, the ETPs evaluate all newly

EXPOSURE RISK TO A MASKED LABORATORY CONFIRMED POSITIVE COVID-19 PATIENT ^{a,b,c} <i>Contact must be less than 6 feet, greater than 5 minutes</i>		EXPOSURE RISK TO A NON-MASKED LABORATORY CONFIRMED POSITIVE COVID-19 PATIENT ^{a,b,c} <i>Contact must be less than 6 feet, greater than 5 minutes</i>	
Healthcare personnel PPE	Exposure risk category	Healthcare personnel PPE	Exposure risk category
HCP – NONE (No PPE)	Significant (medium) risk	HCP – NONE (No PPE)	Significant (high) risk
HCP - NOT wearing facemask or respirator ^d	Significant (medium) risk	HCP - NOT wearing facemask or respirator	Significant (high) risk
HCP – wearing facemask -AND- NOT wearing eye protection ^e	Low risk	HCP – wearing facemask -AND- NOT wearing eye protection ^e	Significant (medium) risk
HCP – wearing facemask with eye protection ^e -AND- NOT wearing gown or gloves	Low risk	HCP – wearing facemask with eye protection ^e -AND- NOT wearing gown or gloves	Low risk
HCP – wearing all recommended PPE (gown, gloves, mask, and eye protection ^e)	Low risk	HCP – wearing all recommended PPE (gown, gloves, mask, and eye protection ^e)	Low risk

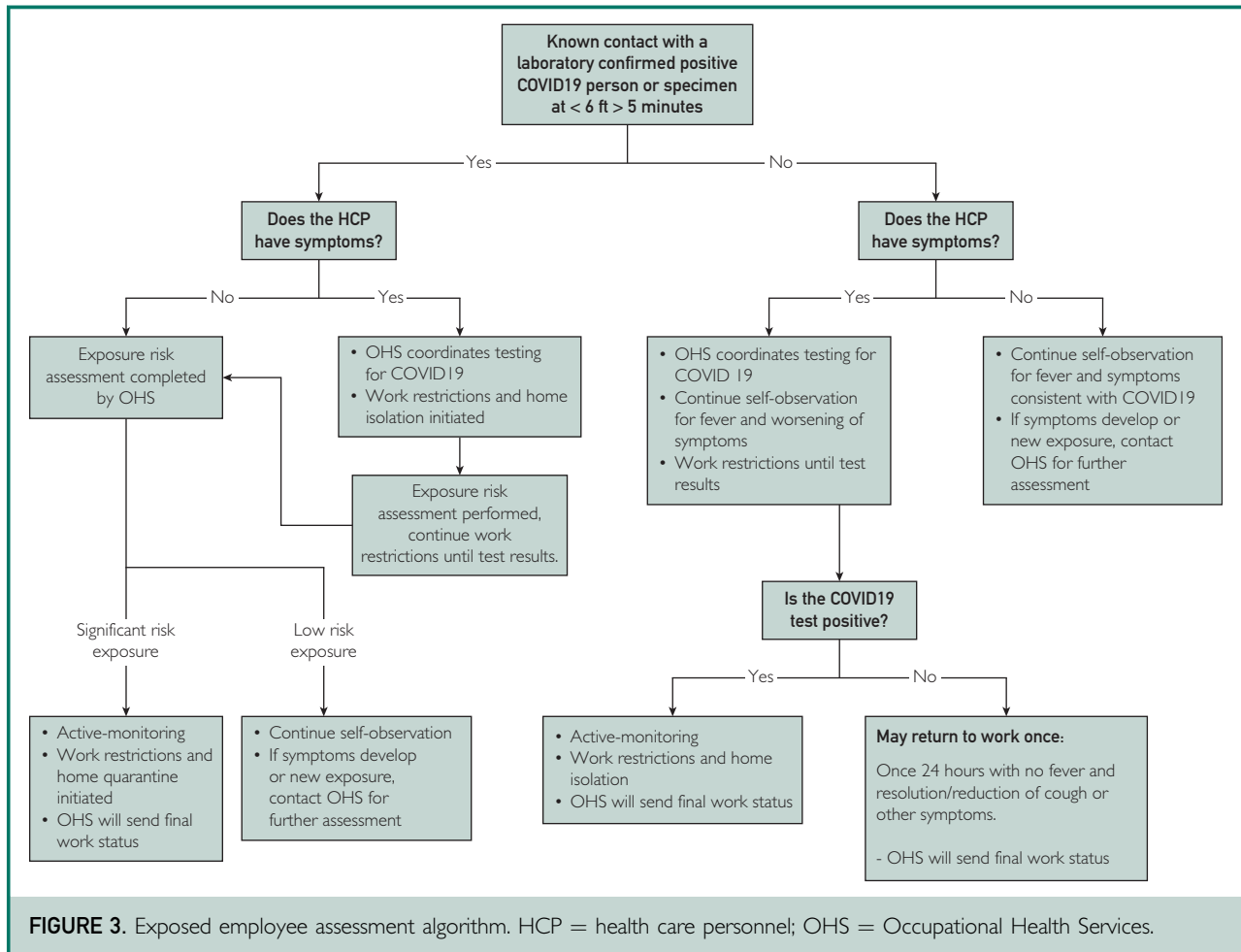
FIGURE 2. Exposure risk to health care personnel (HCP) modified based on personal protective equipment (PPE).
^aThe risk category for these rows would be elevated by one level if HCP performed or were present for a procedure likely to generate higher concentrations of respiratory secretions or aerosols. For example, HCP who were wearing a gown, gloves, eye protection and a facemask (instead of a respirator) during an aerosol-generating procedure would be considered to have a medium-risk exposure.
^bHCP not using all recommended PPE who have only brief interactions (< 6ft, <5min) with a patient regardless of whether patient was wearing a facemask are considered low-risk.
^cHCP who walk by a patient or who have no direct contact with the patient or their secretions/excretions and no entry into the patient room are considered to have no identifiable risk.
^dHCP NOT wearing a facemask or respirator in the role of desk triage, intake staff, reception, scheduling are considered to have LOW risk exposure due to very brief exposure while the patient was wearing a mask.
^eEye protection must be a face shield, safety goggles, or safety glasses.

identified COVID-19—positive patients and HCPs to determine the communicability period (infectious window) and whether the individual exposed others during that timeframe. Once an exposure is identified, the ETP will identify the appropriate individuals to complete a contact log, as outlined above, and triggers dissemination of the contact logs. ETPs also serve as a resource to the EIT and Nursing Exposure Teams.

Non-Clinical Call Center. The NCCC is comprised of non-OHS staff who assist with data collection needs associated with contact tracing. These individuals are redeployed staff

from administrative and laboratory areas. The NCCC provides 24 hours/7 days a week support to any involved HCPs who need assistance with completing an electronic form. When an email is sent to the individual, the NCCC representative calls them to ensure they are able to complete the form in a timely manner. If clinical questions arise during the call, the individual is transferred to the appropriate Nursing Exposure Team based on the location of the employee.

Exposure Investigation Team. The EIT is comprised of physicians and advance practice providers redeployed from the Department of



Medicine. Once the exposed employees complete an Exposed Employee Assessment form, the EIT applies Centers for Disease Control and Prevention and state guidelines to conduct risk assessment and characterize the exposure as high, medium, or low risk. This exposure categorization is then shared with the Nursing Exposure Team as outlined above.

Nursing Exposure Teams. The Nursing Exposure Teams are site-based and address an employee's clinical needs if the employee tested positive for COVID-19, were part of a known exposure and have questions, or would like to inquire about their work status. The Nursing Exposure Team will also issue work restrictions and facilitate testing, as appropriate. Guidelines approved by providers are used for consistency. Provider support for questions

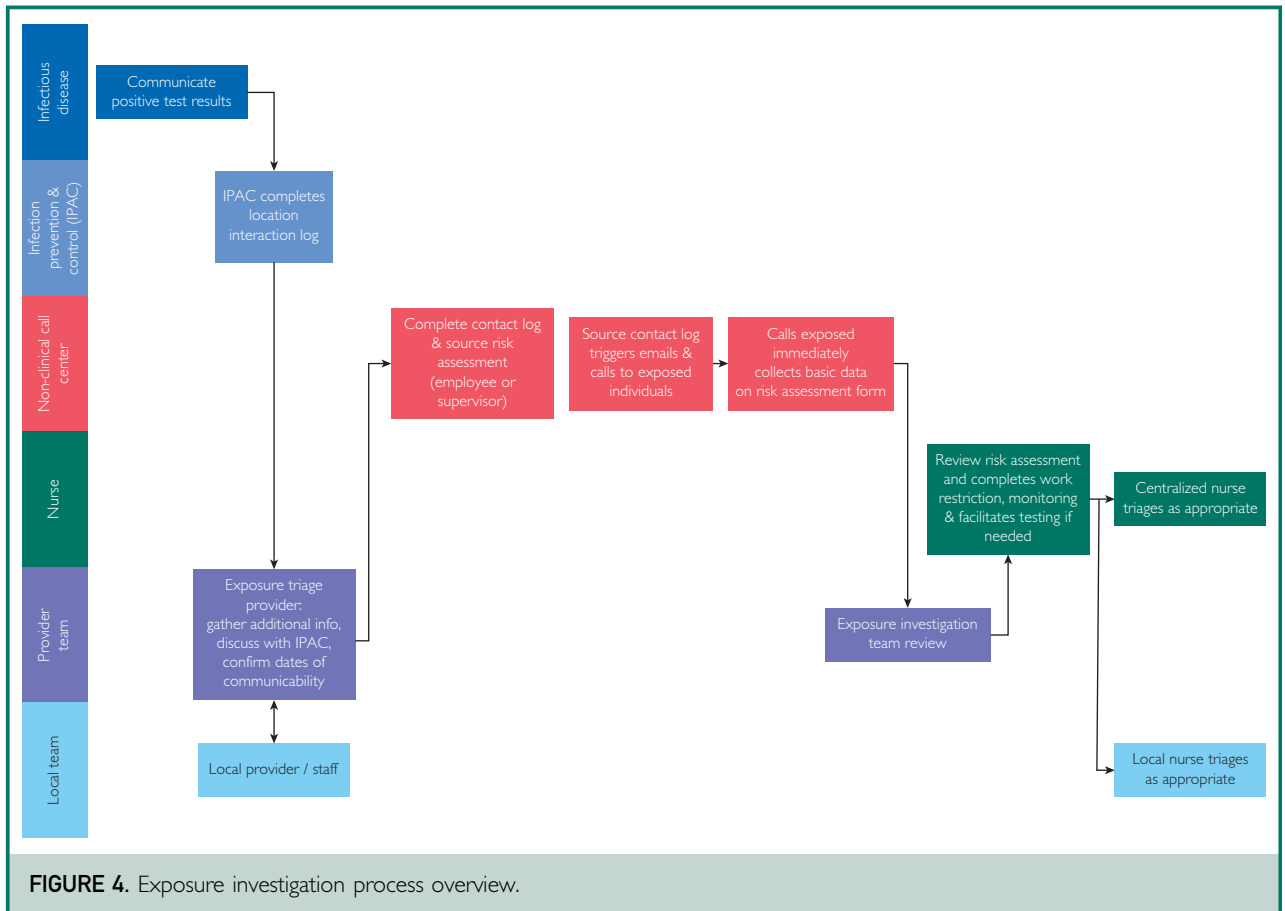
outside of the established guidelines is readily available to the Nursing Exposure Teams.

DIGITAL TOOLS DEVELOPED

Information Technology Systems

The software application used internally by OHS is Occupational Case Management (OCM), a proprietary system. Employees receive notices and submit electronic forms through a portal that is integrated with OCM called the Employee Occupational Health online portal.

The COVID-19 management system is housed within OCM and facilitates launching email notices of potential exposure with links to fill out forms to an unlimited number of employees simultaneously. It also tracks all pending forms so that the NCCC can



follow-up on any forms that have not been completed. With separate queues of work for providers, nurses, and call-center staff, all teams can work in parallel on cases that are in different stages of the workflow.

There is no direct connection to or from the EMR between the OCM database and its digital contact tracing and exposure assessment tools. The system relies on a combination of .NET, Java components, and Sybase.

COVID-19–Positive Self-Assessment Form

If the COVID-19–positive individual is an HCP, they are asked to complete a form that provides essential information to help determine the communicable period and whether potential exposure to others at work may have occurred (Figure 5). The form asks the source individual to check the symptoms that they are currently experiencing (fever, shortness of breath, chills,

etc), asks if they worked while symptomatic, the dates they were on campus, and whether they were previously exposed to a known COVID-19–positive individual.

COVID-19 Exposure Contact Log

The COVID-19 Exposure Contact Log allows supervisors and HCP to identify potential contacts (Figure 6). The contact log is integrated with the human resource system (Lawson) to allow identification of the correct individuals and facilitate electronic access to the exposed individual's contact information including email address and department. In addition to the source employee, trusted stakeholders/delegates (people who have the best front-line information including the ability to identify HCPs who had close contact with the source patient but may not have documented in the EMR) in leadership positions can contribute

EOH Online

Employee Occupational Health Online Services

Employee with Positive COVID-19 Test Form

Instructions

Please complete this form to provide Employee Occupational Health Services with essential information to help determine your infectious window and potential exposure risk to others at work.

If you have any questions, please contact [Employee Occupational Health Services](#).

Name (First Name, Middle Initial, Last Name)	Birth Date (mm-dd-yyyy)	Employee ID	Mayo Clinic Number
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Preferred Phone Number	Preferred Email		
<input type="text"/>	<input type="text"/>		

First date of symptom onset: 


Symptoms you are currently experiencing:

- Fever (100.0F or greater) or subjective fever
- New cough
- Shortness of breath
- Respiratory distress
- Chills
- Myalgia (muscle aches)
- Headache
- Nausea/vomiting
- Diarrhea
- Anosmia (loss of taste or smell)
- Rhinorrhea (runny nose)
- Sore throat
- Fatigue
- Dizziness
- None

Did you work while symptomatic? Yes No

If yes, please list all dates of work, location of work, including 1 - 2 days prior to symptom onset.

Date:  Location:

Date of positive COVID-19 test result: 

Were you previously exposed to a known positive COVID-19 person? Yes No

If yes, please provide the date and who you were previously exposed to:

Date: 

Previously exposed to whom?

Please select all quarantine(s) you were previously under:

- Government
- Public Health
- Occupational Health

Submit

FIGURE 5. Health care personnel with COVID-19 assessment form.

EOH Online
Employee Occupational Health Online Services

COVID-19 Exposure Contact Log Form

Instructions
 Please complete this form to provide Employee Occupational Health Services with essential information on Mayo Clinic personnel who the COVID-19 positive employee or patient may have potentially exposed.

If you have any questions, please contact [Employee Occupational Health Services](#).

COVID-19 Positive Individual's Last Name <input style="width: 90%;" type="text"/>	COVID-19 Positive Individual's First Name <input style="width: 90%;" type="text"/>	Mayo Clinic Number (if Known) <input style="width: 90%;" type="text"/>	Birth Date <input style="width: 90%;" type="text"/>
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COVID-19 Positive Communicable Start Date <input style="width: 95%;" type="text"/>	COVID-19 Positive Communicable End Date <input style="width: 95%;" type="text"/>
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Exposed Employees

Employee Name	Exposure Start	Exposure End
<input style="width: 95%;" type="text"/>	<input style="width: 95%;" type="text"/>	<input style="width: 95%;" type="text"/>
<input style="width: 95%;" type="text"/>	<input style="width: 95%;" type="text"/>	<input style="width: 95%;" type="text"/>
<input style="width: 95%;" type="text"/>	<input style="width: 95%;" type="text"/>	<input style="width: 95%;" type="text"/>
<input style="width: 95%;" type="text"/>	<input style="width: 95%;" type="text"/>	<input style="width: 95%;" type="text"/>
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<input style="width: 95%;" type="text"/>	<input style="width: 95%;" type="text"/>	<input style="width: 95%;" type="text"/>
<input style="width: 95%;" type="text"/>	<input style="width: 95%;" type="text"/>	<input style="width: 95%;" type="text"/>

FIGURE 6. Staff Exposure Contact Log.

to the contact tracing process including unit managers, supervisors, attending physicians, and index case (COVID-19–infected individual) if HCP.

Exposed Employee Assessment Form

Potentially exposed employees receive an email requesting they complete the Exposed Employee Assessment Form (Figure 7). The form allows the individual to provide essential information used to determine their risk of exposure (proximity, duration, and PPE worn). The form asks the potentially exposed employee to check any symptoms

that they are currently experiencing (fever, shortness of breath, chills, etc), whether they work in a patient care setting, and if they have been tested or diagnosed with COVID-19.

DISCUSSION

Contact tracing has been extremely successful in identification and control of other pathogens such as tuberculosis¹¹ and is one of the strategic tools to prevent spread of COVID-19.¹² It has become a key component of COVID-19 containment.¹⁻³ However, knowledge of contact tracing procedures is

EOH Online

Employee Occupational Health Online Services

Exposed Employee Assessment Form

Instructions

Please complete this form to provide Employee Occupational Health Services with essential information to determine your risk of exposure including on any symptoms you may be experiencing. Someone from Employee Occupational Health Services will reach out to you to discuss additional information.

If you have any questions, please contact [Employee Occupational Health Services](#).

Name (First Name, Middle Initial, Last Name)	Birth Date (mm-dd-yyyy)	Employee ID	Mayo Clinic Number
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Preferred Phone Number	Preferred Email		
<input type="text"/>	<input type="text"/>		

Infected Patient

Source Patient Last Name	Source Patient First Name	Mayo Clinic Number	Birth Date
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
COVID-19 Positive Communicable Start Date		COVID-19 Positive Communicable End Date	
05/07/2020 <input type="text"/>		05/08/2020 <input type="text"/>	

Symptoms you are currently experiencing:

- Fever (>100.0F) or subjective fever
- New cough
- Shortness of breath
- Respiratory distress
- Chills
- Myalgia (muscle aches)
- Headache
- Nausea/vomiting
- Diarrhea
- Anosmia (loss of taste or smell)
- Rhinorrhea (runny nose)
- Sore throat
- Fatigue
- Dizziness
- None

FIGURE 7. Exposed Employee Assessment Form.

limited and guidance on how to implement contact tracing in the occupational setting of large complex health systems and hospitals is needed.

With these newly developed electronic tools, additional expertise, and organization into functional teams, we have been able to reduce the time from notification of a COVID-19—positive test result to identification and assessment of any exposed

HCP and completion of the exposure investigation to under 2 hours on average. Key benefits of this process include: 1) the ability to quickly develop a list of potentially exposed employees supported by developing a digital contact log integrated with the human resources demographics database; 2) the ability for multiple teams to work simultaneously on exposure investigations; and 3) centralization and

Do you work in a non-patient care setting (e.g. office setting only)? Yes No

Do you work in a patient care setting? Yes No

If yes, did you have contact at less than 6 feet, greater than 5 minutes with the source patient? Yes No

If yes, please provide the date(s).

Please select if you were wearing any of the following personal protective equipment:

- Gown
- Gloves
- Eye Protection (goggles or eye shield – personal eye glasses do not qualify)
- Surgical Mask
- N95
- PAPR
- None

Did you perform or were you present in the room for a procedure likely to generate higher concentrations of respiratory secretions or aerosols such as cardiopulmonary resuscitation, intubation, extubation, bronchoscopy, nebulizer therapy, open tracheal suctioning, nasotracheal suctioning, non-invasive ventilation (BIPAP/CPAP), heated humidified high flow nasal cannula, upper GI endoscopy, ENT procedures on the upper airway, or sputum induction?

Yes No

If yes, please select the procedure(s):

- Cardiopulmonary Resuscitation
- Intubation
- Extubation
- Bronchoscopy
- Nebulizer Therapy
- Open Tracheal Suctioning
- Nasotracheal Suctioning
- Non-Invasive Ventilation (BIPAP/CPAP)
- Heated Humidified High Flow Nasal Cannula
- Upper GI Endoscopy
- ENT Procedures on the Upper Airway
- Sputum Induction

FIGURE 7. continued

standardization of key pieces of the process (initial investigation, exposure investigation and assessment) with the assistance of electronic tools.

HCP, supervisors, and the OHS team have all expressed that the new process provides added efficiency and integration of standardized processes across the Mayo Clinic enterprise sites and has improved support to exposed employees. This process and its electronic tools make scalable contact tracing feasible. The ability to sustain contact tracing and exposure investigation will enhance the institution's ability to keep our

health care environments safe for both patients and personnel alike.

Study Limitations

As with any practice change or quality improvement process, concerns about applicability and replication of the intervention in other health systems exist. We attempted to describe the intervention with sufficient details to facilitate implementation elsewhere. The ability to integrate with the facility's human resources system which contains HCP contact information is key. Like many practice change interventions, this implementation did

not follow a true experimental or comparative design. The current intervention was developed and applied quickly due to the demands of the COVID-19 pandemic. Continuous enhancement, optimization, and evaluation are ongoing.

CONCLUSION

A framework for efficient, scalable, and sustainable contact tracing of COVID-19 has been implemented successfully in a multi-state large health system setting. Optimization and evaluation are ongoing.

ACKNOWLEDGMENTS

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Abbreviations and Acronyms: EIT = exposure investigation team; EMR = electronic medical record; ETP = exposure triage provider; HCP = health care professional; IPAC = Infection Prevention and Control; NCCC = Non-Clinical Call Center; OCM = Occupational Case Management database; OHS = Occupational Health Services; PPE = personal protective equipment

Potential Competing Interests: The authors report no potential competing interests.

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