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ORIGINAL RESEARCH

Lessons Learned from the State of Ohio H1N1 Influenza Outbreak After-Action Review

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Abstract

Objective: In early 2009, H1N1 influenza was identified within the human population [1-5]. Centers for Disease Control and Prevention (CDC) officials responded with focused assessment, policy development, and assurances [6-8]. The response was mobilized through efforts including procurement of adequate supply of vaccine, local area span of control, materials acquisition, and facilities and resource identification [8].

Methods: Qualitative evaluation of the assurance functions specific to the system's ability to assure safe and healthy conditions are reported [9]. The methodology mirrors Homeland Security Exercise and Evaluation Program (HSEEP) used to assess system capability [10].

Results: Findings demonstrate the effectiveness of community responsive disease prevention efforts in partnership with the public health systems mission to unify traditional public sector systems, for-profit systems, and local area systems was accomplished. As a result of this response pharmaceutical industry, health care providers, health care agencies, police/safety, colleges, and health and human service agencies were united [11].

Conclusions: Findings demonstrate the effectiveness of community response strategies utilizing feedback from system stakeholders. After-action review processes are a critical part of all-hazards preparedness. This analysis of local health district response to the H1N1 influenza outbreak informs future public health service delivery. Results provide a synthesis of local health department's emergency response strategies, challenges encountered, and future-focused emergency response strategy implementation.

Keywords

H1N1, Influenza, Outbreak, Prevention, Mass vaccination, Volunteer management, Community mitigation, Interoperable communications, Risk communications, Epidemiological surveillance

Introduction

The 21st-century public health system is charged with establishing effective public health policy, assessing and addressing threats, and assuring safe conditions in which all citizens can live [12]. The nation's local, state, and federal public health agencies have a critical and central role to maximize system-wide pro-health accomplishments. The nation's public health system, as demonstrated by the 2009-10 H1N1 pandemic response, documented the capacity of public health organizations to operate as a system [13]. On June 11, 2009, the World Health Organization (WHO) declared a worldwide pandemic, indicating that H1N1 spread through community-level transmission worldwide [1,3,7,14-16]. This system linked the community health and human services agencies at the local, state, national, and international level to effectively address a pandemic that had the potential to cause mass global casualties.

This H1N1 influenza public health systems capacity assessment addresses a broad array of emergency response operational issues, best practices, and challeng-



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es faced in providing essential public health services during a pandemic outbreak [13]. Six capabilities were addressed including 1) Mass Vaccination, 2) Volunteer Management, 3) Community Mitigation, 4) Interoperable Communications, 5) Risk Communications, and 6) Epidemiologic Surveillance and Investigation. Sixty-one of the 130 local public health departments in the State of Ohio voluntarily participated in the evaluation. Data was collected between the months of August, 2009 through March 2010. Findings provided in this report include qualitative data analysis that is intended to give an in-depth understanding of how system responses developed and were managed over the 2009-10 H1N1 mass vaccination response. The qualitative analysis is intended to provide an understanding as to why certain policies, procedures, and best practices emerged at the local level. Potential limitations of the qualitative analysis include generalizability to all Local Health Departments (LHDs) in the state due to potential response bias. The participating jurisdictions cover approximately 70% of Ohio's population, as the majority of non-participating LHDs represented city or rural county jurisdictions.

This analysis represents feedback from both capability and activities that were experienced throughout the H1N1 influenza pandemic in a combination of health department types [17]. As local public health departments move toward voluntary accreditation and other performance-based evaluation systems, it is critical that systems for data collection be developed and instituted to maximize efficiency [18]. To achieve public health objectives of maximal population-level effectiveness, data-driven decision making through centrally coordinated dynamic processes are essential. Future all hazards emergency response preparation requires time to pause and reflect on 21st-century events [19]. Examples include the September 11, 2001 terrorist attacks [20], Hurricane Katrina in 2005 [21], the H1N1 influenza outbreak of 2009-10 [22], and the Ebola outbreak of 2014-15 [23]. The primary mission of the public health system uniquely positions the workforce and organizations to transcend barriers in meaningful and impactful ways. The past decade has demonstrated that public health can and does affect community-level health and population-level health [24,25]. A critical challenge to be addressed over the next decade will be to retool the system to work both efficiently and effectively toward the primary objective of maximizing community health and prevention of disease.

Activity-level analysis

Activities are groups of similar tasks that, when carried out according to plans and procedures, allow an entity to demonstrate an associated capability. Such analysis helps assess the effectiveness of individuals working together in the discipline or at the organizational level, and how well team members communicate across organizational boundaries during an incident. Ac-

tivity-level analysis formed the basis for this response evaluation. Activities were selected for evaluation from multiple sources including; the Target Capabilities List and the Ohio Department of Health Public Health Emergency Response Grant [26] guidance documents.

Task-level analysis

Tasks are specific, discrete actions that individuals or groups must successfully perform or address during response. Task-level analysis assists representatives of responding entities in analyzing shortcomings or strengths related to these individual actions. This analysis can also help entities target plans, equipment, and training resources to improve specific task performance. While this research does not specifically address task level analysis, it does provide information that may identify task-level improvement opportunities.

Capability-level analysis

Capabilities are combinations of elements (e.g., personnel, planning, organization and leadership, equipment and systems, training, exercises, assessments, and corrective actions) that provide the means to achieve a measurable outcome. The capability-level analysis is designed to assist managers and executives in developing operating plans and budgets, communicating with political officials, setting long-range training and planning goals, and developing interagency and inter-jurisdictional agreements. For the purpose of evaluating this response, six capabilities were selected based upon the broad categories of public health response activities conducted.

Methods

A qualitative analysis was conducted based upon surveys received from 61 participating local public health jurisdictions. The six emergency response capabilities are reported by best practice-related response items as well as identified challenges. For each capability, additional analyses were conducted on specific response activities to provide additional depth and context.

Two independent reviewers trained in qualitative data analysis analyzed the data generated by all participating LHDs. Both reviewers classified and coded the data and developed theme analyses as a result of the data reported by the respondents. Within each of the six domains, key questions have been selected and are reported.

Researchers developed the original survey data collection instrument. Questions were developed across the six target capability areas as well as for clinical operations and vaccination shipment data. Survey questions consisted of dichotomized (yes/no) questions, quantitative numeric data, and short answer/best practices response narrative type. The full survey instrument can be provided upon request.

Sample population and selection

All LHDs within the State of Ohio were invited to participate. The Association of Ohio Health Commissioners served as the lead agency on the initiative with the assistance of researchers from the Ohio State University Center for Public Health Practice and an external faculty consultant. The response rate, as calculated as the total number of participating local public health jurisdictions divided by the total number of jurisdictions statewide, is calculated at 47%. While just under half of the state's local health districts participated, these jurisdictions cover approximately 70% of Ohio's population. Responses were received from most of the major metropolitan areas including Akron, Canton, Cincinnati, Cleveland, Columbus, Toledo, and Youngstown as well as geographically dispersed suburban and rural districts.

Data collection protocols

Data collection occurred in two phases. During the first phase, representatives from participating jurisdictions entered their data into a commercial online survey system. A separate survey was deployed for each of the six assessed capabilities. Additionally, respondents used the online survey system to enter data about each mass vaccination clinic and all vaccine shipments during the reporting period, which was August 1, 2009, through December 31, 2009. Additional data was collected from January 1, 2010, through March 31, 2010. These data were also entered directly by the participating jurisdictions.

The Association of Health Commissioners (AOHC) provided all communications to the participating jurisdictions regarding data collection and assisted in data entry for some participants. There was also a strong motivation for accuracy as participating jurisdictions used the information they entered to hold subsequent local after-action review meetings with their response partners.

Mass vaccination tracking systems varied widely by LHD. Common tracking methods included the Ohio Department of Health IMPACT SIIS system. The IMPACT SIIS is the statewide immunization information system [27] which uses hand-written logs and Microsoft EXCEL spreadsheet data entry. Given the variability within LHD delivery systems and staffing models, a variety of methods for tracking vaccine and vaccination supplies emerged. Many LHDs reported that limiting ordering, distribution, and accounting to one representative per jurisdiction was an effective approach in promoting accuracy and maximizing efficiency.

Local public health districts were afforded the opportunity to address the H1N1 epidemic using an approach that was most appropriate for their unique set of circumstances. Public health districts were tasked with the primary objective of mass vaccination to specific populations. Local area leadership had the flexibility and au-

tonomy to develop, operate, and implement emergency response plans for vaccinating the entire public.

Results

Findings are reported for each of the six emergency response capacities; 1) mass vaccination, 2) volunteer management, 3) community mitigation, 4) interoperable communication, 5) risk communication and 6) epidemiologic surveillance and investigation. Results are intended to provide details as to effective strategies implemented as well as to offer post-event review to guide future systems improvements.

Capability 1: Mass vaccination

The best practices for utilizing Incident Command System (ICS) for mass vaccination activities include color-coded vests, communication before and after, clear staff role delineation, and maintaining same staff in same roles across time. ICS was consistently reported as an effective approach across all LHDs. Some effective tools were used by LHDs including job action sheets, feedback protocols, briefing/debriefing, written protocols, structural details, and common language. LHD's reported using locations such as schools, health districts, and community centers to create mass vaccination clinics. Challenges with ICS include operational implementation, staff matching for operational role(s), staff education about common language, and lack of sufficient staff to provide mass vaccination operations. Challenges for identifying and enrolling H1N1 vaccine providers included: lack of user-friendliness with complex data entry systems, lack of participation among providers, and minimum dose requirements for participation.

The most commonly cited challenge was the complexity and associated issues relating to the IMPACT SIIS data entry system. Respondents consistently reported that the Ohio Department of Health (ODH) on-line system for providers was complex, not user-friendly, the ODH order system was confusing, and some provider computer systems were outdated. Many health districts reported that local healthcare providers opted not to participate because training was time-consuming, taking them away from their regular clinical practice commitment. Many providers did not like governmental intrusion into their practice. Additionally, local providers stated that there were no incentives for participation and, in fact, there were disincentives. Some providers lacked adequate refrigeration units to secure and maintain vaccine at appropriate temperatures. The ODH Friday briefings were beneficial as they opened communication lines between all parties.

Capability 2: Volunteer management

Improved communications including advance briefings and debriefings were suggested as an effective strategy to promote high-quality mass vaccination clinics. Many LHD representatives reported that the par-

icipation of students from health professions schools/colleges, particularly nursing programs, was an effective partnership extending the number of appropriately skilled personnel. It was recommended that an up-to-date volunteer database be maintained including multiple health-related professionals such as nurses, family medicine practitioners, EMT's, social workers, mental health professionals, and other such professionals. The recommendation to maintain appropriate credentialing and licensure in this database was advised. Google scheduling was suggested as an effective tool for volunteer scheduling and coordination. Many LHDs hosted hospitality efforts such as feeding volunteers and recognition for their efforts. Written policies and procedures for volunteers were vital to successful operations.

There was need for formal written and operational policies and training for volunteers. Additionally, there was a need to develop processes and protocols for managing volunteer staff in practice within the mass vaccination clinical setting. The medical reserve corps (MRC) was an asset, but expansion for the MRC across multiple health-related disciplines was necessary. The utility of an expanded MRC would resolve a concern of many health district representatives relating to the issue that there were unresolved legal issues, liability issues, and health professionals credentialing concerns. In the future, there needs to be a larger and expanded pool of volunteers. There were issues reported as to dependability and reliability of volunteers. Problems were created by time conflicts relating to mass vaccination clinic scheduling that conflicted with regular work scheduled for volunteers who have practices and regularly scheduled work at the same time as the clinics. A consistent theme was reported that volunteers are needed to report in a 'just-in-time' model prior to a mass vaccination clinic to receive instruction and training. Communication with volunteers presented a challenge for volunteers with no e-mail access. A system for communication in the future that overcomes this challenge will be vital to success. Of specific concern for LHDs was an early rush and response on the part of community-based volunteers that decreased substantially as time passed. This is of particular concern for future public health emergencies that might occur for an extended period.

Capability 3: Community mitigation

Public information management was critical. Foremost, it is essential that public information officers provide clear and consistent messages to the media. Among the media messages that were reported by LHD representatives were: 1) hand-washing and hygiene, 2) "Cover your cough", and 3) social distancing. Public health worked effectively with local school superintendents statewide to monitor absenteeism rates and to modify attendance policies. Public information management was vital, and it was important to have correct and consistent media messaging. Local school cooper-

ative agreements were beneficial as well as frequent departmental briefings. Targeted efforts to reach out to Spanish speaking populations through targeted media messaging in many communities were achieved.

Many respondents mentioned an initial fear and panic in their jurisdiction that challenged their infrastructure. Some reported that incorrect information was disseminated through the media that decreased the effectiveness of the LHD's campaign to educate the public on the virus. After disease incidence waned, and rumors of the virus being less severe than originally expected spread, the general public grew apathetic and disinterested in receiving the vaccine despite repeated recommendations from the LHDs. Some school districts acted against or without LHD authorized recommendation. In particular, social distancing was found difficult to implement, especially when businesses, schools, and parents began to perceive the virus as less of a threat. Many LHDs provided schools with CDC H1N1 toolkits and guidance documents to best assist at the local level. Many LHD representatives also commented that their communication with the ODH was strained and less than productive. Many respondents cited that ODH had inconsistent messages and information, and this was a source of frustration and confusion. Vaccine ordering and delivery, lack of staff, and difficulties in communicating with the CDC were also of concern.

Capability 4: Interoperable communication

Most LHDs mentioned the use of traditional modes of communication in their responses. Blast faxing, mass e-mails and phone calls were seen as efficient strategies to communicate with healthcare providers. Several respondents added that the voice over Internet protocols kept involved parties informed throughout this "highly fluid", potentially moment-to-moment changing situation. Multi-Agency Radio Communication System (MARCS) radios were a frequently discussed topic in LHD's responses. Some found that staff training in MARCS radio operation was beneficial. Some respondents also discovered that MARCS radios were ideal for communications between the physician practices/clinics and departmental operations centers.

While staff training in MARCS radios was a topic of concern, most LHD representatives described the improvement of MARCS radio abilities as a best practice worth pursuing. Improvements to the MARCS system include the use of a portable 800 MHz tower, removal of the interference with other emergency communication systems, and increased collaboration with emergency medical assistance (EMA). Many representatives found that their MARCS radios did not function in the buildings in which they were operating. Some LHDs lacked enough MARCS radios for their operations. Some lacked the ability to set up phone banks to receive the multitude of calls they were getting. Several representatives lamented about the lack of regional and state cooper-

ation and large amounts of information from the CDC and the ODH, which could barely be processed by the limited staff. Another cause of concern for the LHDs was problems in receiving timely and accurate information from their vertical partners. Many health district representatives stated that frequent changes in guidance from partners such as the CDC and ODH overwhelmed them and decreased their credibility with other partners. LHDs must have streamlined approaches that increase efficient leadership and minimize ambiguity and confusion.

Capability 5: Risk communication

One of the challenges concerning risk communication and disease prevention messaging experienced by LHDs was that information received at the local level from the ODH as well as from the CDC conflicted with earlier communications to the public. Indeed, as the H1N1 response activities unfolded from early 2009 through 2010, the local response was necessarily dynamic as the unfolding of the pandemic and subsequent risk communication strategies emerged. Often, the general public was confused by these changing and at times conflicting messages. LHDs with public information officers (PIOs) report that centrally coordinated community-level disease prevention communications through a central point person were effective and reduced confusion and public unrest.

Many of the LHDs expressed concern that local media aggravated public fear and confusion. Concerns over media were mixed. As some representatives reported that their existing and open communication with the local media was effective and was defined as a best practice, other LHDs lacking existing communications with local media suffered from strained relations. LHDs with PIOs often implemented a strategy of regular communication with local media with timely and regular communication. Multiple communication avenues proved to be most effective including telephone, press conferences, web-based and other routes of information dissemination. The recall of vaccine also presented problems for LHDs, and some reported community members failing to trust the effectiveness of the vaccine. Finding ways to communicate risk to minority groups, especially those for whom English is a second language, was also cited as a challenge. Finally, the media's frequent distortion of information was a continuous challenge faced by many LHDs.

Capability 6: Epidemiologic surveillance and investigation

Many LHD representatives referred to effective communication and solid relationships with local partners including hospital infection control staff, family medicine practitioners, and other community physicians as an important practice. Overseeing a coordinated effort such as epidemiological surveillance, LHDs believed that

maintaining long standing lines of communication with these community partners ensured both accuracy and cooperation in surveillance. The school symptom surveillance system was another key best practice according to many respondents. One specific improvement to this was modeled after a best practice in Tarrant County, Texas [28,29]. Many respondents also cited the continued creation of weekly reports when considering best practices. These reports organized epidemiological data and trends so that the LHDs could best assist physicians in addressing issues surrounding the virus and immunization of their patient populations. Some LHD representatives advocated utilizing their standard surveillance practices, explaining that these can be applied to any abnormal situation. These LHDs felt that by using systems already in place they decreased the "unnecessary" work created by building a new surveillance system, thereby decreasing response time.

An area of major concern for LHDs involved the changes in the ODH testing algorithm. Many respondents reported that the "inconsistency" of recommendations from ODH and CDC was a source of confusion for physicians and LHDs alike. Numerous LHDs described themselves as overwhelmed at times. The sharing of one epidemiologist between multiple health districts and small staffs were frequently viewed as problematic. Many of respondents also noted difficulties with cooperation of surveillance partners. Several LHDs cited physicians' inconsistent reporting or confusion with the algorithms as obstacles to successful surveillance, which was one of the factors that adversely impacted the quality and timeliness of data collection. Rural respondents reported that the lack of health care providers in their areas was a contributing factor affecting timeliness and accuracy.

Emergency department visits and influenza-like infection hospital visits were both prevalent syndrome-related surveillance indicators, with EpiCenter cited as an important tool for detecting anomalies in that data. In some cases, LHDs reported that they followed this data for surrounding regional hospitals as well, especially when there were no hospitals in their jurisdiction. EpiCenter was also used in some LHDs to track respiratory and constitutional syndromes, cough, and fever symptoms at those hospitals. Many respondents mentioned attendance tracking systems at local school systems in describing their surveillance indicators. Over-the-counter sales of thermometers and related medications were indicators that many LHDs reportedly used. LHDs tracked this information using the Nation Retail Data Monitor (NRDM) system. LHDs used Ohio Disease Reporting System (ODRS) to track influenza hospitalizations. Also, some respondents mentioned tracking the number of rapid influenza tests completed and confirmed as well as influenza-related deaths through the coroner's office. Additionally, web search tracking was cited among several LHDs.

Discussion

Consistency of information was a significant issue throughout the six-month evaluation period data was reported. Of critical importance was that public health emergencies are fluid, constantly changing with the passage of time. As new information and best practices toward response emerge, disease prevention officials are charged with implementing real-time responses to maximize public health protections. Communications are central to effective response plans. These communications are multi-directional including within workforce, up and down the chain of command, across affiliated organizational partners, between media, and to the general public. Of particular importance is that local area leadership be afforded the flexibility in establishing and implementing methods that best serve the entire citizenry.

Training and education

Advanced preparation as well as just in time training are essential for future public health emergency response operations. Maintaining core clinical medicine skill sets within the workforce as well as the voluntary medical reserve corps is vital. Local leadership must continue to be vigilant about maintaining fundamental-basic, clinical skill sets and assure the workforce is appropriately trained. Given the immediacy and complexity of the H1N1 immunization response, the ability to reach out to voluntary workers within the community was instrumental. The clear and consistent message received in their public health practice response was that the volunteer base was less than sufficient to meet community-level needs during a large-scale response [30]. Databases and systems to coordinate voluntary workers need to be improved in an intentional and on-going systematic manner.

Education differs from training. Training can be understood as hands on, skill-set oriented, and process outcomes oriented. Education is more overarching, encompassing understanding and awareness among individuals. As demonstrated in this evaluation, there are different levels of educational needs and educational resources. Messages are dynamic; changing with the passage of time. Although both training and education are active, it is important to recognize that training is skills-based and should be assured in an on-going systematic manner. Education is multi-directional and needs to be implemented effective and responsive.

Coordination

Coordination of activities in a changing, complex, and dynamic environment is critical. Articulation and awareness of the ICS protocols are necessary but not sufficient, full and effective communications are required throughout the multiple-evolved communities and are necessary to inform, engage, and evolve the community-wide system stakeholders [30]. The evaluation themes include fear and varied information among the media, schools, and a host of other sources. An ef-

fective communication plan requires transparency, full participation, centralization, and coordination. Above all, the effective coordination of disease prevention during a public health emergency is essential. An effective response takes advanced planning and effective coordination requiring a great amount of time and diligence.

Conclusions

This post-event analysis of qualitative data generated across the 6-month H1N1 influenza outbreak reinforces many of the best practices as defined by the ICS. The six emergency response capacities are an effective structural model by which to evaluate system effectiveness and response. The vast majority of the post event analysis points to effective and efficient public health systems response.

Areas for systems improvement relate specifically to improved mobilization of emergency response systems and enhanced communication updates about outbreaks. Also recommended, was the importance of PIOs serving as intermediaries between the press and the public.

Effective internal organizational communications relating to the chain of command, specifically effective up and down the chain of command communications were recommended. Effective communication between federal, state, and local public health authorities play a critical role in epidemiological surveillance and outbreak risk reduction.

Based on these findings it is fair to state that the State of Ohio public health system response to the H1N1 outbreak was effective. The response demonstrated effective system wide success across all six emergency response capacities. If one key lesson is to be learned from this assessment, it would be that after-action review processes are of vital importance, playing a critical part in the all-hazards preparedness operations ultimately reducing the spread of disease.

This after-action review provides evidence as to the utility of vaccination planning and delivery at the population level [31]. Resources are provided by the WHO as to effective planning, implementing, evaluating, and re-tooling of mass vaccination initiatives. As demonstrated by this and other pandemics, the key to effective population-level response is maximized by systems thinking and systems-level quality improvement utilizing best practices evidence.

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