Public Health Emergency Operations Coordination: Findings from After Action Reports and Case Reports

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Committee on Evidence-Based Practices for Public Health Emergency Preparedness and Response

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1 Executive Summary

The National Academies of Sciences, Engineering, and Medicine, Committee on Evidence-Based Practices for Public Health Emergency Preparedness and Response commissioned this report to synthesize findings from After Action Reports and case reports related to activation of public health emergency operations. More specifically, the report seeks to summarize barriers, facilitators, benefits and harms associated with activating public health emergency operations centers (EOCs). The report is intended to support findings from research studies, provide a different perspective from research studies, or provide the only available perspective concerning a specific phenomenon of interest.

The Committee identified AARs and case reports directly or indirectly related to public health EOCs by conducting a broad literature search and call for reports. These reports were then further prioritized through the development and application of a "Sorting Tool." Reports were categorized as either "high priority" or "low priority" using the criterion of relevance, adapted from the AACODS checklist (Authority, Accuracy, Coverage, Objectivity, Date, Significance). Tabletop exercises were deprioritized unless they elicited new themes. Data were then extracted and coded in Excel.

A total of 35 AARs and 29 case reports were categorized as high priority and included in the thematic analysis. Review findings suggest that the size or scope of the event, activation triggers, complexity, and surge capacity needs are useful factors for determining when to activate public health emergency operations. Reports did not focus on the circumstances in which public health should activate a separate or supporting EOC or lead a multi-agency EOC, however, it can be inferred from lessons learned that a public health EOC should be activated in order for local public health departments to lead and/or support state level responses. Findings also suggest that leading a multi-agency EOC is advisable in response to infectious disease outbreaks requiring coordination and information sharing with other agencies, whereas supporting a multi-agency EOC is recommended for planned events, natural and environmental disasters that require information sharing and response coordination.

Activation of public health emergency operations seems to typically result in more efficient response operations, serving as a benefit. However, several factors facilitate or impede successful operations, including prior experience using ICS; inter-agency relationships and coordination; adequate staffing; appropriate and reliable communication technology; and strong, decisive leadership. Additionally, an unintended consequence may include staff fatigue resulting from activation due to over-reliance on a few key personnel or insufficient staffing depth to meet response needs.

Findings from this AAR/ case report review indicate that activation of public health emergency operations is advisable when the needs of the incident exceed the capacity and/or capabilities of a public health agency. Activation is also appropriate for complex and multi-jurisdictional responses. Following the decision to activate, response operations typically become more efficient and able respond to emergent needs with more flexibility. However, breakdowns in the chain of command and communication channels often hinder the effectiveness of response operations. To optimize for success, findings suggest that agencies should invest in preparedness efforts to ensure that strong relationships, adequately trained staff and leadership, and communications mechanisms are in place in advance of an emergency.

2 Introduction

Public health threats involve decision-making about whether or not activation of public health emergency operations is warranted. Although studies have examined the value of the Incident Command System (ICS) approach more generally, it is unclear when and what circumstances activating emergency operations centers (EOCs) is an effective strategy for responding to public health emergencies. This report was commissioned by the National Academies of Sciences, Engineering, and Medicine, Committee on Evidence-Based Practices for Public Health Emergency Preparedness and Response to synethesize the gray literature around the factors that are useful for determining when to activate public health emergency operations; the circumstances for which public health should activate a separate EOC, lead a multi-agency EOC, or play a supporting role in a multi-agency EOC; how responses change following activation; barriers and facilitators to successful operations using ICS; and the benefits and harms associated with activation.

Additionally, evidence-to-decision considerations for activation of public health emergency operations (values/preferences, resources and net benefit, equity issues, acceptability and feasibility) are discussed. Findings from this review will be used to add weight to findings from research studies examined in the commissioned paper entitled *Public Health Emergency Operations Coordination: Qualitative Research Evidence Synthesis*, provide a different perspective from research studies, or to provide the only perspective concerning specific phenomena of interest.

3 Methods

Literature search

The Committee identified gray literature published by relevant domestic and international organizations and agencies. This included Association of Public Health Laboratories (APHL), Assistant Secretary for Preparedness and Response (ASPR), the Association of State and Territorial Health Officials (ASTHO), Centers for Disease Control and Prevention (CDC), Center for Health Security, Council of State and Territorial Epidemiologists (CSTE), European Centre Disease Prevention and Control (ECDC), Disaster Information Management Research Center at the National Library of Medicine at the National Institutes of Health (NLM/NIH), Department of Homeland Security (DHS), Federal Emergency Management Agency (FEMA), US Government Accountability Office (GAO), National Association of County and City Health Officials (NACCHO), National Center for Disaster Medicine and Public Health (NCDMPH), Preparedness and Emergency Response Centers (PERRC), Public Health Canada, Public Health England, RAND Corporation, and the World Health Organization (WHO). Additionally, the committee obtained 370 after-action reports published from 2009 to 2019 from the Homeland Security Digital Library (HSDL).

In addition to online searching, the Committee proactively solicited reports, both published and unpublished, through a request for documents. The reports were solicited through internal list servs at the National Academies, as well as through external mechanisms. An online request was published on the committee's study webpage, and the Board on Health Sciences Policy distributed the call for reports through the Forum on Medical and Public Health Preparedness for Disasters and Emergencies and the Disaster Science Action Collaborative. Staff contacted CDC, the study sponsor, for document suggestions, and also had them disseminate the announcement to their networks, and particularly the former PERRCs and PERLCs networks. Additionally,

staff sent targeted emails PHEPR practitioner associations (e.g., NACCHO and ASTHO) and disaster science organizations (e.g., DR2, NCDMPH, and ASPPH). Submissions were accepted through March 8, 2019. This proved to be an effective way to collect after action reports (AARs), theses, and white papers. Reports that did not fall into the AAR category (white papers, peer-reviewed publications, etc.) will be called "case reports" for the purposes of this report. The scope of this report is AARs and case reports that did not report a research study. The commissioned paper entitled *Public Health Emergency Operations Coordination: Qualitative Research Evidence Synthesis* provides a synthesis of qualitative studies that reported qualitative methods.

Prioritization of after action reports and case reports

The literature search resulted in a total of 78 after action reports and case reports directly or indirectly related to activation of public health emergency response operations. To further prioritize which reports to review, a Sorting Tool was developed with input from the Committee. Reports were categorized into "High" priority or "Low" priority based on relevance to the research question of interest. The definition of "relevance" was adapted from the AACODS checklist (Authority, Accuracy, Coverage, Objectivity, Date, Significance). Rigor was not used as a sorting criterion because the primary purpose of this AAR/case report review was to synthesize experiential data to add weight to findings from research studies, provide a different perspective from research studies, or to provide the only available perspective concerning specific phenomena of interest. Please see Appendix A for the tool and reviewer guidance.

AARs covering tabletop exercises were categorized as low priority given that findings from tabletops are not based on real experience or simulations. However, if a tabletop AAR was relevant to the research question, the AAR was included in the analysis if the specific area of relevance did not otherwise emerge from analysis of the high priority report.

Time-permitting, reports categorized as low priority would be to be randomly sampled. If the initial random sample yielded new themes, additional reports would be randomly sampled until saturation was reached. However, because application of the sorting tool resulted in 80% of the reports being considered high priority, random sampling of low priority reports was not conducted. Tabletops were also not analyzed as the themes they covered emerged from the analysis of high priority reports.

Coding and synthesis of data from selected AARs and case reports

Matrices were created in an Excel spreadsheet to structure report characteristics (type of event, type of report, location, etc.) and data were extracted directly into Excel. Excel was used for ease of comparing data based on report characteristics. Once coding was completed, key word searches of the high priority reports were conducted in Mendeley to ensure reports with details relevant to the key findings were not overlooked in the analysis phase. A codebook was developed based on the key areas of interest and used to code data in Excel. Although AARs and case reports were jointly analyzed, findings were considered by report type to assess for any differences. There were no notable differences between themes emerging from AARs or case reports, therefore, findings are presented jointly below.

4 Findings

4.1 After Action Report/ Case Report Characteristics

The AAR/case report sorting tool was applied to 78 total reports (40 AARs and 38 case reports). Of these 82% were categorized as high priority (35 AARs and 29 case reports). **Figure 1** provides a detailed breakdown of the approach to sorting and prioritization.

Figure 1: Prioritization of AARs and Case Reports

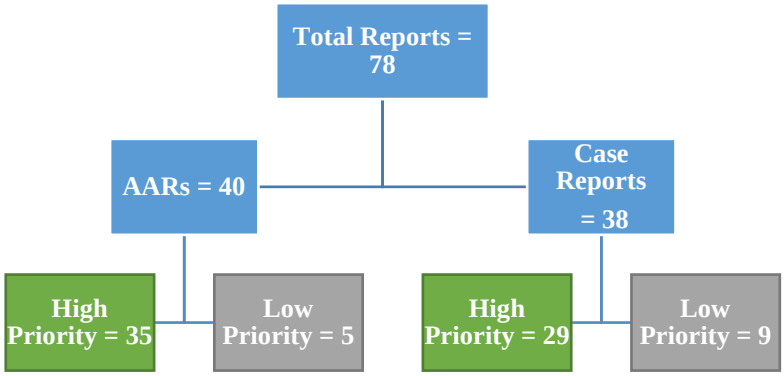

Table 1 provides a summary of AAR/ case report characteristics. Three-quarters (75%) of the AARs/case reports were based on real events. Full scale exercises and functional exercises accounted for 11% of the reports each. Two percent were described as both functional and full scale exercises. Hazards and threats ranged from infectious diseases (H1N1, Measles, West Nile, etc.), Legionnaires' Disease, natural disasters, planned events (e.g., papal visit), and man-made disasters (e.g., oil spill, refinery fire, etc.). The year of incidents ranged from 2002 to 2014 and incidents were reported from 24 states in the United States, and Mexico and Australia.

Table 1: After Action Report/ Case Report Characteristics

Characteristics of AARs and Case Reports (N = 64)		
Type of Report	After Action Report 55% (n=35) Case Report 45% (n=29)	
Type of Event	Real Event 75% (n=48) Exercise 25% (n=16) • Full Scale 11% (n=7) • Functional 11% (n=7) • Full Scale/ Functional 3% (n=2)	
Hazard/ Threats	Public health threat	Anthrax, Ebola, H1N1, Hepatitis A, Measles, MERS-CoV, PanFlu, SARS, West Nile, Zika, Legionnaries' Disease
	Natural disasters	Earthquake, Flood, Hurricane, Nor'easter, Storm, Tsunami threat
	Other	Blackout, Bomb threat, Explosion, Oil spill, Papal visit, Refinery fire
Incident Years	2002 - 2014	
Location	USA: AK, CA, CO, CT, DC, DE, FL, IL, IN, LA, MD, MI, MN, NC, ND, NH, NY, OH, OK, OR, PA, TX, WA, WI; Australia; Mexico	

4.2 Synthesis of Findings: Themes and Dimensions

Findings are presented in the context of the Key Evidence Review Questions and organized into themes and theme dimensions. **Table 2** provides a summary of findings. Overall, the case reports provided richer data on specific research topics given their narrower scope. For instance, some case reports focused on lessons learned over time for a particular hazard, or examined the use of the Incident Command System (ICS) for a specific incident. After Action Reports varied in quality and level of detail provided, however, they were particularly useful in identification of barriers and facilitators to successful public health emergency response. In some instances, scant data from both the AARs and case reports yielded only one theme dimension. Additional research is recommended to gain a more nuanced understanding of these themes.

Key Question 1 - What factors are useful for determining when to activate public health emergency operations?

Size and scope of the event are important considerations

Findings from case reports suggest that it is helpful to activate early even if the size and scope are initially unknown. A case report involving Measles exposure in a hospital acknowledged that earlier activation would have been prudent despite the initial underestimation of exposure. Public health officials responding to a 2016 Legionnaires outbreak in Sydney, Australia also credit their early decision to activate for their successful response (242). There is often a period of initial uncertainty regarding the need to activate, particularly in regards to infectious disease exposure and novel diseases (180). Risk assessments can be a useful way to carefully weigh the potential public health impacts against the cost implications of a resource-intensive activation (242).

Recognition that weather events can have greater impact than anticipated is also an important consideration. For instance, New Hampshire was able to successfully respond to a 2012 Nor'easter because they activated ICS ahead of the storm and prepared to respond to a winter weather emergency even though it was predicted to be an average snowstorm. Their decision to activate in advance allowed for more rapid escalation of response operations when needed (632).

Novelty of a disease, severity, and potential for it to become widespread are worthwhile factors to consider

Novel diseases often have unknown severity and potential to become widespread, however, findings suggest that activating in response to an emergent disease or outbreak can help minimize risk (233, 242). For instance, Sydney's aforementioned experience of five cases of Legionnaires' disease within 2 weeks in 2016 triggered a multiagency investigation involving ICS (242). The AAR indicates that early and judicious use of ICS helped prevent further public health risk. The U.S. response to the emergence of novel H1N1 similarly led to EOC activations across the country (233, 163, 160, 665). State and local jurisdictions activated in anticipation of widespread impact and large-scale response operations.

Activation triggers are useful in deciding when to activate

Drawing from CDC's experience with Middle East Respiratory Syndrome Coronavirus (MERS-CoV) in 2012-2014, triggers are useful in determining when to activate, re-activate, or deactivate response operations. They can be helpful during disease outbreaks where the number of cases may inform the decision to activate and the level at which to activate (174). Triggers may be defined in advance of an event, however, with novel diseases new triggers may need to be developed. For instance, CDC developed new triggers for activating the EOC for MERS-CoV given the uncertainty of the epidemiology of the disease. However, pre-defined triggers would benefit from flexibility as adequacy of resources to meet response needs at a given time also plays an important role in the decision to activate.

It may also be useful to consider flexible triggers at a local level that do not necessarily rely on a state declaration of an emergency as response needs can still overburden local resources even in the absence of a formal emergency declaration. During the 2009 H1N1 response in New Hampshire, ICS was not activated because an emergency was not declared by the state. However, in hindsight, local officials felt ICS would have been useful given the "sustained, coordinated efforts" required to meet response needs (663). AARs suggest that declaration of a public health emergency serves as a trigger for activation response operations (641).

Additionally, development of standardized triggers amongst response agencies for when to physically activate a regional multi-agency coordinating entity (MACE) location was recommended based on lessons learned from New Hampshire's 2009 H1N1 response (647). Some regions had physically opened a MACE, whereas others simply had one person answering phone calls and sending emails for activation, resulting in a disconnect between State and local expectations for response.

Higher complexity and multi-jurisdictional involvement often call for activation

Several case reports also cited that activating an EOC is useful for more complex and multi-jurisdictional responses that present threats to public health (06, 248, 138, 163, 133, 638). Activation allows agencies to coordinate using a standardized structure and improves overall response operations. Additionally, many reports described the activation of public health emergency operations in the context of a formally declared emergency in which other EOCs were also activated. Although not explicitly stated, it can be inferred that the formal declaration of an emergency and status of other EOCs are important factors to consider when deciding whether to activate (663).

Activating ICS can help effective surge in response to public health emergencies

As incident needs extend or expand beyond the capacity of existing resources, activating ICS can provide a means for effective surge in response to public health emergencies (172, 174, 651). A typical example comes from a 2017 Hepatitis A outbreak in San Diego during which cases continued to grow, leading to the need for additional vaccination, sanitation, and education measures (651).

Additionally, lessons learned from decisions not to activate during previous incidents influenced decisions to activate for subsequent public health emergencies (06, 172, 199). For instance, in 1999, Nassau County, NY decided not to activate in response to West Nile Virus, a new disease with unknown magnitude (06). However, in 2008, when the threat remerged, the decision was made to activate given the complexities and recognized need for resources. Therefore, looking to past experience can be a practical method to determine whether to activate.

Key Question 2 – In what circumstances should public health activate a separate public health EOC, lead a multi-agency EOC, or play a supporting role in a multi-agency EOC based on identified or potential public health threats?

Few AARs and case reports touched on this key question as they typically focused at the more granular level on the strengths and opportunities for improvement within the chosen structure for a particular response. Findings in this section are based on inferences from the few reports that briefly addressed these issues.

EOC should be activated in order for local public health departments to lead local and/or support State level public health emergencies.

Although AARs and case reports did not specifically examine this key question, it is evident that local public health departments activate and benefit from activating EOCs to lead local responses to a public health emergency (160, 130). Activation allows local jurisdictions to keep up with the pace of the response and improves interagency coordination if other agencies are involved (657, 663). Activation at the local level is recommended in support of State level public health threats based on lessons learned when decisions were made not to activate (663). Additional research is needed to examine circumstances in which a separate public health EOC would be recommended over other response structures.

Public health should lead a multi-agency EOC in response to infectious disease outbreaks (e.g., H1N1) that require coordination and information sharing between response agencies.

Public health should lead a multi-agency EOC in response to public health threats (e.g., infectious disease outbreaks) when coordination and information sharing between response agencies are critical to completion of response objectives. Activation helps clarify roles among the supporting response agencies (e.g., emergency management, police, fire, and school officials). Lack of a formal command can lead to operational gaps, as identified during Illinois' 2009 response to H1N1 (638). Additionally, establishing public health as the lead can minimize confusion over command and control issues during a public health emergency (663). For instance, during New Hampshire's 2009 H1N1 response, two separate chains of command were set up due to the existence of two state agencies designated to respond to these types of events, resulting in lack of clarity (647).

Multi-agency EOCs would benefit from public health support functions for planned events, and natural and environmental disasters that require information sharing and response coordination

Numerous AARs and case reports described the benefits of public health support functions during planned events or incidents with potential for public health implications (653, 279, 660, 637, 656, 652, 131, 657, 139, 670). For instance, during the 2013 Boston Marathon bombing public health helped facilitate family reunification (652).

During a 2011 tsunami threat in California, public health "activated surveillance and epidemiology, environmental health and mental health and psychological support functions" (279). Public health also participated in mass care and management and distribution of medical supplies. AARs from environmental disasters with potential for short-term and/or long-term public health impacts (e.g., oil spill, refinery fire) also recognized the importance of including public health in multi-agency activations.

Clear designation of the lead public health agency is important to facilitate effective coordination between EOCs.

Although the key question focused on the specific role of public health in activations, a recurring issue in AARs was the need to clarify the role of state versus local EOCs (667, 646, 663, 665, 668). This is particularly important to ensure clear chains of command and decision-making authority during a response. Regardless of the structure established, jurisdictions should clearly designate the lead public health agency, and public health agencies across levels should work to better integrate their functions. For instance, in a 2009 full-scale exercise conducted in New Hampshire as part of the NH Cities Ready Initiative, the need to further define the role of the Incident Command Center (ICC) in relation to the State EOC was identified because it was unclear if ICC staff were at the same level as the State EOC (646) despite being lead for specific response operations. Similar challenges were also noted during the State's response to H1N1 in 2009-2010 (663).

Confusion was also noted in Texas's 2009 H1N1 response in which staff assigned to the Multi-Agency Coordination Center (MACC) organizational structure received response assignments from staff within the Department of State Health Services (668). Assignments were often not coordinated through appropriate ICS channels, resulting in questions about line of authority, conflicting assignments, and timelines. The Ohio Department of Health also identified similar areas for improvement following their response to H1N1 in 2009 (665), noting the need to clarify reporting structures and de-conflict assignments and competing priorities between ICS, Health Department programs, and the State EOC.

Key Question 3 – How does the response change following the activation of public health emergency operations?

Responses typically become more efficient following activation of public health emergency operations.

AARs and case reports examined in this review suggest that response efficiency improves following activation. Improved situational awareness, interagency coordination, and information sharing is strengthened (174, 662, 667). Timeliness of activities also improves due to increased availability of resources and/or capabilities for extended, expanded, or emergent responses (174). For instance, public health activation during a 2002 response to West Nile Virus in Arkansas enabled initiation of a public hotline to answer questions regarding the virus, and development of a specially designed website to provide instructions for submitting diagnostic specimens (139). Findings from CDC's early response to MERS-CoV state that activating the EOC relieved some administrative demands, which meant that the technical staff members could turn their attention to pressing public health issues. For instance, "the EOC Joint Information Center was pivotal in providing assistance with developing websites, Health Alert Network notices, travelers' health notices, and social media messages (174)."

Activation also enables greater access to subject matter experts during responses with potential public health implications. During the 2010 Deep Water Horizon response a public health unit coordinated response efforts across a multi-state area of operations. The AAR states that the "formation of this unit allowed for the sharing of public health concerns, needs and requests, and thus a more efficient and effective coordination of efforts (660)." Similarly, a county level response to 2009 H1N1 in Oregon enabled the development of "situation

display/reports, resource ordering, PIO products, and specific measures for disease investigation and distributing antiviral medications (641)." AAR findings indicated steady improvements to the response and acknowledged the flexibility to scale up or down as needed based on the needs of the response.

Key Question 4 – What are the barriers and facilitators to successful public health emergency operations using ICS?

Many AARs in this evidence review focused on the barriers and facilitators to successful emergency response operations. This is likely because AARs are often used by jurisdictions to improve ICS processes based on evaluation of PHEP or HPP capabilities. Six themes emerged upon examination of this key question.

Prior experience using ICS and a culture of preparedness

Staff's level of familiarity with ICS can serve as either a barrier or facilitator to a successful response. Numerous AARs identified that previous knowledge and experience of staff enabled positive outcomes (650, 212, 242, 670). Whereas, lack of familiarity with ICS or limited experience with larger-scale disasters was cited as a barrier to effective response operations (634, 212). Some recommended the use of experienced staff and subject matter experts early on in the response to a novel outbreak (661). However, it is also important to note that overreliance on a few key personnel can lead to staff fatigue (664).

Lack of clarity over roles and responsibilities was reported as an issue in many of the AARs (647, 657, 646, 641). Numerous reports recognized the need for additional training on NIMS, ICS, partner roles, and job-specific roles (652, 642, 648, 643, 633, 631, 138, 179, 174). Agencies with a culture of preparedness identified their preparedness trainings and exercises as an important contributor to successful responses (158, 131, 650, 653, 643). In reflecting on the Boston Marathon response, the AAR authors state, "years of integrated ICS training and planning with partner agencies and a strong level of familiarity with one another's operations and response capabilities allowed for multi-agency healthcare representation to take place at the [Medical Intelligence Center], and for partners to feel comfortable in sending staff to link into operations (652)." Lutz and Lindell (2008) also point to the importance of tailoring trainings for target audiences that do not frequently participate in responses (215).

Additionally, while jurisdictions acknowledged the value of ICS, lack of adherence to basic principles also led to inefficiencies in some instances. For example, absence of Incident Action Plans (IAP), response objectives, and routine briefings were reported to hinder response operations (647, 665, 631, 660, 658). The absence of routine updates to the Incident Commander inhibits well-informed and timely decision making (634), and ongoing lack of communication through the chain of command can lead to delayed emergency notification, mutual aid, and timely resource requests (193). Inclusion of operations briefings, debriefs, SitReps/Incident Action Plans (IAPs) with response objectives, and job action sheets were noted as contributors to response success in AARs (657, 646, 650, 634, 631, 652).

Inter-agency relationships and coordination

Numerous reports identified strong inter-agency relationships and partnerships as facilitators of success (650, 633, 653, 158, 652, 168, 233, 173, 212). Trust and rapport promote a greater

willingness to share resources and information during a response (174, 667). These relationships are often fostered during the preparedness phase through inter-agency trainings and exercises, facilitating a clearer command structure when an incident occurs (212). Pre-existing partnerships with state and local agencies also help reduce the burden on local resources (650).

Adequate staffing

Challenges with adequate staffing serve as a barrier to timely, and effective response activities. Staffing may be impacted by the incident itself (travel bans, shutdown of transport systems, inaccessible roads, etc.), or administrative issues such as hiring freezes (664, 652, 663, 189). This may overburden existing staff. However, pulling in subject matter experts early on in the response can allow response staff to focus on other aspects of response operations (647, 660). Sufficient staffing depth is also an important facilitator to ensure availability of trained staff for response roles (641). For instance, during the 2009 H1N1 response in Oregon, critical resources such as the Public Information Officers were deployed to the Health/Medical Coordination Center, leading to functional gaps at the health department's Incident Command Post (641).

Findings suggest that a clear distinction between the role of agency executive leadership and ICS Command is also critical to avoiding confusion over priorities. When agency executives issue a formal statement supporting the response, it sets a clear expectation that staff from other parts of the agency will be assigned to response roles and staffing was less of an issue (641, 661, 131, 636, 635). Lack of a policy directive to prioritize response activities over day-to-day responsibilities can lead to frustration, confusion and inefficiency (668). Providing Incident Commanders the authority to determine work hours aligned with ICS and planning processes can help reduce the friction between day-to-day expectations and emergency activation expectations (641, 661). However, staff flexibility is also critical as even after the policy directive is issued, staff need to be willing and committed to serving in their roles (632, 661, 161).

The need for greater attention to continuity of operations planning (COOP) also arose in AARs as an often-overlooked, but important aspect of response management (647, 632, 630, 666). Greater focus on COOP may minimize confusion over staff roles and responsibilities and enable adequate response staffing.

Appropriate and reliable communication technology

Communication technology plays a critical role in response operations. Several AARs described challenges with WebEOC, or local web-based systems intended for situational awareness and information sharing (643, 128, 666). While WebEOC is viewed as a useful resource, there is sometimes insufficient access and integration across regional, state, and local levels (664, 639). Drawing from a hospital-based exercise, there was a lack of consistency across hospitals in the use of incident management solutions such as Groove™ or WebEOC, which hindered the ability to share important data (643).

In addition to appropriate technology, it is important to periodically test functionality and ensure staff are familiar with how to operate equipment (phones, radios, etc.), and software WebEOC (633, 654, 147). Distribution lists should also be up-to-date (648). Although such efforts during preparedness can help enhance communications during a response, technology issues often arise during responses. Therefore, one jurisdiction noted the importance of including an IT Unit within the ICS structure (643).

Similarly, contingency plans and redundant systems are necessary for systems or power outage scenarios (633, 128, 189). As one report stated, "When WebEOC shut down, no one

seemed to know what to do. Most operations ceased and there was no way of tracking what was already ordered as well as taking new orders (633)."

Strong, decisive leadership

Case reports and AARs highlighted the positive impact that advance planning, leveraging of partners, and early activation can have on response outcomes (643, 638, 661, 652). Implicit is the need for strong leadership willing to be decisive despite uncertainties inherent to emergencies. Leadership need to have the ability to receive new, sometimes unexpected information, and to revise objectives as needed (163).

A case report review of five responses from 1993 – 2005 recommended that ICS managers "maintain and nurture network aspects of the ICS, partly because new members will emerge and partly because bonds of trust need to be strengthened in the dynamic context of an unfolding emergency (212)." Although hierarchical authority is an essential component of ICS, leadership should seek to promote trust by creating a shared sense of purpose and highlighting contributions of different network members (212).

Key Question 5 – What are the benefits and undesirable effects associated with activating or delayed activation of public health emergency operations?

Improved public health emergency response

As previously mentioned in this report, benefits associated with activation include standardized structure, greater clarity of roles, improved coordination, and sustained staffing (652, 639, 130, 653, 133, 203, 144).

Other benefits include the practical experience gained by staff under urgent/emergent conditions (242). One AAR indicated that, "many within the ICS… shared that the lessons learned and experience gained in response to a real event was very valuable. Staff commented that exercises are helpful, but the hands-on work and 'living through it' have better prepared them to assist in the future (670)." Additionally, one case report from a 2005 mass influenza campaign in Florida reported that activation helped gain buy-in from organizations and volunteers who were reluctant at first to participate (138). It did so by providing detailed expectations and job boundaries, and allowing those hesitant to join to reliably estimate what their anticipated workload would be in advance (138).

Staff fatigue

Very few AARs or case reports directly or indirectly discussed unintended effects associated with activation or delayed activation of public health emergency response operations. Some mentioned staff fatigue, especially when the response is overly reliant on a few key personnel (174, 664, 632). However, in some instances this issue stemmed from staff being unclear on how to prioritize response roles compared to day-to-day work (664). Therefore, some fatigue can be avoided by instituting clear policies regarding prioritization of the response.

Table 2: Summary of Findings

Key Question	*Synthesized Theme*	*Theme Dimensions*	*Citations*
What factors are useful for determining when to activate public health emergency operations?	Size or scope of the event	• Uncertainty of size or scope • Risk assessment and foresight	180, 632, 242
	Novelty of disease with unknown severity and potential for it to become widespread	• Minimize risk of public health impact	233, 163, 160, 665, 242
	Activation triggers	• Pre-defined triggers pre-event • Ad hoc triggers	174, 663, 652
	Complexity and multi-jurisdictional involvement	• Declaration of Emergency • Activation status of other agencies' EOCs	663, 06, 248, 138, 248, 638, 133, 138, 163
	Need for effective surge in response to public health emergencies	• Resource and staffing needs for response activities • Lessons learned from past decisions not to activate	06, 651, 174, 172, 199
In what circumstances should public health activate a separate public health EOC, lead a multi-agency EOC, or play a supporting role in a multi-agency EOC based on identified or potential public health threats?	EOC should be activated in order for local public health departments to lead local and/or support State level public health emergencies.	• Pace of response and resource needs • Interagency coordination	657, 663, 242, 160, 130
	Public health should lead a multi-agency EOC in response to infectious disease outbreaks (e.g., H1N1) that require coordination and information sharing between response agencies	• Clarity of roles among supporting response agencies (emergency management, police, fire, and school officials) • Unified Command considerations	663, 647, 638
	Multi-agency EOCs would benefit from public health support functions for planned events, natural and environmental disasters that require information sharing and response coordination	• Planned events with potential for public health implications • Disasters requiring public health support functions (e.g., surveillance and epidemiology, environmental health, mental health and psychological support functions, mass care and/or management and distribution of medical supplies) • Environmental disasters with potential for short-term and/or long-term public health impacts (e.g., oil spills, refinery fire)	653, 279, 660, 637, 656, 652, 131, 657, 139, 670
	Clear designation of the lead public health agency is important to facilitate effective coordination between EOCs	• Activation of local public health EOC without adequate coordination with State EOC	667, 646, 663, 665, 668
How does the response change following the activation of public health emergency operations?	Responses typically become more efficient following activation of public health emergency operations.	• Improved timeliness, situational awareness, information sharing, and interagency coordination • Enhanced ability to scale up or down to meet the needs of the response • Increased availability of resources and/or capabilities for extended, expanded, or emergent responses (e.g., coordinated messaging, hotline and website management, dissemination of Health Alert Network notices, input from subject matter experts)	174, 667, 641, 139, 660, 662, 652, 661, 638, 133, 668, 651, 06, 163, 670

What are the barriers and facilitators to successful public health emergency operations using ICS?	Prior experience using ICS and a culture of preparedness	• Familiarity with ICS • Clarity of roles and responsibilities • Adherence to ICS principles and consistency of communication channels	650, 212, 242, 670, 634, 661, 664, 657, 646, 641, 642, 648, 643, 633, 138, 179, 174, 158, 131, 653, 215, 647, 665, 660, 658, 193, 634, 631, 652
	Inter-agency relationships and coordination	• Trust, rapport, and strong relationships among response partners • Clear command structure • Consistent representation from the various response agencies	650, 633, 653, 158, 652, 168, 233, 173, 212, 650, 174, 667
	Adequate staffing	• Executive leadership support for response • Flexibility of staff to take on response roles that differ from day to day roles • Sufficient staffing depth to prevent staffing shortfalls of key response roles	647, 632, 630, 666, 161, 661, 668, 641, 131, 636, 635
	Appropriate and reliable communication technology	• Consistency and integration of software (e,g., WebEOC) across agencies • Staff training and exercises on software and equipment • Information technology (IT) unit in ICS structure • Contingencies and redundant systems	212, 163, 652, 661, 638, 643, 664, 639
	Strong, decisive leadership	• Advance planning and early activation • Decisiveness despite uncertainties and willingness to adapt and revise objectives as needed • Promotion of trust within ICS structure	212, 163, 643, 638, 661, 652
What are the benefits and undesirable effects associated with activating or delayed activation of public health emergency operations?	Improved public health emergency response	• Standardized structure, clarity of roles, improved coordination, sustained staffing • Practical experience under urgent/emergent conditions • Buy in from partner agencies	133, 653, 639, 668, 138, 163, 652, 242, 670, 203, 144
	Staff fatigue	• Reliance on a few key personnel • Lack of clarity about how to balance day-to-day responsibilities with emergency response roles	174, 664, 632

4.3 Evidence to Decision Discussion

Constructs from the evidence-to-decision framework were also applied when reviewing the AARs and case reports. This section describes considerations related to the values and preferences of the public health agency workforce with regard to activation public health emergency operations; the resources necessary to activate public health emergency response operations and the expected net benefit; equity issues associated with activation; and the acceptability and feasibility of activation. Some findings are limited by the lack of detail provided in many of the reports and are noted accordingly.

Values and Preferences

Review findings suggest that overall, the public health agency workforce values and prefers to use ICS when it comes to activating public health emergency operations. Although some tension was noted with regard to shifting from or balancing day-to-day responsibilities with response needs, public health agencies seem to value the use of ICS to coordinate response operations. This is evident by examples of jurisdictions that previously did not use ICS, preferring to use ICS in future responses due to the structure that it provides (06, 663, 637). In a case report examining the CDC's use of the ICS model during the 2009 influenza pandemic, findings indicated that CDC preferred to modify the traditional ICS model to include a policy unit to "guide the interpretation, coordination, and adjudication of policy during the response (233)." This is not a standard element of ICS, however, CDC found it helpful to modify the structure to better suit the operational context. Therefore, public health agencies could consider similar adaptations if they have the potential for improving public health response operations. During the 2009 H1N1 response in Wisconsin, some staff also felt that use of traditional ICS was like "fitting a square peg into a round hole" and that modifying the structure and adjusting resources based on expertise would generate better response outcomes (670). However, others felt that use of ICS distracted staff from focusing on response objectives (670). This suggests that at least some staff prefer not to use ICS for public health emergencies.

A couple of reports also described experiences with standing up ICS with or without a physical EOC. During H1N1 in Texas, a virtual reporting structure was established in which staff worked from their day-to-day locations, which resulted in delays in responding to response-related requests and assignments (668). The after action recommendation was to develop a policy directive that directs personnel working under a virtual response structure to prioritize response assignments. It is unclear if a physical EOC may have minimized this challenge. The North Dakota Department of Health preferred to keep the number of staff in their physical EOC smaller during 2010 and 2011 flood responses based on their experience with the 2009 Red River flood response (172). They found that large numbers of staff in the Department Operations Center made for a difficult work environment, and therefore preferred to keep support staff in supplemental locations or usual offices depending on the acuity of the response. While this approach reportedly reduced noise, increased productivity, and reduced stress for command staff without noticeable loss of control over response assets, some support staff reported some reduction in their situational awareness compared with the 2009 response. These contextual differences suggest that public health departments should consider the cost benefits and preferences of staff when deciding on physical or virtual EOC set ups.

Resources and Net Benefit

The resource, cost, and logistical constraints of implementing ICS are important considerations when deciding to activate (242). Although the AARs and case reports reviewed in this paper did not describe resources in detail, some recognized that activating and sustaining a response to a major public health event requires large numbers of staff at various locations (161). One jurisdiction addressed this need by formally communicating the expectation that all divisions within the public health agency were required to provide staffing resources for response efforts (636). In terms of non-human resources, AAR findings suggest that jurisdictions should be able to maintain an alternative EOC location with the necessary communications infrastructure (656).

Significant resources also go into training and exercises required for preparing agencies for a public health emergency response. Reports indicated that trainings and exercises were worth the time commitment and served as an asset in subsequent response operations (670, 163). Some emphasized the need for continuous federal investment in public health preparedness capacity as it has been shown to help state and local agencies achieve federal benchmarks, capacity-building activities, and functional capabilities (137, 172). Federal grant funding has also gone towards development of data systems that are critical in response and establishment of WebEOCs (172). Overall, there seems to be agreement that the resources are worth the net benefit, however, this may be a biased view as the majority of reports that were reviewed were written primarily by staff from the field of emergency preparedness and response.

Equity Issues

Very few reports discussed equity issues associated with activating public health emergency operations. Based on recommendations in AARs, however, there appears to be some consideration of equity during planning and response phases. For instance, one report noted the inclusion of interpreters and on-site physician consultants during a mass influenza clinic (158). Inclusion of interpreters helps ensure that language barriers do not impede provision of services. Findings from the Boston Marathon bombing also suggested that creating demographic profiles of healthcare organizations can help better understand the unique challenges associated with neighborhoods and populations (652).

Allocation of scare resources also presents challenges. During the 2009 H1N1 responses in Texas and Delaware, response leads had to make difficult decisions about how best to allocate the limited vaccine supply. While Delaware had an "Ethics Group," it was not activated and therefore not officially involved in vaccine allocation decisions (664). This led to confusion among the medical community about the decision-making process and criteria. In Texas, a group of experts was convened to address ethical issues and how best to prioritize and distribute scare resources (668). Although data regarding the equitable distribution of vaccines was not provided in the reports, inclusion of an ethics committee may encourage decisions that account for equity issues. Another approach is the inclusion of community representatives in the EOC for joint decision-making (173). While this is a more inclusive approach, it is important to ensure that the representatives are well-trained on response operations.

It is also important to consider equity issues internal to the EOC. One case report briefly touched on the need to avoid gender bias in training, "given the fact that there is a much greater proportion of women within emergency relevant organizations than in emergency mission organizations (215)." However, the rationale provided did not go so far as to say that gender bias

in trainings should not exist at all. Additional research is recommended to better understand how biases or inequities internal to the EOC relate to equitable response outcomes.

Acceptability and Feasibility

Review findings indicate that the activation of public health emergency operations is both feasible and acceptable to most key stakeholders. However, further research is needed to better understand the circumstances in which agency executives make a decision not to activate. The majority of reports examined in this paper were written in the context of the decision to activate. Therefore, it is difficult to ascertain the circumstances in which activation was considered unacceptable or unfeasible.

5 Limitations

Findings in this report are limited by the lack of availability of AARs and case reports focused on the specific research questions of interest. AARs and case reports that were indirectly related to public health were helpful in informing findings, however, more directly related reports may have enabled a more nuanced understanding of information sharing specifically in the context of public health. Further research is recommended to address this important research gap.

An additional limitation is the varying level of rigor of the reports. Although some reports mentioned evaluation or research methods, many did not provide sufficient detail or any methods at all. Therefore, there is a potential for possible bias based on unknown methods. Guidance aimed at improving after action methods and the level of detail included in after action report methods sections is recommended for both transparency and quality purposes. For a quality assessment of after action reports reviewed in this paper, please refer to the commissioned paper entitled *Quality Assessment of After Action Reports: Findings and Recommendations*.

Findings may also be limited by selection bias as only AARs and case reports publically available or volunteered by jurisdictions were included in this review. It is possible that AARs considered too sensitive to post publically could have provided additional or conflicting views. Additionally, there is potential for reporting bias as political considerations may impact what gets included or excluded from AARs. Some AARs may be weighted towards actionable issues as AARs typically focus on identifying corrective actions based on lessons learned. Therefore, it is possible that some challenges were left out on the basis of the ability to act on them.

6 Conclusion

Based on findings from this AAR/ case report review, activation of public health emergency operations is optimal when the needs of the incident exceed the capacity and/or capabilities of a public health agency. Furthermore, early activation is recommended for public health threats that have the potential to be severe or become widespread as it can help minimize risk of public health impact. Additionally, activation is recommended for planned events with potential for public health implications, disasters requiring public health support functions, and environmental disasters with potential for short-term and/or long-term public health impacts.

Findings also suggest that activation is appropriate for complex and multi-jurisdictional responses, including but not limited to formally declared emergencies. Activating in these

circumstances seems to typically facilitate more effective coordination through ICS and Unified Command structures. Following the decision to activate, response operations typically become more efficient and able respond to emergent needs with more flexibility. However, breakdowns in the chain of command and communication channels often hinder the effectiveness of response operations. To optimize for success, findings suggest that agencies should invest in preparedness efforts to ensure that strong relationships, adequately trained staff and leadership, and communications mechanisms are in place in advance of an emergency.

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665 Ohio Department of Health. (2010). *Fall 2009 H1N1 Response After Action Report – Improvement Plan.*
666 Tri-County Health Department. (2017). *Public Health Emergency Dispensing Exercise (PHEDEX) After Action Report and Improvement Plan.*
667 Texas Department of State Health Services. (2018). *Hurricane Harvey Response After-Action Report.*
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670 Wisconsin Division of Public Health. (2010). *2009 H1N1 Influenza Response After Action Report/ Improvement Plan.*

Appendix A: After Action Report/ Case Report Sorting Tool

Sorting Criteria: Significance	Prioritization	Comments	Reviewer guidance	*Notes*
1. Does the report include information relevant to activating a public health **EOC**?	**High/ Low** ***Yes = High*** ***No = Low***	[Reviewer to provide brief explanation for prioritization]	*Yes = High Priority*: The report provides sufficient relevant information to inform a thematic analysis. It adds context, is meaningful, useful, and may be used to inform decision making *No = Low Priority*: The report either briefly mentions, or does not mention the key areas of interest. Insufficient information to inform a thematic analysis.	*Adapted from AACODS checklist - "This is a value judgment of the item, in the context of the relevant research area"* *Reports categorized as "High" priority will be analyzed by report type (AAR vs Case Report) and key area of interest (EOC)* *Reports categorized as "Low" priority will be randomly sampled. The number sampled will be dependent on # of low priority reports and time available. If initial random sample yields new themes, additional reports will be randomly sampled until saturation is reached.* *AARs covering tabletop exercises will be categorized as low priority given that findings from tabletops are not based on real experience or simulations. However, if a tabletop AAR is relevant to the research question, the AAR will be included in the analysis if the specific area of relevance did not otherwise emerge from analysis of the high priority report.* *Some reports may have little to no information related to EOC to warrant inclusion into the analysis. These reports will not be included in the analysis.* *Note: Rigor is not used as a sorting criterion because the primary purpose of this AAR/case report review is to synthesize experiential data to add weight to findings from research studies, provide a different perspective from research studies, or to provide the only available perspective concerning specific phenomena of interest. Additionally, reports eligible for the AAR/Case Report thematic analysis are those that have been excluded from the analysis of research studies. Therefore, they already do not meet a certain threshold for rigor.*

Appendix B: Sorted After Action Reports/ Case Reports

ID	AAR Reference	EOC Prioritization
630	Wood County Health District. (2017). *2017 Regional Functional/ Full-Scale Exercise After Action Report/ Improvement Plan.*	High
631	Florida Department of Health. (2017). *2017 Statewide Hurricane Full Scale Exercise After Action Report/ Improvement Plan.*	High
632	City of Nashua. (2012) *October Nor'easter After Action Report.*	High
633	Oklahoma Department of Emergency Management. (n.d.). *Earth Wind and Fire After Action Report/ Corrective Action Plan.*	High
634	Logan County Health District. (2015). *2015 Logan County Health District Full Scale Exercise After Action Report/ Improvement Plan.*	High
635	Tri-County Health Department. (n.d.). *Public Health Incident Management Team (PHIMT).*	High
636	Tri-County Health Department. (2013). *Public Health Incident Management Team-NACCHO Model Practice Award Application 2013.*	High
637	Contra Costa Health Services. (2012). *Chevron Richmond Refinery Fire of August 6, 2012 After Action Report Based on Medical/Health Debriefing Conducted September 10, 2012.*	High
638	DuPage County Health Department (2009). *H1N1 After Action Report - Improvement Plan.*	High
639	Governor's Office of Homeland Security & Emergency Preparedness. (2012). *Hurricane Isaac After Action Report & Improvement Plan.*	High
640	Carver County Public Health. (2014). *One Flu Over the Turkey's Nest After Action* Report/ *Improvement Plan.*	Low
641	Multnomah County Health Department. (2009). *'Swine Flu Multco' Spring 2009 H1N1 Response After Action Report/ Improvement Plan.*	High
642	Becker County Community Health. (2013). *People and Stuff HSEM Region 3 Logistics Exercise After Action Report/ Improvement Plan.*	High
643	Chicago Department of Public Health, Illinois Department of Public Health, & Metropolitan Chicago Healthcare Council. (2011). *Illinois Hospitals Pediatric Full-Scale Exercise After Action Report.*	High
644	Montana Department of Public Health and Human Services (2014). *Big Sky Push II Full Scale Exercise After Action Report/ Improvement Plan.*	Low
645	United States Environmental Protection Agency. (2012). *Nevada 2012 Bio-Hazard Response and Recovery After Action Report*	Low
646	New Hampshire Department of Safety and Department of Health and Human Services. (2009). *Cities Ready Initiative Operation Rapid RX Full-Scale Exercise After Action Report.*	High
647	New Hampshire Department of Safety and Department of Health and Human Services. (2009). *New Hampshire Spring 2009 H1N1 Response After Action Report/ Improvement Plan.*	High
648	Minnesota Department of Health. (2013). *Operation Loon Call 2013 After Action Report/ Improvement Plan.*	High
649	Scott County Public Health. (2014). *Operation Water Woes Tabletop Exercise EOC Operations/PIO After Action Report/ Improvement Plan.*	Low
650	San Francisco Department of Public Health (2010). *Fall/Winter 2009-2010 H1N1 Swine Flu Response After Action Report/ Improvement Plan.*	High
651	County of San Diego. (2018). *San Diego Hepatitis A Outbreak After Action Report.*	High
652	Boston Public Health Commission (2013). *2013 Boston Marathon ESF-8 Health & Medical Planning, Response, & Recovery Operations After-Action Report/Improvement Plan.*	High

653	Massachusetts Emergency Management Agency, Massachusetts Department of Public Health, City of Boston, City of Cambridge, Town of Watertown, Massachusetts Bay Transportation Authority Transit Police Department, Massachusetts National Guard, & Massachusetts State Police (2014). *After Action Report for the Response to the 2013 Boston Marathon Bombings.*	High
654	Buffalo Hospital & Wright County Public Health. (2013). *Buffalo Hospital Closed POD After Action Report/ Improvement Plan.*	High
655	Tri-County Health Department. (2017). *Community Inclusion Point of Dispensing (POD) Public Health Emergency Distribution Exercise.*	Low
656	Capitol Region Council of Governments (2017). *Ebola Virus Disease Full Scale Exercise After Action Report.*	High
657	Capitol Region Council of Governments (2016). *Ebola Virus Disease Functional Exercise After Action Report.*	High
658	Metropolitan Medical Response System Capitol Region Connecticut (2016). *CT Region 3 ESF-8 Ebola Preparedness & Response After Action Report/ Improvement Plan.*	High
660	Florida Department of Health (2010). *2010 Deepwater Horizon Oil Spill After Action Report/ Improvement Plan.*	High
661	Multnomah County Health Department. (2010). *H1N1 Fall 2009 MultCo After Action Report/ Improvement Plan.*	High
662	Minnesota Department of Heath Department. (2014) *DOC FE Flash Floods 2014 After Action Report/ Improvement Plan.*	High
663	New Hampshire Department of Health and Human Services and Department of Safety (2010). *New Hampshire H1N1 Response After Action Report/ Improvement Plan*.	High
664	Delaware Division of Public Health (2010). *Novel H1N1 Influenza Delaware Response After Action Report/ Improvement Plan.*	High
665	Ohio Department of Health. (2010). *Fall 2009 H1N1 Response After Action Report – Improvement Plan.*	High
666	Tri-County Health Department. (2017). *Public Health Emergency Dispensing Exercise (PHEDEX) After Action Report and Improvement Plan.*	High
667	Texas Department of State Health Services. (2018). *Hurricane Harvey Response After-Action Report.*	High
668	Texas Department of State Health Services (2010). *Texas Department of State Health Services Response to the Novel H1N1 Pandemic Influenza After Action Report.*	High
669	Wisconsin Hospital Emergency Preparedness Program. (2010). *After Action Report (AAR) for H1N1 Influenza.*	High
670	Wisconsin Division of Public Health. (2010). *2009 H1N1 Influenza Response After Action Report/ Improvement Plan.*	High

ID	Case Report Reference	EOC Prioritization
06	Adams, E. H., Scanlon, E., Callahan, J. J., & Carney, M. T. (2010). Utilization of an incident command system for a public health threat: West Nile virus in Nassau County, New York, 2008. *Journal of Public Health Management and Practice,16*(4), 309-315.	High
128	Beatty, M. E., Phelps, S., Rohner, C., & Weisfuse, I. (2006). Blackout of 2003: Public health effects and emergency response. *Public Health Reports, 121*(1), 36-44.	High
130	Branum, A., Dietz, J. E., & Black, D. R. (2010). An evaluation of local incident command system personnel in a pandemic influenza. *Journal of Emergency Management, 8*(5), 39-46.	High
131	Buehler, J. W., Caum, J., Alles, S. J. (2017). Public Health and the Pope's Visit to Philadelphia, 2015. *Heathl Security, 15*(5), 548-558.	High
133	Centers for Disease Control and Prevention. (2013). CDC's Emergency Management Program Activities – Worldwide 2003-2012. *Morbidity and Mortality Weekly Report, 62*(35), 709-732.	High
135	Dausey, D. J., Buehler, J. W., & Lurie, N. (2007). Designing and conducting tabletop exercises to assess public health preparedness for manmade and naturally occurring biological threats. *BMC Public Health, 7,* 1-9.	Low
137	Davis, M. V., MacDonald, P. D. M., Cline, J. S., & Baker, E. L. (2007). Evaluation of public health response to hurricanes finds North Carolina better prepared for public health emergencies. *Public Health Reports, 122*(1), 17-26.	High
138	Fishbane, M., Kist, A., Schieber, R. A. (2012). Use of the emergency incident command system for school-located mass influenza vaccination clinics. *Pediatrics, 129,* S101-S106.	High
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