What is Outbreak Response?

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Definition: Outbreak response involves the steps necessary to investigate and contain a COVID-19 outbreak. COVID-19 outbreaks occur when multiple people are infected through the same source (e.g., workplace, social event, congregate setting) over a short period of time.

The most effective outbreak response brings together the full range of COVID-19 public health interventions. These include contact tracing for cases, care resource coordination for cases and their close contacts in order to support isolation and quarantine, and testing and vaccination made available to close contacts as well as casual contacts (any other individuals who may have been exposed to confirmed cases but may not fit the close contact definition). It also includes the people working on the outbreak team and anyone involved who is liaising with the communities, businesses, local health departments, mayoral offices, etc. who are involved in the effects of or the response to the outbreak.

The strategy is ideally executed by local health departments in conjunction with a contact tracing program. The outbreak response team can be as small as a few people with mixed public health expertise – epidemiologists, contact tracers, resource coordinators. It is also possible that some settings will identify 'flex' team members from a regionally based pool that can be activated to support local outbreaks when needed. Similarly, it is useful to build the outbreak response team in collaboration with on top of a well-trained contact tracing workforce. This could mean the team is integrated with and an offshoot of a contract tracing workforce, or perhaps receiving information and collaborating with the contact tracers. This comprehensive strategy is designed to stop transmission by focusing on COVID-19 clusters, where multiple people are infected in localized outbreaks.

These are key terms important for outbreak response:
- **Outbreak investigation:** uncovering when and where a case was infected and who else was exposed; mapping out the reach of the cluster including all cases, close contacts, and casual contacts; identifying key areas for risk mitigation
- **Outbreak containment:** all the interventions put into action to suppress a cluster and prevent future ones
- **Tactical vaccination:** one of the interventions of the outbreak containment strategy involves deploying vaccination efforts specifically to people and communities who are part of an outbreak (close and casual contacts, or other connected people who may be at risk of the outbreak, e.g., place of employment, place of worship, other places with shared airspace, etc.)
- **Casual contacts:** people who do not meet the strict definition of close contact and those who do not need to quarantine but may have been exposed through sharing common spaces. For example, coworkers in a workplace outbreak who likely share airspace, people worshiping at the same church, people who attended the same party, etc.

All together, this strategy is:

- **Equitable**: COVID-19 finds and thrives in high social vulnerability environments. By bringing essential resources and outreach to high-risk settings where cases are already occurring, the strategy invests in marginalized communities to ensure equity in response.
- **Comprehensive and coordinated**: It unifies key pillars of response (testing, tracing, vaccines, treatment, supported isolation/quarantine), and the same team oversees performance of, or linkage to, each.
- **Efficient**: It identifies locations that have cases for a reason—low vaccination rates, facility features, activities taking place—and targets interventions to them.
- **High Impact**: By working to identify and contain clusters early, interventions prevent spread in both the immediate setting and in the wider community. It uses existing public health infrastructure and workforce and unifies the outbreak control strategies already in place across the US. As testing volume drops, investigating clusters and intervening is even more critical to identify undiagnosed infections.
- **Flexible and Adaptable**: Easily integrating into varied public health structures, outbreak response teams are part of the solution to the transition from emergency response to long-term systems improvement.

Why Outbreak Response in COVID-19 is important

COVID-19 is a clustering disease, and people are believed to be most infectious prior to symptom onset. This results in exposures occurring in workplaces, schools, recreational activities, and other public-facing locations prior to individuals knowing that they are sick.

There are generally two types of COVID-19 outbreaks: slower, ongoing chains of transmission and larger, more explosive outbreak events.

Slower, ongoing chains of transmission are seen frequently in workplaces where extended exposures result in many people being exposed, often even despite best efforts to implement protective measures. These outbreaks can produce several cases each week and span over the course of weeks or months.

Larger, more explosive outbreaks can also occur in workplaces, but are frequently seen in public-facing locations, such as restaurants or night clubs, and other high-risk exposure activities, such as youth sports and recreational activities where exertion and heavy breathing may increase exposure risk or where preventive measures are more difficult to implement.

Given the transmission dynamics seen in COVID-19 outbreaks, immediate widespread testing and vaccination are critical to interrupting disease transmission and containment of the outbreak. Contact tracing and care resource coordination ensure that those with highest

exposure to COVID-19 are able to safely quarantine, further interrupting disease transmission. True close contacts are highest risk for COVID-19 infection, but casual contacts can also be at risk for infection and therefore can propagate transmission if not tested following a possible exposure.

Lastly, the virus has been and will continue to exploit vulnerability within communities, exacerbating existing inequities. By focusing on outbreaks, teams necessarily tailor their response to meet the needs of vulnerable communities. This often includes unvaccinated pockets of people, and because an outbreak occurred within a community once, renders it at risk for another outbreak. Outbreak response is an opportunity to vaccinate entire communities and social networks as well as mitigate other risks, before an outbreak can occur again.

The Elements of Outbreak Response

Outbreak response are the activities that support a strategy of outbreak investigation and containment:

Core Elements of Outbreak Response

The core of outbreak response involves testing, contact tracing, vaccination, and care resource coordination.

- **Testing**: A wide net should be cast when recommending and facilitating testing for those linked to a cluster, from close and casual contacts to household members. Casual contacts are those who do not need to quarantine but may have been exposed through sharing common spaces. Those who test positive will enter the contact tracing program, where source investigation will take place. A process should be in place to be able to record, and include for investigations, home-based rapid test results. Mobile testing units, knowledge of nearby testing locations, and education for organization leaders are all good cluster-based testing strategies.
- **Tracing**: Additional contacts discovered through cluster investigation should be entered into the contact tracing program.
- **Tactical vaccination**: Tactical vaccination focuses education and outreach efforts on people connected to documented cluster outbreaks who are unvaccinated or under vaccinated. These are the people who are most likely to become infected and infectious in the short- and long-term, and it opens up entire social networks who many need access to vaccination. Tactical vaccination can be supported through mobile vaccination units, helping people register for vaccines, and educating individuals and trusted authorities linked to the cluster.
- **Social support services**: Those infected with or exposed to COVID should be connected to support services if they need help with accessing testing, resources for safely isolating/quarantining, or vaccines. Because outbreaks tend to occur in vulnerable populations, incorporating resource coordination can connect people to the social safety

net and – for example – reduce food insecurity by enrolling families in SNAP (previously called food stamps) and connecting them to food banks.

Comprehensive Outbreak Response

A comprehensive outbreak response will include additional epidemiological, clinical, and public health measures to ensure the full scope of the outbreak is understood, contained, and future outbreaks are mitigated.

- **Sequencing**: All positive test samples should be sequenced for variants. This is especially important for clusters in communities with known or suspected variants or unusual outcomes. Sequencing can also be used to associate additional cases with clusters or even form the basis of detection of clusters when sequencing data is available in real time.
- **Therapeutics**: Linking people infected with or exposed to COVID, especially those at risk of severe outcomes, to [monoclonal antibody therapy](). This is a promising prevention method that is becoming more widely accessible as it moves from intravenous to injection-based delivery. Outbreak response is an opportunity for early identification of contacts who may benefit from monoclonal antibody therapy and could be directly linked to providers for evaluation.
- **Sector-specific guidance**: Guidance tailored to the location should be given, including for ventilation, collection of patron lists, linkage with mobile testing and vaccination services, and other measures that help with cluster prevention and investigation.
- **Community outreach**: The outbreak response team should proactively conduct community outreach based on lessons from the cluster investigation and response. This can range from contacting similar locations to recommending preventive measures, talking to trusted authorities in the local community, and providing outreach materials for locations.

Workforce & Training

Key Roles and Management

There are two primary roles within an outbreak response team: outbreak specialists and specialized case investigators. The Outbreak Specialists rely on the larger [contact tracing workforce](). It is critical that the bulk of the contact tracing workforce be trained at least on the basics of source investigation, epidemiological principles of clustering, and basic cluster investigation. The more well trained the contact tracing workforce is, the smaller and more agile the outbreak investigation team itself can be.

- **Outbreak Specialists:** Review exposure sources provided by COVID-19 cases; triage exposure sources and identify clusters; collaborate with specialized case investigators to conduct location outreach and exposure notifications; collaborate with Care Resource Coordinators to identify and address social support needs and bottlenecks to testing, treatment, vaccination, and isolation/quarantine; map and document cluster across all cases and contacts; connect cluster location with testing and vaccination resources to prevent future outbreaks; provide guidance and technical support to the location in accordance with local guidelines; record data and metrics around cluster investigation; report to local and state governments swiftly and accurately; where relevant, teach and mentor contact tracing staff on source investigation, epidemiology of clusters
- **Specialized Case Investigators:** Collaborate with outbreak specialists to support cluster investigations; conduct location outreach for exposure notifications; assist with widespread notification of individuals possibly exposed during outbreaks; explain risk of infection and transmitting COVID-19; connect the location and individuals with testing and vaccination resources
- **Management and Leadership Team:** Responsible for oversight and accountability of the team; review metrics to ensure appropriate prioritization; encourage collaborative workflow development and team building; adapt to evolving epidemics; HR and administrative support
- **[Contact Tracing Workforce](#):** The outbreak-specific workforce outlined above relies on a strong contact tracing workforce, including contact tracers, case investigators, and care resource coordination. Communication pathways between these two teams are critical to identify outbreaks as well as clear data priorities and standards on how data is recorded.
- **[Care Resource Coordinators](#):** The team providing social support is often embedded within the contact tracing workforce to ensure cases and contacts have the material support they need for isolation/quarantine. Integrating resource coordination within outbreak response is important given the high number of cases/contacts that may be identified, often with a high degree of vulnerability. In addition, specifically putting resource coordination within the outbreak team means that these personnel can assist with community partnerships, navigating barriers to testing, vaccination, and treatment, and work with community partners on culturally appropriate communication strategies (including specific language needs).

Best Practices for hiring

- **Diverse workforce:** Outbreaks occur in high-risk groups; these groups tend to be demographically or geographically similar. A workforce that is made up of all socio-economic and demographic backgrounds will help to understand the cultural and societal contexts of outbreaks. Language skills can be critical for tracing and outbreak response; hiring a team who speak the main languages in the community is necessary.
- **Varied backgrounds**: Knowledge of public health systems and disease control measures are beneficial in outbreak response programs but are not the sole areas of expertise valuable to the response. Many other skillsets, such as communication, public

relations, health education, and a variety of employment backgrounds are beneficial to outbreak investigation and response as these outbreaks are not restricted to typical public health environments. The ability to communicate and build trusting relationships with community members, businesses, and health departments is often a skill that can't be easily taught, and is incredibly valuable in relationship building and mitigating transmission.

Training

In ideal circumstances, a specialized outbreak response team can be from the existing contact tracing workforce, but this may vary depending on the context. Outbreak specialists and specialized case investigators should have a basic understanding of case investigation and contact tracing. While not necessary, a moderate understanding of epidemiological and clinical principles is helpful for a fast-paced and quickly evolving outbreak response team.

Extensive academic backgrounds or first-hand knowledge of epidemiology beyond contact tracing experience is not required for most roles in the outbreak response team, however a leadership team that is able to guide new team members through necessary concepts is beneficial to the growth of the team.

The team should first receive the baseline COVID-19 contact tracing training modules, including on advanced case investigation, source investigation, retrospective contact tracing, basic COVID-19 epidemiology, introduction to clusters, and methods for location outreach. See 'Introduction to COVID-19 source investigation and clusters' for an example training module. Then, strategic development should be ongoing for both the outbreak specialists and specialized case investigators, as disease and transmission dynamics evolve frequently, and should include:

- Trend assessment (geographical, sector-specific, demographic, etc.)
- Development of sector-specific strategies for communicating with businesses and other public locations
- COVID-19 guidelines as they evolve for tracing, testing, and vaccination

Training for the outbreak response team should be seen as constantly ongoing. While formal initial trainings can be helpful to get the team started, informal and conversational seminars can be more effective in facilitating ongoing training and understanding.

Workflows and Adaptability

Workflows

Outbreak response workflows are generally dependent on the level of transmission within the community. Source investigation is critical at all stages of an epidemic, but the specific outbreak-response can be adapted based on high and low levels of COVID-19 community transmission and local prioritization.

At any time, the core workflow elements of outbreak response rely on:

- **Source Investigation:** Understanding where COVID-19 comes from is critical to interrupting ongoing chains of transmission and prevent future outbreaks. Source investigation should be conducted with each confirmed, probable, or suspected case of COVID-19, and includes baseline questions case investigators and contact tracers use to assess possible high-risk exposure sources within the 14 days prior to symptom onset. As COVID-19 is a clustering disease, it's likely that more than one person was exposed at that same exposure event. Source investigation is critical in both high and low transmission settings. Examples of source investigation questions, including by sector, are included in 'Asking about and documenting COVID-19 exposure sources'.
- **Location Outreach:** Once an exposure source has been identified, the location needs to be informed as quickly as possible of the potential exposure. Conducting outreach to these locations serves as a touch point with management, the business owner, or other point person for the organization where preventive measures can be reinforced and any misunderstandings can be addressed. Asking general questions, such as 'how many people have been out sick recently?' can open wider conversations than individual exposure the outbreak team has already identified. The importance of widespread notification, testing, and vaccination can also be discussed with the point of contact. Rosters of employees, guests, patrons, or congregants can be collected so the outbreak team can assist in widespread and anonymous notifications of possible exposures and recommendations for testing. Guidance for making these notifications and starting investigations is given in the 'Working with COVID-19 exposures in public or crowded locations' document.
- **Widespread Notification:** Notification to individuals extending farther than the close contact definition is critical in stopping the spread of COVID-19. Close contacts are those individuals at highest risk for contracting COVID-19, but frequently exposures occur over extended periods of time or involve high-exertion activities with heavy breathing that can increase the risk of transmission of COVID-19, despite those individuals not being strictly considered a 'close contact'. Ensuring there is a system in place to notify these casual contacts is another critical piece to outbreak response. Widespread notifications are important in both high and low transmission settings. This may change from setting to setting. For example, it may involve notifying all employees at a workplace, all churchgoers, notices at a gym, patrons at a restaurant, etc. Should the point of contact prefer to do these notifications internally, the lead outbreak investigator can provide the necessary information and templates for them to do so, examples provided in 'Widespread notification following COVID-19 exposures'.
- **Cluster Mapping:** Mapping chains of transmission and outbreak events often highlight transmission dynamics to the lead investigator and help to visualize where preventive

measures may have broken down. Maps can be simple, but are invaluable tools to help share the lessons learned with community partners and local or state government officials who may not be as closely involved in COVID-19 transmission dynamics as public health officials are. Cluster maps are valuable in both high and low transmission settings. Examples and instructions on cluster mapping can be found in the 'How to make a case map for outbreak investigations' document.

When a high percentage of cases can be thoroughly and completely interviewed by available staff, workflow modifications can include:

- **Individual Case-Linkages:** In areas with low levels of community transmission, mega-clusters may not be as frequently identified, but *COVID-19 always comes from somewhere.* Cases are either imported into or spread within a community. Strategies should be developed to look at COVID-19 case demographic and geographic data to identify hidden linkages between cases. This strategy should be coupled with widespread testing and vaccination campaigns to protect these social groups and geographical areas from outbreaks in the event of an increase of COVID-19 community transmission.

Additionally, some elements can be added to these core workflows as resources allow and when needed based on the types of transmission that are most common in the area:

- **Community Outreach:** Increases in transmission can be anticipated ahead of social events, holidays, and religious celebrations. Sector-specific community outreach is an effective tool for increasing messaging and education related to preventive measures. For example, if a church leader were inclined to send a COVID-19 prevention message to their congregation ahead of a large religious holiday, their community is likely to heed their advice much more seriously than a public health official. Every opportunity to engage community leaders and leverage their channels of communication should be used to mitigate outbreak events, in both high and low transmission settings.
- **Super-Spreading Event Response:** COVID-19 is a clustering disease, and in areas with high levels of community transmission, larger outbreaks are common in workplaces and public-facing locations. Quick identification of these outbreaks is crucial, as workplaces and public-facing locations act as amplifiers for COVID-19 transmission, creating an opportunity for extensive household and community spread. Strategies should be developed to quickly identify these mega-clusters, coupled with swift sector-specific mitigation techniques and widespread exposure notifications. Testing and vaccination should be encouraged for staff and any community member associated with the outbreak location.

Data Use and Cluster Detection

Sophisticated tools like algorithmic cluster detection and text-based data mining can be helpful in cluster detection, but they should not form the basis of investigation. Standard methods of manual data review by outbreak specialists and case investigators, as well as clear

communication across the teams and high-quality data collection, are a much more important starting point.

One of the key tools to detecting clusters is a data system that allows all users to both record key individual-level information related to clusters (e.g., source investigation results) and to 'flag' cases that are potentially part of cluster events. This can be done with the use of specific variables in the data system, or through external methods such as spreadsheets to track potential cluster leads. This allows cases of interest to be reviewed by the outbreak team, without requiring all contact tracing staff to be fully trained on investigation techniques.

Another key tool is the ability to generate reports or perform complex searches in your data system. At minimum, Outbreak Specialists should be able to generate reports to view the demographics (date of birth, language, city of residence, gender), basic clinical information (vaccination status, presence of symptoms and symptom onset date), and contact tracing data (exposure source, household connections, employer name/address). Further, the ability to perform keyword searches through these fields for all cases is required (ex. searching for all cases reported among a given employer name). '[Proposed data queries to assist in outbreak investigations](#)' provides a list of standard reports that can be useful in cluster detection and identification.

Adapting to Evolving Epidemics

A core element of effective outbreak response is to remain dynamic and flexible, and to use the information that is being gathered in ongoing outbreaks to better discover and respond to future outbreaks. Some elements of this include:

- **Shifting trends:** Outbreak response teams will quickly develop a sixth sense for changes in disease transmission, severity, and affected populations. These shifts in COVID-19 trends should be monitored and reported to local and state public health authorities, and prioritization adjusted to accommodate as necessary. For example, shifts may occur in age patterns, types of exposure settings, vaccine breakthroughs, geography of outbreaks, etc.
- **Prioritization:** As transmission dynamics shift, prioritization should also shift to ensure outbreak response is being targeted to the highest-risk populations. These priorities could be demographic, geographic, or sector specific.
- **Surges:** Numerous outbreaks are occurring during COVID-19 surges when community transmission is at its highest, but the types and size of outbreaks shift with transmission levels. Outbreak response teams should be dynamic and able to identify high priority outbreaks, defined by extent or risk for poor clinical outcome. These outbreaks should have resources made available as fast as possible for widespread testing and vaccination.

Data Systems, Metrics, and Monitoring

Outbreak response metrics and evaluation should be conducted in tandem with evaluation of the standard contact tracing system in place. Much of the work of the outbreak response team will be dependent on the quality and availability of data collected through normal contact tracing. In particular, exposure sources and employer information are critical foundations of an outbreak response team.

Much like building the outbreak investigation team and outbreak investigation itself, monitoring of the program should be flexible and adapt to what is possible with the current team. Metrics and outcomes can range from simple (e.g., number of clusters created, number of cases associated) to more complex (e.g., percent of transmission explained, average cluster attack rates and vaccine effectiveness).

Defining and Tracking Success

Examples of metrics:
- Number of clusters created in a time period
- Number of clusters per transmission sector
- Number of cases and contacts associated with clusters
- Percent of contacts and casual contacts reached during cluster investigation
- Numbers of people connected to testing, vaccination, and other social support services

Examples of exploratory data analysis to identify trends, confirm or readdress priorities, and identify gaps:

The process of cluster identification, investigation, and analysis is a cycle where any one step should be informing the others. At a minimum, the following should be assessed regularly:
- Proportion of an age group's cases that are connected to clusters
- Proportion of cases reporting a given primary language that are connected to clusters
- Vaccination status of cluster identified and all cases identified
- Attack rates and total sizes of clusters per sector and over time

Systems Strengthening

A fully integrated and comprehensive outbreak response team helps to target resources (human, time, and material) to populations that are the most vulnerable to COVID-19. Whether by geographic or demographic characteristic, or shared social beliefs on COVID-19 and/or vaccination, COVID-19 identifies individuals and locations that need the resources the most.

People are often more willing to discuss testing and vaccination following an exposure or outbreak to COVID-19, despite their previous hesitancies. Flooding these populations with individualized education campaigns, testing and vaccination resources, and care resource coordination ensures the highest risk individuals get the support they need to isolate and quarantine safely, but also to access reliable resources to seek testing and vaccination.

Improving vaccination in these populations prevents severe disease and future outbreaks, lessening the burden on the healthcare infrastructure and allowing Local Health Departments to prioritize other public health interventions in addition to COVID-19 response. Those who become convinced to get tested and vaccinated through an outbreak response can also in turn be trained to become vaccination ambassadors for their family, friends, wider social networks, and communities.

Communication

While many Local Boards of Health (LBOH) or Departments of Public Health (DPH) are jurisdictional, COVID-19 is not. Communication across LBOHs, and between LBOHs and DPHs, is critical in responding to clusters. The outbreak specialists should be in constant communication with all departments involved in a cluster; the jurisdiction of the cluster event itself and the jurisdictions of residence for each individual exposed or possibly exposed in the cluster event. Depending on the size and scope of the cluster, frequent communication with the DPH is recommended as well.

Throughout the investigation, outbreak specialists can work with the LBOHs to collect close contacts, casual contacts, and provide appropriate guidance to the business owners or hosts of social events. LBOHs can deploy their testing and vaccination resources to identified cluster locations to mitigate spread and future outbreaks. Following the investigation and completion of the cluster response, the outbreak specialists can present a cluster map to local officials involved in the response. These presentations and resulting discussion can help to glean lessons learned and prevent clusters in the same location or similar sectors, and can help guide policy decisions.

In addition to outbreak specialist-identified clusters, LBOHs and other state officials can share tips with the cluster team to get ahead of transmission before significant transmission occurs in high-risk locations.

Strong communication with the Local Health Authorities is critical, but the ability to communicate clearly with business owners and community members is also necessary to ensure swift exposure notifications and recommendations for testing and vaccination.

Appendix

This appendix includes links to the examples and templates that can be used as tools for outbreak response. All of these documents can be found at: https://www.pih.org/outbreak-response-toolkit

A. Introduction to COVID-19 source investigations and clusters