Patient Unified Lookup System for Emergencies (PULSE) 
Drill Report

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Submitted to: California Emergency Medical Services Authority 
Submitted by: California Association of Health Information Exchanges 
PULSE +EMS Subject Matter Expert Advisor 

The PULSE project was developed in collaboration with Office of the National Coordinator for Health Information Technology (ONC) staff to support nationwide health information exchange and care coordination efforts.
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1. Drill Overview

The California Emergency Medical Services Authority (EMSA) received a significant investment from the Office of the National Coordinator for Health Information Technology to support the integration of health information exchange with emergency medical services in California. This funding in part supports the development of a disaster response medical history portal called the Patient Unified Lookup System for Emergencies (PULSE) that is the subject of this document.

The culminating activity of the PULSE grant is a table-top drill of the use of PULSE and integrated components during a mock disaster, demonstrating and evaluating the capabilities of PULSE in support of the work of healthcare volunteers at multiple facilities by ensuring connections are maintained with four health information organizations and testing connectivity of the Disaster Healthcare Volunteer (DHV) system and Directory Services. PULSE is a web-based application accessed via single sign-on through the DHV portal that allows a user to search for and retrieve health information on disaster victims or evacuees. It supports two roles: volunteers that are searching for patients matching the demographics of victims or evacuees, and volunteers that are reviewing information discovered on victims or evacuees in order to treat them. During the drill, DHV volunteers were asked to respond to short scenarios, each one asking them to search for patients, retrieve health information on them if available, and answer specific questions. The scenarios covered five separate types of patients that might be seen during a real disaster: evacuees transferred from a healthcare facility in the affected area, victims transported by first responders, victims transported by friends or family, walking wounded in need of first aid, and evacuees in need of routine care now that they are displaced from their normal care providers. Searches were made using fictitious patient demographic information and included a specific request for information, such as drug allergies for the patient that were retrieved following the search for health information.
2. Drill Design

Objectives of PULSE
Natural or manmade disaster situations often force individuals to seek care outside of their usual facilities or provider networks. Additionally, the disaster area’s healthcare system is often stretched beyond its limits during a disaster, and volunteers must be placed into service to care for victims and evacuees. The result is that those delivering care may not have access to the primary systems holding the health information of the patients being received at their facility, leading to suboptimal outcomes and potential patient safety issues.

PULSE is intended to provide healthcare professionals with access to electronic health information for victims and evacuees during time of large-scale disaster – information that may be drawn from disparate systems within and outside of the effected region. Users of PULSE include disaster healthcare volunteers that will access health information through a web-based portal, and healthcare professionals that may use the capabilities of PULSE to search for and retrieve information from within the capabilities of their electronic health record systems or health information exchange systems. PULSE is not intended to be a replacement for an electronic health record, electronic patient care reporting system, or any other means for documenting care, but a supplement to existing electronic and paper-based systems designated for that purpose.

PULSE is integrated with the existing California Disaster Healthcare Volunteers (DHV) database, California’s implementation of Emergency Service Advance Registry for Volunteer Healthcare Professionals (ESAR-VHP) that provides a registry for individuals who wish to volunteer to serve during an emergency or disaster. Healthcare professionals preregistered through DHV and activated for a disaster response will be able to access the PULSE portal, with DHV providing the means for authentication and authorization to access protected health information electronically.

PULSE is also integrated with Directory Services, a component of the California Trusted Exchange Network (CTEN). Directory Services provides a services registry with the information PULSE requires to identify the healthcare organizations and facilities that participate in PULSE, and the means to search for and retrieve health information from them electronically.

PULSE correctly matches patient identities with varying amounts of input demographics or knowledge of organizations that have previously provided care, and retrieves health information suitable for the varying needs of the specific victim or evacuee.

See Patient Unified Lookup System for Emergencies (PULSE) System Requirements for more information on the concepts for PULSE.

Objectives of the Drill
The primary objective of the Drill was to review the initial deployment of PULSE functionality in support of the work of healthcare volunteers at multiple facilities by:

1. Ensuring connections with four health information organizations (HIOs);
2. Testing connectivity of the Disaster Healthcare Volunteer system, as operated by Intermedix, and Directory Services as part of the California Trusted Exchange Network (CTEN), as operated by California Association of Health Information Exchanges;

3. All of which is part of the PULSE system created and operated by Audacious Inquiry.

Additional objectives included conducting just-in-time training on PULSE for the first shift in the alternate care facilities (ACF), open all three ACFs, and begin patient intake.

**Incident Action Plan**

Karen Boruff served as Incident commander and provided the following report during the morning Incident Command briefing:

A 6.9 magnitude earthquake struck the South Hayward fault approximately 1.4 kilometers east of Hayward in Northern California at 1:14 in the morning on June 14, 2017. The earthquake was later upgraded to 7.2. The initial earthquake was followed at 1:31 and 1:42 by 6.5 magnitude earthquakes on the North Hayward and Rogers Creek faults, respectively. The earthquakes registered very strong to severe in intensity on the Mercalli Scale. The earthquake took place following a major sporting event in the San Francisco Bay Area, with an unknown number of visitors in addition to the nearly 2 million residents living in the affected area.

Following the earthquake and aftershocks, power and water service was disrupted. There were reports of damaged gas lines with multiple small fires throughout the East Bay, as well as reports of a damaged fuel line supplying San Jose airport with a resulting major fire. The following instructions were included in the morning briefing:

- There were reports of widespread injuries overloading the capabilities of the local hospitals and trauma areas to address the volume of injured victims. Users needed to expect injured victims transported by first responders as well as family and friends.
- There were reports of serious damage to three hospitals in the affected area. Users needed to expect evacuees displaced from these hospitals.
- Residents in the affected area had been asked to shelter in place as they can. However, relief is not expected for 72 hours and users needed to expect walking wounded and evacuees seeking routine care despite this request.

Evacuation centers, including three alternate care facilities, were set up in Sacramento, Placer, and San Joaquin counties during the first operational period ending at 9:00am. The governor declared a state of emergency, prompting Emergency Medical Services Authority to authorize activation of PULSE.

**Use Cases and Scenarios**

There are five primary use cases for PULSE, which are retrieving health information to aid in caring for:

1. displaced patients evacuated from healthcare facilities in the disaster area for which a potential source of health records may be known
2. injured victims of the disaster transported by first responders for which little identifying information or prior healthcare history may be known
3. injured victims of the disaster transported by themselves, family, or neighbors for which more identifying information and healthcare history may be available
4. walking wounded victims and evacuees presenting to alternate care facilities with minor injuries requiring treatment
5. evacuees seeking primary care for chronic conditions or health issues unrelated to the disaster itself but unable to obtain it through their regular care providers or facilities

For the drill, PULSE users were prepared to support these use cases through the instructions provided during the morning briefing.

The Drill was designed to explore PULSE users’ ability to address six potential scenarios when searching for a matching identity and retrieving health information on a victim or evacuee that might correspond to any of the five use cases. Those six potential scenarios were:

1. No matches could be found for the name and demographics of the victim or evacuee in any participating healthcare system or facility
2. A matching identity was found for the victim or evacuee at an expected healthcare facility (e.g., close to the victim or evacuee’s home)
3. A matching identity was found for the victim or evacuee at an unexpected healthcare facility (e.g., far from the victim or evacuee’s home)
4. Matches were found for the victim or evacuee at multiple locations with similar demographic information representing ambiguous matches to the victim or evacuee
5. Matches were found for the victim or evacuee at multiple locations with similar health information, suggesting they belong to the same individual
6. Matches were found for the victim or evacuee at multiple locations with differing health information, suggesting they might belong to different individuals which must be investigated

Because of the high number of visitors to the affected area, PULSE users for the Drill needed to expect patients might have health information located at areas other than those from which they were evacuated.

In addition, the just-in-time training of PULSE users included the following warnings to provide additional preparation for these scenarios:

- Not all victims or evacuees will have health information in any of the participating health systems
- Some victims or evacuees may have health information in multiple systems as a result of relocation or seeking medical care while traveling, and health information present in the systems might differ

Table 1 lists the number of victim or evacuee identities required to examine all five use cases and all six scenarios.
Table 1  Use cases and scenarios included in the drill, listing the minimum number of victim/evacuee identities and minimum number of care summaries required to explore all combinations.

<table>
<thead>
<tr>
<th>Use Case</th>
<th>No patients found</th>
<th>Patient found at expected facility</th>
<th>Patient found at unexpected facility</th>
<th>Multiple ambiguous matches</th>
<th>Multiple matches with agreeing information</th>
<th>Multiple matches with conflicting information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Patients evacuated from healthcare facilities in affected area</td>
<td>0/0</td>
<td>1/1</td>
<td>1/1</td>
<td>2/2</td>
<td>1/1</td>
<td>1/2</td>
</tr>
<tr>
<td>2. Injured victims transported by first responders</td>
<td>0/0</td>
<td>1/1</td>
<td>1/1</td>
<td>2/2</td>
<td>1/1</td>
<td>1/2</td>
</tr>
<tr>
<td>3. Injured victims transported by themselves, family, neighbors</td>
<td>0/0</td>
<td>1/1</td>
<td>1/1</td>
<td>2/2</td>
<td>1/1</td>
<td>1/2</td>
</tr>
<tr>
<td>4. Walking wounded presenting with minor injuries</td>
<td>0/0</td>
<td>1/1</td>
<td>1/1</td>
<td>2/2</td>
<td>1/1</td>
<td>1/2</td>
</tr>
<tr>
<td>5. Evacuees seeking primary care unrelated to the disaster</td>
<td>0/0</td>
<td>1/1</td>
<td>1/1</td>
<td>2/2</td>
<td>1/1</td>
<td>1/2</td>
</tr>
</tbody>
</table>

Within each cell are the number of unique victim or evacuee identities and the number of unique care summaries (i.e., identities/summaries) required to support the use case and scenario combination. Complete coverage of all use cases and all scenarios requires at least 30 unique victim or evacuee identities and at least 36 unique care summaries that might be retrieved by PULSE.

The drill was conducted by handing users hand-written patient demographics corresponding to victims or evacuees, which included first and last name, date of birth, gender, and address, with a request that might match one of the various use cases. Typical requests included:

1. Find current medications and allergies; current medications, allergies, and a problem list; or a problem list to support use case 1 for patients evacuated from healthcare facilities in the affected area
2. Find current medications and allergies or current medications, allergies, and a problem list to support use case 2 for injured victims transported by first responders
3. Find current medications and allergies or current medications, allergies, and a problem list to support use case 3 for injured victims transported by themselves, family, or neighbors
4. Find current medications or current medications and allergies to support use case 4 for walking wounded presenting with minor injuries requiring first aid
5. Find current medications; current medications and allergies; current medications, allergies, and a problem list; or a problem list to support use case 5 for evacuees seeking primary care

In some cases, the demographic information was purposefully unclear or incomplete, designed to prompt the user to request additional information or search for identities with the incomplete information presented to them.

During the first part of the drill, PULSE users were asked to play both user roles: searching for matching patient identities, and retrieving and reviewing health information on each one. During the second part of the drill, teams of two PULSE users at the same alternative care facility were asked to each play separate roles, one searching for matching patient identities and staging matches, and the other retrieving and reviewing health information for each staged identity.

Drill Participants
The following organizations participated in the table-top drill:

- ONC Grant Recipient for PULSE
  Organization: Emergency Medical Services Authority (EMSA)
  Role: Grant implementation, oversite, and provide attestation for PULSE
- PULSE Technical Advisor
  Organization: California Association of Health Information Exchanges (CAHIE)
  Role: Design and facilitate PULSE table-top drill
- PULSE Message Broker and Portal
  Organization: Audacious Inquiry (Ai)
  Role: Development of components that query for health information
- Disaster Healthcare Volunteer (DHV) portal
  Organization: Intermedix (Collaborative Fusion)
  Role: Maintain single sign-on for access to PULSE portal
- Directory Services
  Organization: California Association of Health Information Exchanges (CAHIE)
  Role: Registry of PULSE participants
- PULSE Operator
  Organization: Audacious Inquiry (Ai)
- Drill Participants
  Organization: Santa Cruz Health Information Organization (SCHIO), OCPRHIO, UC Davis Health System, and Sutter Health
  Role: Onboard to PULSE and participate in drill
  Role: Registry of PULSE participants

Drill Participants also included 10 Disaster Health Care Volunteers from the Sacramento Medical Reserve Corps and Sacramento County. These participants played the roles of volunteers retrieving and/or
assessing health information retrieved using PULSE as if working in an ACF during a disaster. The occupations used for the drill were: physician, pharmacist, physician assistant, nurse, nurse practitioner, and emergency medical technician (EMT)/paramedic.

Health Information
The drill used test or demonstration instances of health systems and fictitious identities for all victims and evacuees. Identities were constructed using:

- Fictitious first and last name combinations, sometimes using “Zzz” or “Xxx” prepended to the last name to specifically signify a fictitious test patient as required by the policies of a specific drill participant
- Genders appropriate for the fictitious first name
- Pseudo-randomized birth dates corresponding to actual dates
- Fictitious addresses, either generic addresses (e.g., “1 Main Street”) or fictitious addresses using non-existent streets, but always with actual cities and ZIP codes within California corresponding to the geography served by the drill participant

Care summaries conforming to the C-CDA standard were then created for use in the drill by anonymizing existing patient data. For each care summary, the XML document was edited to remove all identifying information and replaced with a fictitious identity created as indicated above. Each participating organization was asked to contribute care summaries and fictitious identities for the drill. This process maximized the variety of information in the drill (e.g., both young and old patients, and both long and short care summaries) as well as taking advantage of differing policies, configurations, and capabilities of various sites in constructing care summaries. Of the care summaries contributed, the drill utilized the following:

- Ten care summaries and identities contributed by OCPRHIO
- Ten care summaries and identities contributed by Santa Cruz HIE
- Eight care summaries and identities contributed by Sutter Health
- Four care summaries and identities contributed by UC Davis Health

The care summaries contributed by Sutter Health and UC Davis Health were generated by Epic EHRs. The care summaries contributed by OCPRHIO and Santa Cruz HIE were summarized from health information in the underlying community health record, in turn taking from information contributed by several systems.
Some fictitious identities in the submitted care summaries included fictitious phone numbers and social security numbers, often illegal combinations and sometimes not unique to only one fictitious patient. These elements were not used as part of the demographics in the drill.¹

Additional variations to the contributed care summaries were created by:

- Altering the identity slightly, such as by changing the name Robert to Bob, to represent ambiguous matches for the same individual
- Creating two separate care summaries using the same name but differing demographics to represent unique identities and health histories with the same first and last name
- Altering details of the health information, usually by removing one or more medications, one or more allergies, one or more immunizations, one or more problems, and/or one or more procedures to represent variations in health information for the same individual available from different health systems

This process resulted in 47 unique care summaries (of the 36 required to cover all use cases and all scenarios) with 32 unique identities (of the 30 required to cover all use cases and all scenarios).

Each organization participating in the drill was asked to stage the data they contributed in their test systems, and three of the four sites were asked to additionally stage altered or unaltered care summaries from some other participant to ensure some patients would be located at multiple sites, sometimes with different health information or variations in demographics. In total, 13 fictitious identities (41%) had care summaries staged in multiple locations.

**Drill Schedule**
The schedule for the table-top drill is outlined in Table 2 below.

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00 am-9:10am</td>
<td>Welcome and introductions</td>
<td>EMSA</td>
</tr>
<tr>
<td>9:10 am – 9:20am</td>
<td>Overview of PULSE</td>
<td>CAHIE</td>
</tr>
<tr>
<td>9:20 am – 9:30am</td>
<td>Incident Action Plan</td>
<td>Incident Commander</td>
</tr>
<tr>
<td>9:30 am – 10:00 am</td>
<td>Just-in-time training</td>
<td>CAHIE</td>
</tr>
<tr>
<td>10:00 am – 12:00 pm</td>
<td>Run drill scenarios</td>
<td>DHV users</td>
</tr>
<tr>
<td>12:00 pm – 1:00 pm</td>
<td>Working lunch</td>
<td></td>
</tr>
</tbody>
</table>

¹ Studies have suggested that patient matches may be less accurate when including phone numbers in patient demographics, as phone numbers are often inaccurate. Many health systems and HIEs in California do not record social security numbers, making them useless in patient matching.
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Audience</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:00 pm – 2:00 pm</td>
<td>Debrief – review drill results</td>
<td>All</td>
</tr>
<tr>
<td>2:00 pm – 4:00 pm</td>
<td>Run drill scenarios</td>
<td>DHV users</td>
</tr>
<tr>
<td>4:00 pm – 5:00 pm</td>
<td>Debrief – review drill results</td>
<td>All</td>
</tr>
</tbody>
</table>
3. Analysis

Table 3 lists the number of requests users placed to PULSE and the number of responses returned during the PULSE drill.

Table 3  Cumulative numbers of successful patient matches and document retrievals during the drill.

| Requests for patients matching demographics of a victim or evacuee | • 197 queries for matching patients to PULSE made by users  
                                                                  • 786 resulting queries to External Health Systems made by PULSE² |
| Requests for lists of documents upon staging patients matching demographics of a victim or evacuee | • 140 patients staged by users based on 197 queries for potential matches (71%)  
                                                                  • 253 documents were reported by external health systems with available health information as a result of requests for document lists made by PULSE (an average of 1.8 documents per identity)  
                                                                  • 12 requests (4.7%) for a list of documents from two different drill participants timed out before returning a document list |
| Requests to retrieve a document with health information from the list of documents returned | • Users requested 185 of the 253 documents available within the external health systems (73%)  
                                                                  • All requests for documents resulted in successful document retrieval  
                                                                  • 2 documents (1%), once retrieved, could not be rendered within PULSE  
                                                                  • 1.1MB average document size, with a range of 0.1MB to 6.8MB |

Due to the premature deletion of the audit log files PULSE accumulates during an exercise or activation, it is unknown how many requests for matching patients may not have been successfully answered by external health systems.

Searching for and Staging Matching Patients

During the drill, PULSE users properly identified all six victims or evacuees (100%) that had no health information in any external health system and therefore no patient matches to the demographics presented. Users failed to match only one victim or evacuee (2.1%) that did in fact have health information that could be retrieved by PULSE. It was confirmed that PULSE could successfully match the demographics to a patient and retrieve health information, indicating that this failure represented unrecognized user error.

² The number of external health systems that did not respond to the request for matching patients is not known.
The algorithms used to identify matching patients varied significantly across the participants, corresponding to the variations in operational policies of the various institutions. For example, Sutter Health and UC Davis Health both required addresses in order to match a patient, but OCPRHIO and Santa Cruz HIE did not. Santa Cruz HIE could often match a patient even if the name was spelled incorrectly, but none of the other three participants could. Sutter Health required that the full street name match (e.g., 100 Main Street) whereas UC Davis might allow for a partial match or abbreviation (e.g., 100 Main or 100 Main St), or might produce a match if the ZIP code was missing. As a result, not every patient search correctly identified every care summary that was staged for the drill.

Further, none of the participating systems matched variations on a name (e.g., Robert versus Bob). And none of the systems identified potential matches for incorrect demographic information (e.g., the name, gender, and birth date matched, but the addresses were different). As a result, none of the care summaries staged with alterations to the demographic information were retrieved, and the scenario “Matches were found for the victim or evacuee at multiple locations with similar demographic information representing ambiguous matches to the victim or evacuee” could not be tested.

Both of these scenarios represent real-world issues with matching patients across healthcare domains and organizational boundaries. The latter, for so-called “ambiguous matches” is somewhat emphasized by the NwHIN patient discovery specification which does not allow a single site to pass on multiple potential matches for a patient identity, even if local policy would allow it.

Retrieving and Reviewing Health Information
Nearly 5% of requests for a list of documents containing health information failed to return a document list, perhaps suggesting that the requests for a document list needed to be given more time within PULSE before timing-out. Eleven of the twelve failures were for one external health system, one for a second. Time-outs are a configurable parameter within PULSE. It is recommended that time-out failures be monitored during PULSE operation and the parameters adjusted as necessary based on network conditions, external system loads, and PULSE user needs.

No requests for documents failed to return a document. However, PULSE users decided not to retrieve and examine every document available, even though some documents may have included conflicting information. A real emergency might have:

- a higher retrieval rate since it is more critical to retrieve information for an actual victim or evacuee than during a drill, or
- a lower retrieval rate as a result of the urgency to address the needs of many victims or evacuees reaching an ACF simultaneously.

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3 See the Nationwide Health Information Network (NHIN) Patient Discovery Web Service Interface Specification Version 2.0 for more information

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PULSE does not currently interpret document content and therefore cannot alert a user of potential conflicting information or prompt to user to retrieve and examine other documents. The potential impact of not examining all available information should perhaps be covered as part of PULSE user training. Future enhancements of PULSE might retrieve and combine all documents into a single report so the users automatically obtain all available health information and can view and interpret conflicts.

Two staged documents were successfully retrieved by PULSE but were too large to render within the browser. Upon investigation, this failure turned out to be due to limitations of the laptops used in the drill, since XML documents were rendered within the browser, not translated to HTML in PULSE servers. Changes to PULSE to address this issue are being investigated.

**Overall Usability**

PULSE users received just-in-time training on the use of PULSE immediately after the morning briefing. Training comprised a description of PULSE’s operation, as well as a demonstration on how to search for a matching patient, stage the matches discovered, request a document including health information, and view the document to answer the question posed by the scenario. The training plan called for having all users walk through a few additional searches together, but users declined additional training and found the single demonstration sufficient.

In general, PULSE users found it straight-forward to enter demographic data, search for patients, understand potential matches, stage matches, and view retrieved documents. Users identified several issues that impacted PULSE usability:

- The size of the browser window had to be adjusted in order to access all fields in the user interface
- The order and location of demographic fields was not optimal; in particular, some users preferred that last name be listed before first name and found they often inverted names
- There was a strong desire to be able to edit the demographics in an existing search, especially to correct typographical errors that resulted in no potential matches
- When multiple patients were staged, it was sometimes difficult to determine which document, corresponding to which staged patient, was being viewed, posing a significant risk to patient safety
- Many of the retrieved care summaries were very large, making it difficult to find the requested health information (e.g., to locate the medication list)

Users were not selective in staging patient matches, and always selected all potential matches rather than investigate the location of a match compared to the home address of the victim or evacuee. This may have been due to instructions during the morning briefing, or a desire to proceed rapidly through staging information. Future drills might increase the complexity of the request made to users in reviewing and retrieving specific health information.

Users recommended that the overall user interface be studied, perhaps conducting a workflow analysis, to improve the user experience and speed the use of PULSE. While users did not find PULSE difficult to use, they believed the workflow could be significantly streamlined.
Finally, users believed that PULSE should be integrated in some way with patient tracking, so that records identified at one ACF might be automatically transferred to another ACF to follow the patient.

**Overall Performance**

Users did not express any real concerns over delays experienced in PULSE responding to input while searching for patient matches or retrieving documents. As the drill proceeded, users tended to start multiple searches and come back to stage patients later. Likewise, users tended to ask that many documents be retrieved and then view the documents later. They found that this workflow improved productivity and allowed them to avoid waiting during delays in retrieving information from external health systems.

The result of this effort, however, was that a great deal of information was loaded by PULSE into the browser, and browser performance began to degrade significantly. Users had to be instructed to limit the number of documents retrieved and/or then discharge patients after viewing a document, a workflow that is likely unrealistic for an actual disaster response where providers may wish to review health information more than once over some prolonged period.

It was recommended that more processing be moved to the PULSE servers rather than taking place in the browser.

The drill was conducted in optimal conditions without stressing the network, creating connectivity issues between users and PULSE or between PULSE and its external components, or overloading any of the systems on which PULSE depends. Future drills should be more realistic rather than assuming an optimal network to better investigate PULSE’s ability to maintain good performance.
4. Improvement Recommendations

Recommendations for PULSE

Drill participants, including the volunteer users of PULSE, gathered mid-way through the drill and after completion to discuss potential improvements to PULSE. The following is a high-level summary of the items identified, which include refinements to the PULSE software and related components as well as the overall program. Some of these items may be addressed as part of the initial phase of development, but many would require additional effort and funding.

- Make it possible to edit demographics in a submitted search for patients to correct errors by retaining entered data after a search has completed
- Add other forms of entry for demographics, such as scanning a driver’s license, autocompleting cities, having ZIP complete city and state, etc.
- Make it possible to search retrieved documents for specific information, rather than having to search through an entire document
- Address performance and/or resource requirements for large documents and staging of many documents
- Conduct a comprehensive usability or workflow study to improve the user interface and user experience (e.g., too many clicks to search for a patient)
- Consolidate all requested documents into a single report with provenance to improve review time
- Highlight within, or parse, C-CDA documents those data elements or fields most appropriate or more urgent for use in an emergency (most likely allergies, medications, problems, perhaps immunizations)
- Add capabilities for managing victim/evacuee identity, such as a master patient index (MPI)
- Add capabilities to retain patient information and chart treatment at an ACF
- Add an administrative dashboard and portal to aid in monitoring and configuring PULSE during activation and once activated, including ability to change configuration parameters (e.g., query time-out settings) while active
- Extend time that searches and records are stored in the cache
- Automate generation of after-action reports
- Create a detailed and comprehensive user guide with step-by-step instructions for conducting searches and queries, as well as quick reference guides to include with ACF materials/equipment
- Include PULSE in DHV training and conduct routine training, at least annually, but perhaps quarterly
- Extend time that searches and records are stored in the cache
- Address differences in local policy – establish minimum criteria/policies for disasters

Recommendations for Future Drills

Participants and volunteer users of PULSE also discussed potential enhancements to future drills involving PULSE. The following is a brief list of the items identified.
• Create a more realistic workflow that includes people moving through the system, victims and evacuees arriving in clumps, etc.
• Make requests for health information that require more rigorous investigation of what is retrieved from participants
• Simulate network issues, participant system connectivity issues, etc. (i.e., conditions when the infrastructure is imperfect)