Using an EMS Multiagency Coordination Center and Health Information Exchange Admit, Discharge, and Transfer Messages to Manage NCR Patient Movements Under Medical Surge

Phase 1: The EMS MACC

Prepared for the Colorado North Central Region Healthcare Coalition

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Phase I Introduction

This report is written as the first phase of the project, *Using an EMS Multiagency Coordination Center and Health Information Exchange Admit, Discharge, and Transfer Messages to Manage NCR Patient Movements Under Medical Surge*. It closely examines the Colorado North Central Region's limited experience with implementing Emergency Medical Services MACCs during recent large-scale exercises and assumptions made during those exercise EMS responses. The report makes eight major recommendations, with detailed sub-recommendations, to create a more coherent, robust, and integrated process for activating and operating a real-life NCR EMS MACC, especially for EMS responses to evacuate or decompress healthcare facilities.

The sub-recommendations can be grouped into roughly three implementation stages, (1) minimum steps and technology required to activate a new, virtual EMS MACC expected to function as well or better than the physical one activated for the 2019 NCR Healthcare Coalition Surge Test (CST); (2) NCR-wide, cross-disciplinary policy, process, procedure, training, and exercise development to formalize and ensure the virtual EMS MACC has a clear, collaborative role and performs strongly under a much wider variety of conditions; and (3) technology development and integration to better anticipate, be alerted to, and visualize surges in demand, gain better situational awareness, and efficiently allocate and track scarce resources and patients.

This Phase I report concludes by summarizing specific steps and example technologies that would allow the NCR Healthcare Coalition (HCC) and its EMS community to rapidly proceed with the first, minimum implementation stage.

Problem Statement and Short Background

The Denver Metro EMS community relies on significant mutual-aid resource sharing to operate on a daily basis. Scarce ambulance resources are allocated on a first-call, first-served basis with requesting agencies largely in the dark about which nearby agencies are most likely to have ambulances available when needed. The challenges are North Central Region-wide, across public, nonprofit, and for-profit EMS agencies and all EMS delivery models.

Conventional National Incident Management System emergency management approaches to allocating EMS resources have not proven successful in most NCR EMS incidents. Colorado's patchwork of political jurisdictions, public and private EMS service areas, and local regulatory control does not lend itself to "incident command" and centralized resource allocation systems. Frequent EMS demand spikes and multi-patient incidents are resolved through routine resource borrowing without agencies recognizing or declaring a disaster—even when disaster status could lead to emergency operations center (EOC) activation and help with centralized ambulance resource procurement.

If an EOC is stood up, there is no guarantee emergency management staff will be able to locate nearby ambulance resources more rapidly than the impacted EMS agency. To the extent there is EMS surge capacity in the NCR at any given time, it is mostly in the private sector, where there are few incentives to routinely share the number of ambulances available other than in response to a specific mutual-aid telephone request.

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Because of a common understanding of these challenges by many NCR EMS leaders, then-EMS Bureau Chief Ralph Vickrey was able to organize a large number of NCR EMS agency representatives into a Multiagency Coordination (MAC) group at Cunningham Fire for the 2016 Colorado Department of Public Health and Environment Pneumonic Plague Functional Exercise instead of staffing their home jurisdictions' EOC (or not participating in the exercise at all). Many facility, public health, and emergency management callers seemed shocked when the EMS MAC group declined to assign ambulances, either because the particular request was deemed an inefficient use of scarce ambulance resources or because there simply were no ambulances left. Some callers were also surprised when ambulances they thought were exclusively "theirs" had already been requested and sent as mutual aid to other jurisdictions. Despite these realizations, the 2016 Exercise MAC group never developed a good quantitative understanding of the ambulance supply–demand mismatch for the pneumonic plague scenario.

During the 2018 NCR Healthcare Coalition Surge Test, EMS agency representatives were not involved in exercise play. As a result, hospitals largely requested ambulances to evacuate their facilities via their parent health systems' EOCs. Each was allowed to rely on estimates of available ambulances as if it were the only entity consuming ambulances in the entire region, resulting in an approximately 250 % overestimate in total NCR ambulance resources.[1]

To avoid repeating the artificialities of the 2018 Surge Test and extend the 2016 EMS MAC group's work, the NCR HCC supported a Combined Regional EMS Planning and Preparedness Meeting[2] request to stand up an EMS MAC Center (MACC) to receive competing requests from and allocate scarce ambulances to evacuating hospitals during the 2019 Coalition Surge Test.[3] The following analysis relies primarily on concepts that were tested in the 2019 Coalition Surge Test MACC, and for elements not tested in the 2019 Surge Test, other NCR operational experience.

1. The 2018 NCR Coalition Surge Test claimed to use 183 ambulances of various types. The 2019 Surge Test EMS MAC group found only 74 to be available when ambulance agencies were polled in a systematic fashion. *See*, Michelle Deland, North Central Region: Coalition Surge Test 8 (2018) (PowerPoint presentation) (on file with Colo. NCR HCC).

2. The every-other-month Combined Regional EMS Planning and Preparedness Meeting is a collaborative meeting of the Colorado All-Hazards NCR and Denver Urban Area Security Initiative EMS Subcommittee plus EMS leadership from the Denver Metro EMS Medical Directors' Coordinators, Mile-High and Foothills Regional Emergency Medical and Trauma Advisory Councils' Mass Casualty Incident Committees, NCR HCC, and regional EMS agencies and stakeholders.

3. Ambulance availability was still subject to certain exercise assumptions—e.g., there were no incident impacts that increased the number of 911 EMS calls above baseline during exercise play. See, Colorado North Central Region Healthcare Coalition, 2019 North Central Region Healthcare Coalition Surge Test Exercise Situation Manual 6 (April 3, 2019) (on file with Colo. NCR HCC).

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EMS MACC Essential Functions and Operational Experience

EMS MACC Activation (Unexercised)

The NCR EMS MACC has never been activated for a real-life event nor has an activation method been proposed or exercised. The initiative for standing up the MACC in three exercises has come from, and the MACC has been staffed by, members of the Combined Regional EMS Planning and Preparedness Meeting. In each case, the MACC was assembled at an arranged location with established communications equipment before exercise play began.[4]

The assumption that an NCR EMS MACC stood up in support of a real event should also be staffed from the Combined EMS Meeting group meets many of the NIMS recommendations for MAC groups. Specifically, "MAC Group members are typically agency administrators or senior executives from stakeholder agencies impacted by and with resources committed to the incident.… During incidents MAC Groups act as a policy-level body, support resource prioritization and allocation, [and] make cooperative multi-agency decisions."[5] Combined EMS Meeting members are generally in the right roles in their organizations and at the right level of experience; interested in and have thought about improving NCR ambulance availability and allocation problems; and already accustomed to collaboratively discussing and working on problems with their co-resource-holders and co-responders from the Combined Meeting.

An EMS MAC group member herself may be the one to observe there is or is about to be a spike in ambulance demand and should be able to call for the MACC to be stood up. In this case, a notification will have to reach the other MACC members, who will have to agree and be available to staff the MACC. Once the MACC is activated to some minimum capacity, EMS agency officers, dispatch centers, hospital leadership, any active hospital Incident Command System, any active EMS ICS, and other emergency management will need to be rapidly notified of the EMS MACC's activation and know if and how to alter their workflows in response to the activation.

Currently, there are no identified triggers or pathways to alert the MAC group to activate the MACC from dispatch centers, EMS and other public safety duty officers, hospital operational leaders, and governmental or facility emergency managers. There are also no automated methods to identify impending spikes in NCR ambulance demand by monitoring facility electronic health records (EHRs), the CORHIO health information exchange (HIE), CDPHE EMResource and EMTrack, other emergency management incident management systems (e.g., WebEOC), or computer-aided dispatch (CAD) systems and to alert the MAC group with enough details to make a decision about activating the MACC.

4. The three exercises where NCR MACCs were stood up are the 2016 CDPHE Pneumonic Plague Functional Exercise, 2019 NCR Coalition Surge Test, and 2019 NCR HCC Behavioral Health Evacuation Exercise.

5. Federal Emergency Management Agency, Emergency Management Institute, National Incident Management System (NIMS) 2017 Learning Materials 38–39. (undated) (PDF presentation) (available at https://training.fema.gov/nims/docs/nims.2017.instructor%20student%20learning%20materials.pdf).

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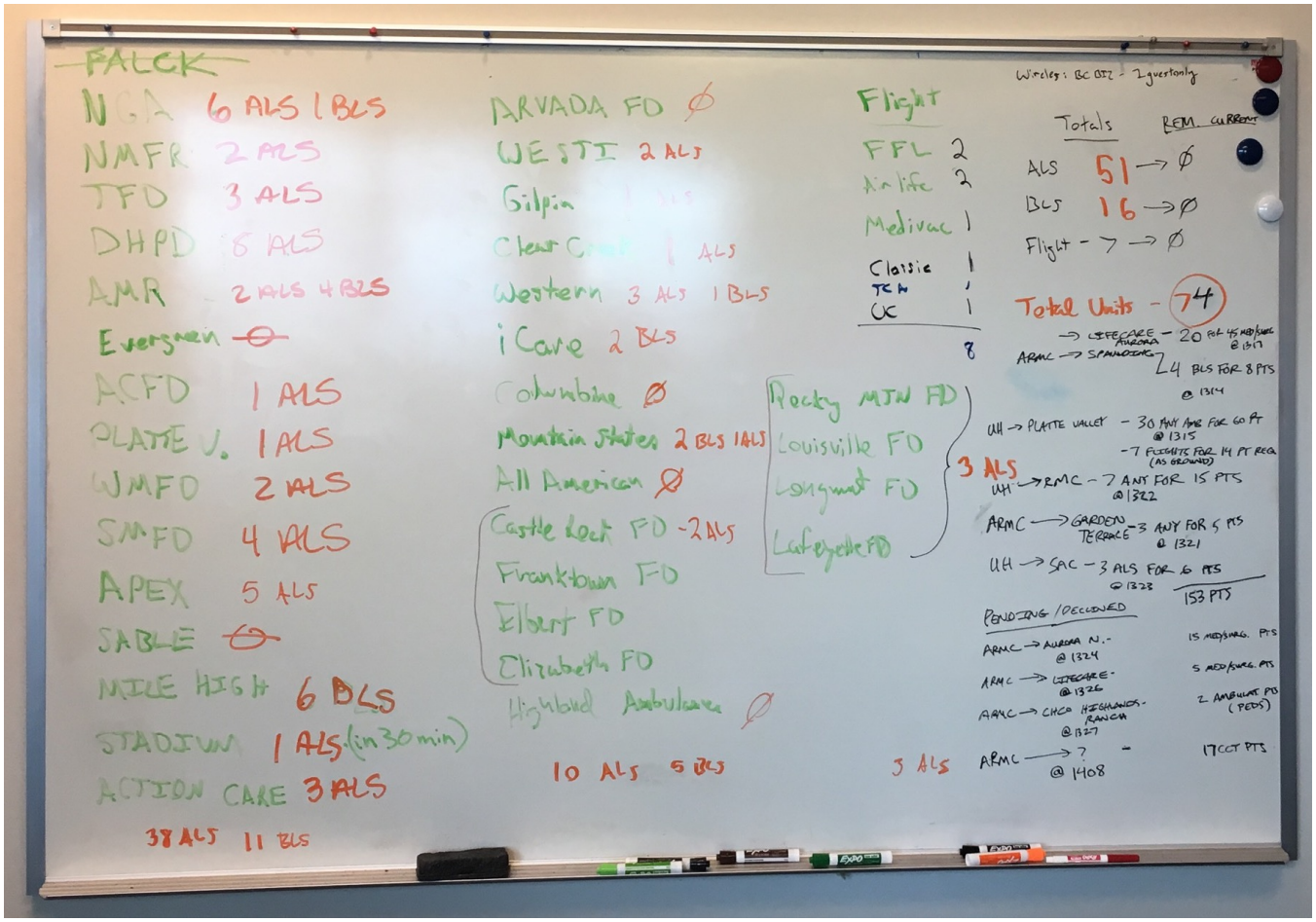
Obtaining Real-Time Available Resource Inventory and Capabilities (2019 CST Experience)

A list of all transporting EMS agencies in the NCR was not already assembled into one current document, at least to the knowledge of the EMS leaders staffing the 2019 Coalition Surge Test EMS MACC. Once gathered at the MACC, members manually extracted Mile-High and Foothills Regional Emergency Medical and Trauma Advisory Council (RETAC) member lists from the respective public websites, excluding non-transporting agencies by memory.[6] Air ambulance agencies and their NCR critical-care ground transport components were identified from MACC members' personal knowledge. The resulting master list of 40 NCR transporting EMS agencies was written on a dry-erase whiteboard (Figure 1). Creating the list took about 30 minutes.

Figure 1. EMS MACC whiteboard at conclusion of 2019 NCR Coalition Surge Test.



MACC members began calling the dispatch centers for each of the transporting EMS agencies on the whiteboard list. During each call, the members identified themselves and explained they were running a drill; they wanted to

6. *See*, Mile-High Regional Emergency Medical and Trauma Advisory Council, About Us: Stakeholders, https://www.milehighretac.org/about-us (last visited Jun. 30, 2019) and Foothills Regional Emergency Medical and Trauma Advisory Council, Transporting Agencies, https://foothillsretac.com/clinical-care/transporting-agencies/ (last visited Jun. 30, 2019). Grand County agencies, included in the Foothills RETAC but outside the NCR, were also excluded.

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know how many ambulances each dispatcher's system(s) would be theoretically willing and able to send in response to a hospital evacuation at that moment; and that no further dispatch or EMS agency actions would be needed as a part of the exercise. MACC members first called their own agencies' 10-digit dispatch center phone numbers and were able to receive answers relatively quickly from their dispatchers or dispatch supervisors.

Calling other EMS agencies' dispatch centers varied in complexity. Usually the MACC members had to rely on their personal phonebooks or own dispatch centers to obtain the correct 10-digit phone numbers for other agencies, and on prior knowledge to know which EMS agencies were dispatched by a particular center. Some dispatch centers were more able or willing to come up with an answer than others. In the case of one county dispatch center responsible for dispatching several transporting EMS agencies, the dispatchers refused to answer EMS MACC queries and forwarded the MACC call to the county emergency manager. The county emergency manager then had to send the MACC call back to the county dispatch center to get the available ambulance count. Approximately 30 phone calls were made by MACC members over 25 minutes to gain a point-in-time estimate of 74 total ambulances (and their basic life support (BLS), advanced life support (ALS), and critical-care capabilities) available for hospital evacuation in the NCR.

While the available ambulance estimate obtained by the EMS MACC during the 2019 NCR Healthcare Coalition Surge Test is undoubtedly one of the most comprehensive and accurate ever made for the Denver region at a single point in time, both the accuracy of and method used to make the estimate were subject to a number of limitations. These limitations stem from three broad categories of exercise assumptions.

First were assumptions built into the Coalition Surge Test that there were no significant community or EMS system incident impacts other than the need to evacuate the two designated hospitals (University of Colorado Hospital (UCH) and Medical Center of Aurora (MCA)).[7] In reality, tornados touching down twice in a urban area will almost certainly result in 911 ambulance calls that consume all nearby EMS resources before hospitals can make an evacuation decision or an EMS MACC or other emergency management structures can be stood up. Clearing these additional 911 calls will take significantly longer than usual if the largest hospitals closest to the impacts are unable to receive patients from the field.[8]

It is also unlikely that a hospital suffering enough "structural damage" to require a "full evacuation" would not require some EMS resources for search and rescue, care for injured staff, care for patients, or internal evacuation. For example, the hospital response might be provided by fire department urban search and rescue teams, which are often staffed using ambulance paramedics, reducing the total ambulances in service for evacuation transport.

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7. *See generally*, Colorado North Central Region Healthcare Coalition, 2019 North Central Region Healthcare Coalition Surge Test Exercise Situation Manual (April 3, 2019) (on file with Colo. NCR HCC).

8. Despite the assumptions, the 2019 Surge Test EMS MACC decided not to poll Falck Rocky Mountain ambulance service for available units. Falck is Aurora's primary ambulance transportation provider. MACC members assumed that any Falck available units would be put out of service rapidly because of their continuous circulation in and out of the University of Colorado Hospital and Medical Center of Aurora. At the start of the 2019 NCR HCC Behavioral Health Evacuation Exercise, MACC members did poll Falck, who said they could make only one ambulance available.

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Second was the assumption that the numbers and types of ambulances dispatchers said they could assign to the Surge Test would actually be assigned in a real event. During the exercise, EMS MACC members were credible enough on the phone to get their questions answered, with some calls requiring extra time and effort. If the MACC called back to actually request that ambulances respond, there are three main reasons to expect the initial availability given would be an overestimate.

1. Ambulances originally available have since been assigned to other calls. The other calls could be 911 calls that have come in since the initial MACC query, unrelated or related to the evolution of the incident causing the surge, or they could be calls from evacuating facilities that have somehow bypassed the MACC. (In the 2019 Surge Test, there were several calls made directly to air ambulance agencies instead of through the MACC, which resulted in double counting those resources.)

2. When an actual response is requested, the MACC is not trusted or deemed to have sufficient authority to order ambulances from dispatchers. Dispatchers may be able to provide a system status in response to an outside emergency management query but may not have authority to actually send units en masse outside the system.

3. Once the MACC's response request reaches an EMS agency representative with sufficient authority, that decision maker is required by policy or uses discretion to retain in-service ambulances for responses in the agency's primary area of responsibility. The Surge Test did not test how long it takes to reach decision makers and obtain a definitive answer. We assume EMS agency decision maker discretion would be exercised differently depending on a decision maker's familiarity with the EMS MACC and its prior incorporation into her agency's policy and practice.

A third category of Surge Test assumptions were realistic but constrained the value of the exercise for understanding limitations in our current models of keeping ambulances in and returning ambulances to service. The Surge Test assumed that the EMS MACC would only allocate staffed ambulances, not non-ambulance vehicles or EMS staff separate from vehicles. A further assumption was that during the 90-minute duration of exercise play an ambulance could only be assigned one evacuation trip. Finally, the EMS MACC only considered NCR-based ambulances in its resource pool.

MACC members quickly realized a more efficient and effective use of non-ambulance transportation and EMS resources could be made if a single staging area were established in a Town Center of Aurora parking lot instead of having public and ancillary healthcare transportation resources be requested directly by and respond directly to UCH or MCA. The assumption is a single EMS staging officer in communication with the MACC could have rapidly assembled EMTs not assigned to ambulances (e.g., from fire companies) with buses to create medically staffed alternative transportation appropriate for many of the 8 BLS patients evacuated from MCA to Spalding Rehabilitation Hospital and the 60 BLS patients evacuated from UCH to Platte Valley in the first 15 minutes of the exercise. As played, just filling these first two requests consumed all the BLS ambulances (16) and over a third (18/51) of the ALS ambulances in the NCR.

Another advantage of considering unified EMS and transportation coordination and staging is the MACC could supplement and coordinate HCC transportation contributions using existing EMS aid and emergency

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management mass-transportation agreements. Implementing staging for ambulances might also be a way to overcome the problem of the initial ambulance inventory overestimating the number of ambulances agencies are actually able and willing to send, especially in more protracted incidents. Agencies could be asked to send ambulances available for hospital evacuation to the staging area—only when an ambulance checks in with the EMS staging officer would the MACC count it as available for assignment. In longer incidents where significant alternative transportation resources are going to be used, communications unit leaders (COMLs) could also be placed at staging to develop communication options for non-ambulance vehicles and any detached EMS personnel operating on them.

The > 90-minute out-of-service time for an ambulance assigned a hospital evacuation trip is certainly correct. At a minimum, the ambulance would have to be requested, respond to the evacuating hospital, load multiple transferring patients under disaster conditions, drive to a facility likely unfamiliar to the crew, unload multiple patients, and complete a transfer of care to potentially overwhelmed hospital staff or facility staff unaccustomed to receiving emergency ambulance patients. Developing better estimates for these times will be important for the MACC to estimate when ambulances might return to service and be able to perform additional evacuation trips, especially with 20 ALS patients still awaiting evacuation at the end of the Surge Test.

The Surge Test was designed to be a test of coordination and medical surge response within the NCR HCC. In terms of beds available to receive evacuating hospital patients in the exercise scenario, these objectives were apparently easily met. However, NCR ambulance resources were depleted in the first 23 minutes of play, leaving 22 patients requiring ambulance transport stranded at evacuating facilities. The EMS MACC should be designed to effectively request and coordinate inter-regional ambulances when they can respond more rapidly than NCR ambulances can return to service. In the long-term, an EMS MACC model capable of operating at an inter-regional scale will be critical for incidents where patients must be moved between regions or that impact multiple regions.

Resource Requests to MACC (2019 CST Experience)

During the 2019 Coalition Surge Test, hospitals were instructed that "all requests for EMS resources will go through the NCR EMS MAC" by dialing one of two provided 10-digit phone numbers.[9] Both these lines ran to phones at seating positions inside the MACC room at the Boulder Office of Emergency Management.

The first call to the MACC requesting ambulances to evacuate patients came 10 minutes into exercise play. MCA requested eight ambulances to move eight patients to Spalding Rehabilitation Hospital. The MACC's response to the first request was delayed about three minutes for MACC members to agree on how hospital requests should be interrogated.

MACC members, assuming non-ambulance transportation or other disposition of ambulatory patients was being directly arranged by the hospitals, decided (1) each ambulance should transport two patients; (2) hospitals would be required to classify patient needs as BLS (EMT-level care), ALS (paramedic-level care), or critical care

9. Colorado North Central Region Healthcare Coalition, 2019 North Central Region Healthcare Coalition Surge Test Exercise Situation Manual Appendix E-1 (April 3, 2019) (on file with Colo. NCR HCC).

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(flight team care); and (3) all air-ambulance services would be used in their critical-care ground ambulance mode to increase critical-care transport capability (i.e., a single crew can transport two patients per ground ambulance as opposed to one per helicopter).

Using only these parameters to interrogate callers and classify incoming requests, the MACC filled resource requests in the order received until all ambulances had been consumed (23 minutes into exercise play). The requests and times were documented on the same dry-erase whiteboard where the agencies and their available ambulances were listed (Figure 1). As requests were filled, running totals of remaining BLS, ALS, and critical care (flight crew) ambulances were updated until none were left. Table 1 shows the requests in order of filling and how they were filled (or left unfilled).

Table 1. Evacuating hospital ambulance requests to 2019 NCR CST EMS MACC and how they were filled.

Time Filled (Hrs.)	Number Patients	Care Requested	From	To	BLS Used (16 Avail.)	ALS Used (51 Avail.)	Critical Care Used (7 Avail.)
1300	Start Exercise Play						
1314	8	BLS	MCA	Spalding	4		
1315	14	CC	UCH	Platte Valley			7
1315	60	BLS	UCH	Platte Valley	12	18	
1317	45	ALS	MCA	Lifecare		20	
1321	5	BLS	MCA	Garden Terrace		3	
1322	15	BLS	UCH	Rose		7	
1323	6	ALS	UCH	St. Anthony		3	
1324	15	ALS	MCA	Aurora North	0	0	0
1326	5	ALS	MCA	Lifecare	0	0	0
1327	2	BLS	MCA	Children's South	0	0	0

There were three problematic unstated assumptions associated with the Surge Test MACC method for distributing ambulance resources. First was the assumption that all patients who could be transported or dispositioned by methods other than ambulance transport were excluded from hospital requests to the MACC. Second was the assumption that ambulance transportation would first be requested for the patients in most critical need of movement and needing the highest level of care. And third was the assumption that requests from the two evacuating hospitals would be close enough in time that a faster caller would not consume a disproportionate or inappropriate share of the total ambulances available or ambulances of any one classification.

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The net result of these three assumptions is the first two requests the MACC filled were allowed to consume all the BLS ambulances (16) and over a third (18/51) of the ALS ambulances in the NCR. Further, when the MACC ran out of ambulances of all capabilities 23 minutes into exercise play, 22 patients—20 of them ALS—were left stranded at MCA. Looking at the total patients of each classification UCH and MCA were each able to transfer also gives the sense that the NCR ambulance resource pool was inefficiently allocated in responding to the Surge Test incident. UCH successfully moved 75 BLS, 6 ALS, and 14 critical care patients by ambulance; MCA successfully moved 13 BLS and 45 ALS.

Assignments by MACC (Unexercised)

The NCR has no exercise or real-life experience with using an EMS MACC to assign particular agencies or ambulances to fill incoming EMS resource requests. Under NIMS, MAC groups "do not perform incident command functions" or "replace the primary functions of operations, coordination, or dispatch organizations."[10] A potential problem with the NCR MACC concept is that the MACC may be stood up before other emergency management or operational structures are ready to use the MACC and effect and coordinate its resource allocation decisions.

The MACC can activate, complete the available ambulance inventory, begin taking hospital EMS evacuation requests, and begin prioritizing those requests. But it is essential some minimum EMS ICS structure is in place at each incident location before actual EMS resources are assigned by the MACC and requested via their dispatch center to respond. Similarly, if a central EMS and transportation staging area is to be used, a staging officer needs to be designated and physically in the staging area before the MACC requests units to report to staging. And EMS resources still should not be sent from a central staging area to a hospital response location until the minimum EMS ICS structure is in place at that hospital.

Under current practice and level of technological integration, the MACC will be in the dark once EMS and transportation resources have been assigned to the EMS ICS at a particular evacuating facility. Unless a process is created to have EMS resources' return-to-service reported from dispatch or incident command to the MACC once their trips are complete, the MACC will have no reliable way of knowing which pending patient movements have been completed and which EMS and transportation resources might be available for an additional incident trip. In fact, the current process could leave the MACC periodically re-polling dispatch centers for newly available ambulances.

10. Federal Emergency Management Agency, Emergency Management Institute, National Incident Management System (NIMS) 2017 Learning Materials 39 (undated) (PDF presentation) (available at https://training.fema.gov/nims/docs/nims.2017.instructor%20student%20learning%20materials.pdf).

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Recommendations, Opportunities, and Challenges

Recommendation 1: Agree on MACC Membership and Activation

Create a standing MAC group of qualified EMS leaders, ideally at least two from each NCR EMS agency, who agree to help develop and maintain MACC policy and technology, be available to receive and evaluate MACC activation requests, and staff the MACC after activation.

Opportunities and challenges:

1.1. Use the Combined Regional EMS Planning and Preparedness Meeting membership to develop, identify, and keep current the list of agency representatives and alternates (the EMS MAC group) who will be notified and staff the EMS MACC when the MACC is stood up.

1.2. The EMS MAC group needs to write incident or emerging incident criteria warranting notification and MACC activation. These criteria should also discuss which non-EMS agencies, groups, or individuals the MAC group thinks should be automatically notified of MACC activation.

1.3. The EMS MAC group needs to identify and adopt resilient notification technology which supports one MAC group member rapidly notifying all other MAC group members to request MACC activation, and then supports two-way, timestamped, logged messaging between group members. The notification technology needs to reliably bidirectionally connect the MAC group with EMS agency officers, dispatch centers, hospital leadership; any active hospital ICS, any active EMS ICS, and other public health and emergency management as groups, individuals, or through integrated machine interfaces. (E.g., a dispatcher can page the MAC group by clicking one button; receive notification of a MACC activation request on her screen; and someday, her CAD computer might recognize a surge in ambulance demand is happening or about to happen and make both notifications itself (see Recommendation 5).)

1.4. Once the EMS MAC group has agreed upon notification criteria, methods, and partners, MAC group members need to create and adopt harmonized MACC notification and interaction policies, procedures, training, and exercises within their own leadership, dispatch, and emergency management structures. The policies should ensure the MACC is trusted by all EMS agencies to do ambulance inventory and allocation even if a particular EMS agency is unable to send its representative to the MACC during an activation (see Recommendation 3).

1.5. The NCR HCC will need to work with the EMS MAC group to identify non-EMS HCC members who should be permitted to request MACC activation and the appropriate routes for those requests (e.g., direct message sent using the MACC notification system; phone call to local EMS agency dispatch; or someday, notification sent manually or automatically via a facility EHR, the CORHIO HIE, or other computer systems). The NCR HCC and EMS MAC group will need to work with non-EMS members to help develop and harmonize their MACC activation request procedures, methods, training, and exercises.

1.6. The decision to activate the EMS MACC should be made consistently enough by its members, through a commonly known and understood process, that other individuals and entities may rely on the MACC activation notification to trigger their own incident procedures. The MAC group and NCR HCC should

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work to have MACC notifications, activation, and coordination adopted into other NCR plans and operations.

Recommendation 2: Maintain Ambulance Agency List

Maintain a shared list of all NCR-based transporting EMS agencies, including of flight services and their critical-care ground based components; which dispatch center dispatches each agency; and the 10-digit phone number for each dispatch center.

Opportunities and challenges:

2.1. A Google Sheet has been started, but this list sharing method is unlikely to be successful because several potential MACC members have agency information technology restrictions preventing them from accessing the Google Sheets service.

2.2. A process and process owner will have to be created to keep the agency list updated between MACC activations.

2.3. The people usually answering the listed phone numbers should have sufficient authority, training, and situational awareness to be able and willing to provide the MACC with accurate available ambulance estimates and to dispatch those ambulances in response to MACC requests. (See Recommendation 3.)

2.4. The EMS MACC concept should be strengthened by listing some nearby out-of-regional ambulance agencies who might respond into the NCR or with whom the NCR EMS MACC is likely to coordinate an out-of-region response.

2.5. The list information needs to be accessible and updatable online by all potential EMS MACC members during an incident. However, non-tabular methods of displaying and interacting with the list, better integrated into other EMS MACC software functions, should be explored. Policy, procedures, and training on how MACC members access and update the list information need to be developed and maintained.

Recommendation 3: Make EMS MACC a Known Entity

Ensure the EMS MACC has enough authority and is known and understood well enough that it is able to rapidly receive accurate responses to its queries about available ambulances and to successfully request ambulance responses from every transporting agency.

Opportunities and challenges:

3.1. NIMS describes MAC Groups as typically composed of "senior executives from stakeholder agencies impacted by and with resources committed to the incident," giving them sufficient authority to broker

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"scarce resource allocation."[11] Unlike the 2016 Plague Exercise EMS MACC, where a critical mass of NCR EMS agency leaders participated, the 2019 Coalition Surge Test MACC only included four agency leaders. Clearly, the most straightforward solution to receiving the desired responses from dispatchers is to have a known member of that agency's leadership making the call to dispatch from the MACC.

3.2. EMS agencies often do not have enough on-duty leadership depth to fill all the incident operations and command positions needed when a large event rapidly unfolds. EMS MACC staffing is unlikely to happen unless it immediately helps reduce agency incident command workload or can be performed concurrently with another leadership role.

3.3. The NCR is large. Even if EMS leaders recognize an incident warrants standing up a MACC and their agencies can spare them from direct incident command and operations responsibilities, it is unlikely they will be able to get to the same physical location in time to be useful for most shorter-duration incidents.

3.4. A purpose-built virtual operations center needs to exist or be able to stood up with minimal effort by any EMS MAC group member so EMS agencies see leadership participation as feasible and worthwhile both between and during incidents.

3.5. EMS agency and dispatch center policy and procedures for interacting with the MACC at all incident stages need to developed and harmonized, then incorporated into regular NCR training and exercises. Having a shared understanding, familiarity, and trust of the MACC's purpose, role, structure, and operations will be especially important to the MACC concept's success in early incident phases when only a few agencies may be able to contribute a leadership representative.

3.6. Plan for the EMS MACC's role evolution and integration during longer incidents as other incident management entities and structures become involved. In particular, plan for the full range of MACC interactions with other disciplines', state-level, and federal-level resource management plans and systems (e.g., ambulance strike teams assembled under the Denver Metro Area Fire Departments Mutual Aid Agreement, resources requested under the Colorado All-Hazard Resource Mobilization Plan, etc.).

11. Federal Emergency Management Agency, Emergency Management Institute, National Incident Management System (NIMS) 2017 Learning Materials 38–39 (undated) (PDF presentation) (available at https://training.fema.gov/nims/docs/nims.2017.instructor%20student%20learning%20materials.pdf).

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Recommendation 4: Make EMS MACC Responsible for all Patient Transportation

Consider making the EMS MACC responsible for all incident patient transportation, including by non-ambulance vehicles.

Opportunities and challenges:

4.1. Existing NCR HCC policies, processes, and systems for maintaining lists of and activating partner non-ambulance transportation assets need to be transferred to or harmonized with EMS MACC operations. Virtual EMS MACC systems must be designed to safely and efficiently manage, track, and communicate with HCC transportation partners, especially in cases when a partner volunteers additional vehicles or personnel mid-incident.

4.2. An ordering process and documentation system needs to be developed that supports cases where an NCR HCC non-ambulance transportation provider might also be subject to existing EMS agency aid or emergency management agreements.

4.3. Realistic estimates of ambulance turnaround times need to be developed for NCR hospital evacuation and decompression scenarios, possibly through field exercises or experiments. Even EMS MACC members' current substantial combined experience is probably insufficient to balance waiting for ambulances to return to service against sending certain patients by non-medical transportation under evacuation conditions.

4.4. Define the relationship between the EMS MACC and EMS and transportation staging areas and officers. Under a conventional ICS, MAC Groups are not usually involved in this level of direct incident management and operations. However, real-life and exercise experience have shown EMS incidents scale so rapidly that conventional emergency management and ICS structures cannot be stood up as rapidly as they might be useful. If the concept NCR EMS MACC may become active before other emergency management structures can be stood up, the MACC's ideal ICS relationships and role should be envisioned at each stage of an evolving incident.

4.5. The NCR EMS MACC concept should be shared with likely co-responders in neighboring regions and joint planning should be done so the MACC's incident-wide EMS coordination capability is not diminished when inter-regional ambulance operations begin.

4.6. Make the EMS MACC responsible for triaging patients to the most appropriate transportation and EMS care considering all the available resources and the needs of the whole patient population. (Again, a core function of MAC Groups in NIMS is scarce resource allocation.) This approach will lead to more efficient resource use because the MACC will not have to assume that all evacuating patients who can be transported by methods other than ambulance have already been dispositioned by requesting facilities. The MACC also has greater access than the hospitals to non-ambulance vehicles and EMS providers, such as RTD buses and fire department EMTs assigned to engine companies—as well as the ability to combine those vehicles and providers into combinations to meet the specific needs of evacuating patients. Finally, the MACC could coordinate these mass care and transportation resources to combine patients with similar needs from multiple evacuating hospitals (or other origination points or scenes) en route to the same destination.

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Recommendation 5: Anticipate Total Incident EMS Needs

Develop methods for the EMS MACC to anticipate approximate total patient transportation and EMS care needs in early incident stages so appropriate resources can be reserved rather than allocated solely on a first-call, first-served basis.

Opportunities and challenges:

5.1. If the evolution of 2019 Surge Test incident is realistic, introducing a simple delay into the EMS MACC's filling of BLS ambulance requests would improve the allocation of ALS and critical care ambulances to those patients who need them most. But BLS ambulance requests would have to be delayed for 12 minutes after the initial hospital call to the MACC (and 22 minutes into exercise play) in order to ensure all evacuating ALS and critical care patients received appropriate ambulance transport (leaving 30 total BLS patients stranded). Delaying filling BLS ambulance requests for 10 minutes after the initial hospital call creates a lesser improvement of 5 ALS patients and 24 BLS patients stranded (in comparison with 20 stranded ALS and 2 stranded BLS in the actual Surge Test). Whether introducing a delay—and how long of a delay—would be effective and acceptable in real-life MACC operations, are important questions. Note that decisions to delay become less risky if the MACC is responsible for all incident transportation because the MACC can begin lining up alternative transportation options for the least-acute, leftover patients while waiting for additional hospital requests to evacuate more-acute patients.

5.2. Investigate if simple changes in hospital EMS ordering workflow and timing; hospital request formats to the MACC; or MACC interrogation of hospital resource requests might result in more appropriate filling of hospital ambulance requests and more efficient use of EMS resources over the entire incident area and duration. Develop EMS MACC procedures and support development of harmonized hospital procedures that incorporate the findings.

5.3. Determine if hospitals consistently manually or automatically update any existing bed availability and request systems (e.g., HAvBED status in EMResource externally, or internally in hospital EHRs) long enough before ambulance and transportation requests are made and in a way that might allow the EMS MACC to infer and anticipate imminent evacuation demands on the EMS system.

5.4. Determine if ADT messages and related data in EHRs and the CORHIO HIE allow hospital censuses to be calculated or estimated. Develop methods to estimate how many of those patients will require EMS care and at what level, should they need to be evacuated.

5.5. Identify other opportunities in existing hospital human and technological processes that would allow the EMS MACC to be alerted or view directly if hospitals are looking for outside beds to transfer large numbers of patients, how many they are looking for, and if there is a method to categorize receiving facility beds to anticipate the EMS levels of care that will be needed during transport.

5.6. Identify or develop a virtual situational awareness system allowing remote EMS MACC members to have a common view of and communicate about actual hospital loading and anticipate not-yet-made patient movement and EMS care requests. The system needs to be easily updated by MACC members, with automatic timestamp and history logging; be compatible with automated updating as the machine

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methods discussed above are developed; and should be integrated into whatever virtual status board is developed to track actual EMS resource requests, assignments, and movements.

5.7. If always-on automated regional hospital bed status and inpatient acuity monitoring systems are built, the EMS MACC concept of operations, policy, and procedures need to address hospital business and policy concerns of how those data and visualizations may be used, especially between MACC activations.

Recommendation 6: Standardize EMS Resource Requests

Create a method and system for the EMS MACC to receive, categorize, and track resource requests in a standard format throughout the request lifecycle.

Opportunities and challenges:

6.1. The EMS MACC should have a permanent phone number or numbers assigned which can be forwarded or redirected to the MACC's current physical or virtual location(s). The MACC's phone system should be implemented to be as resilient as possible to analog and digital service interruptions and be answerable by multiple people in multiple places.

6.2. A standard, consensus format for evacuating facility requests for EMS care and transportation needs to be developed by NCR HCC members, especially around minimum levels of care in transit. NCR HCC facilities and the MACC should adopt harmonized policies, procedures, training, and exercises on using the standardized format. EMS MACC systems for recording incoming resource requests should prompt MACC members to interrogate callers for any missing, required information.

6.3. Investigate alternative, more resilient routes for facilities to send the standardized requests to the EMS MACC (e.g., via SMS messaging).

6.4. Investigate alternative, more automated methods to send the standardized requests to the EMS MACC out of existing hospital EHR and disaster workflows (e.g., from ADT or EMResource messages).

6.5. Develop processes, methods, training, and exercises to ensure all incident EMS resource requests from all sources and pathways are routed to the MACC upon activation. In particular, ensure that EMS agencies' dispatch centers do not fill incident requests as they come in instead of or before sending them to the MACC. The processes developed should also ensure that once EMS ICS and liaison functions are implemented at the evacuating facilities, duplicate resource requests are not made to the MACC by a facility ICS and the EMS ICS on site.

6.6. Identify or develop a virtual status board system with automatic timestamp and history logging for EMS MACC members to input, track, visualize, prioritize, and update all received, pending, in-process, and completed EMS and transportation resource requests. The status board should prompt for and display all the NCR standardized EMS request format elements and should be compatible with displaying a queue of requests received in text or digital formats as those alternative message routes are developed. The status board should be reliably and simultaneously accessible in all the locations from which members might reasonably be joining the EMS MACC.

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Recommendation 7: Plan Evacuation ICS Roles and Relationships

Develop a specific NCR HCC facility evacuation and decompression plan which includes a consensus approach to EMS agency ICS implementation at each evacuation site and creates guidelines for the roles and responsibilities of and relationships between dispatch centers, EMS agency ICS, facility ICS, and the EMS MACC.

Opportunities and challenges:

7.1. Encourage facilities and their home EMS agencies to develop harmonized evacuation and decompression plans, training, and exercises using realistic scenarios that address designating liaisons and coordination between facility ICS, EMS agency ICS, and the EMS MACC under various levels of facility impact and at various incident scales.

7.2. Explore placing an EMS incident commander at each evacuating facility to form unified command with the facility incident commander and other incident commanders on site (e.g., fire and police ICs). Area command and other levels of emergency management can be implemented when more direct operational coordination is needed across EMS incident sites than the MACC can provide.

7.3. Choose standardized EMS ICS positions and nomenclature for EMS command personnel assigned to hospitals during evacuation. Suggest an order for staffing and which EMS ICS positions should be staffed based on incident scale and type. (E.g., in the 2019 Coalition Surge Test, UCH and MCA might each need an onsite EMS IC, transportation officer, and safety officer, with a staging officer and communications officer either at each site or at a central staging area.)

7.4. Create a plan for communications between the EMS ICS and MACC. In particular, consider if the phone and other potential electronic methods of communication discussed in Recommendation 6 are sufficient or if land mobile radio (LMR) capability is needed between field EMS ICS elements and the MACC. LMR capability might also be useful when an evacuating facility's information and communications technology systems are partially or completely unavailable to send resource requests to the MACC.

7.5. In general, EMS ICS elements should be made responsible for tracking individual vehicle, personnel, and patient assignments and movements. Plans should include provisions for tracking and ensuring the safety of facility healthcare, transportation, and other public safety personnel accompanying EMS to the receiving facility, and recognize the reality that early in the incident those assignments are likely to be made ad hoc at loading or staging.

7.6. However, the EMS MACC will need to be notified and document on its virtual status board when an EMS trip has been completed, how many patients of each category were transferred to which receiving facility, and if the EMS and transportation resources used are available to make another trip or are being recalled by the sending agency. The MACC will also need to be notified of EMS resources unable to be assigned or to complete their assignments because of exposed, injured, dead, or otherwise incapacitated personnel and damaged, destroyed, or otherwise inoperable vehicles.

7.7. The EMS ICS and MACC plans and system for tracking people and vehicles should anticipate and be forward compatible with major technology upgrades underway or planned in the NCR and UASI. The

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CAD–CAD integration and GIS Situational Awareness projects seek to exchange response and automated vehicle location data in ways that will create opportunities for the MACC and onsite EMS ICS to streamline or automate many of their vehicle and personnel tracking and notification tasks. The HIE–EMS Patient-Care Reporting Data Exchange project will potentially allow real-time end-to-end tracking of individual patients in their electronic health record as care is transferred from the sending facility to the ambulance to the receiving facility.

7.8. Plans and exercises should anticipate EMS crews will be transporting to unfamiliar receiving facilities that do not routinely take emergency ambulance patients and create processes to ensure the most safe and efficient routing and patient handoffs possible.

7.9. Plans should support sending electronic patient records and documents supporting transfer of care from sending facility to receiving facility EHR (either directly or via the CORHIO HIE) ahead of the patient when possible, allowing the receiving facility to prepare for arrival and reducing sending facility delays and effort. After the HIE–EMS PCR Data Exchange project enables ambulance PCR systems to communicate with the CORHIO HIE, the transferring ambulance crew and care provided should be added to this data flow. (See Recommendation 8.)

Recommendation 8: Give EMS MACC End-to-End Responsibility for Evacuating Patients

Explore processes and methods for the EMS MACC to know the inventory of available receiving beds and level of care associated with each of those beds and for the MACC to take greater responsibility for end-to-end matching of evacuating patients with appropriate transportation, en route care, and receiving facilities.

Opportunities and challenges:

8.1. Determine at what incident scales providers, facility operators, and regulators would consider the benefits of pooling and centrally allocating receiving facility resources to outweigh the costs of not arranging individual patients' transfer of care directly between sending and receiving facilities. Understand what perceived or actual legal, policy, institutional, and process barriers would need to be lowered before and during an incident to allow an altered matching process. Consider if and how the NCR HCC should work to lower the barriers.

8.2. Determine if ADT messages and related data in EHRs and the CORHIO HIE, alone or in conjunction with other data sources like EMResource and State facility licensing databases, allow the estimation and confirmation of each NCR facility's available beds; the level of care associated with each of those beds; and support categorizing those levels of care in a standard way to allow patients to be centrally matched by the EMS MACC or other trusted broker with an appropriate receiving facility and bed during a large-scale incident. These methods should be developed so they support better identification and disaster use of nontraditional, geographically scattered receiving beds (e.g, at standalone surgical centers) than presently occurs. In a wide-area incident, the methods might also allow less-impacted facilities to automatically offer available beds to more-impacted facilities when the less-impacted facilities have excess patient-care capacity but no emergency management capacity to repeatedly manually update their status in systems like EMResource.

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8.3. Determine if evacuating or decompressing facility transfer workflows and resulting ADT messages and related data in EHRs and the CORHIO HIE are currently used for, support, or could be enhanced to support making and accepting inter-facility transfer requests and records exchanges with no or minimal actions required outside the facilities' EHRs. Investigate if these processes could result in automated sending of the Recommendation 6 standardized resource requests to and responses from the EMS MACC, presumably via the CORHIO HIE and the MACC virtual status board system.

8.4. Also investigate how the processes could streamline planning and operations for hospital ICS and EMS ICS at the sending facility if electronic patient records are automatically sent to the designated receiving facility and patients' movements are tracked in their longitudinal HIE records. Identify new or improved EHR and HIE human interfaces needed to take advantage of these data flows under incident conditions. Determine how these processes and data overlap with actual and intended EMResource and EMTrack functions, where they are duplicative, and where and if they can and should be integrated. Ensure new and existing systems are prepared to incorporate and take advantage of the end-to-end individual patient tracking the HIE–EMS PCR Data Exchange project should enable.

8.5. Consider if, under defined overload conditions, evacuating or decompressing facilities could virtually transfer or assign patients from within their EHRs to the EMS MACC using the CORHIO HIE. The EMS MACC would act as an intermediary, responsible for completing the match of evacuating patients with appropriate transportation, en route care, and receiving facilities, and completing the transfer both virtually and in real life. Virtual transfers or assignments to the MACC would need to put patients into standard categories or support straightforward categorization of care needs for the MACC to appropriately and rapidly match patients with receiving beds, transportation, and en route care.

Operational Minimums and Next Steps

EMS MACC Minimum Requirements

For a virtual EMS MACC to be stood up in response to real-life NCR incidents and operate in a role and at a level of function similar to that experienced in the 2019 Coalition Surge Test, the minimum requirements are:

- The NCR EMS MAC group has been identified and developed criteria for incidents warranting EMS MACC activation; a list of individuals, roles, groups, and agencies to be notified of activation; and some authorized senders and method(s) of sending the activation notification. Each list and necessary supporting information (e.g., phone numbers) has been disseminated or loaded into notification systems.

- The EMS MAC group has identified and has ubiquitous access to a resilient virtual conferencing system adequate to replace the level of face-to-face interactions required in the MACC during the 2019 Surge Test and 2016 Plague Exercise.

- The EMS MACC has permanent, disseminated incoming phone numbers which are forwarded to MACC members or the MACC conferencing system during an incident.

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- All or most NCR EMS agencies and their dispatch centers are in agreement that once an EMS MACC is activated for an incident, all incident resource requests will be forwarded to the MACC, and the MACC may inquire regarding available ambulances and request assignment of those ambulances to incident response.

- The EMS MAC group has an updated, shared, ubiquitously available, resilient online list or other better integrated display of all NCR EMS agencies and a 10-digit phone number for each of their dispatch centers.

- The EMS MAC group has identified, tested, and implemented a resilient, ubiquitously viewable MACC whiteboard replacement updatable in real time by at least one of the MACC members.

Overview of Technologies At Hand to Meet Minimums

Each of the following technologies is discussed because it is widely used by and familiar to NCR agencies and is assumed to be generally representative of the capabilities of its class of technology. No one of the technologies is a complete solution meeting all the EMS MACC minimum requirements, but the needed attributes could be relatively rapidly assembled by using two or more of these well-known and readily available solutions side by side.

Nextiva Call Center

The EMS MACC requirement for permanent incoming phone numbers which are forwarded to MACC members during an incident essentially requires a Voice over Internet Protocol (VoIP) virtual call center system. These systems allow phone "agents" to make themselves available to answer calls coming in to the "call center" from wherever an agent happens to be. In the NCR, VoIP virtual call centers appear to be little used in public safety dispatch[12] but are used in health information technology support. CORHIO uses a system called Nextiva Call Center to perform these functions, which likely could be expanded to support the EMS MACC for a lower marginal cost than standing up a VoIP virtual call center from scratch. Nextiva claims to have 99.999 % uptime reliability[13] and so should meet EMS MACC communication resiliency requirements. Nextiva Call Center has detailed timestamped logging and recording features that should meet EMS MACC legal and incident reconstruction requirements.

To use Nextiva Call Center, the EMS MAC group will already have Nextiva accounts established and have received a notification to activate the MACC. MAC group members available to staff the MACC each log in and put themselves available to have incoming resource request calls routed to their individual phones. Because Nextiva does not simultaneously meet the activation notification, virtual conferencing, or whiteboard tracking requirements of the EMS MACC, MACC members will be required to sign into other software systems at the

12. Personal communication with EMS Captain Nathan Bunge, Denver Health Paramedic Division Communications (Jun. 30, 2019).

13. Nextiva, Nextiva Pricing: Compare our most popular features, https://www.nextiva.com/nextiva-pricing.html (last visited Jun. 30, 2019).

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same time as Nextiva. Nextiva does support some single sign-on methods which might allow it and some other systems (e.g., Zoom) to be logged in to by entering a user's name and password only once.

Zoom Meetings and Chat

Zoom Meetings and Chat would likely address the need for ubiquitous access to a resilient virtual conferencing system, offering text chat functionality in addition to audio and video conferencing. Many NCR HCC members seem to successfully participate in various routine Zoom meetings from a variety of locations and devices. Zoom advertises its resilience under disaster and low-bandwidth conditions[14] but we are not aware of those claims ever being tested by NCR end users. Zoom also has detailed timestamped logging and recording features that should meet EMS MACC legal and incident reconstruction requirements.

The EMS MACC would probably need its own host account added to the NCR HCC or another organization's Zoom plan so a known Personal Meeting ID could be permanently associated with the EMS MACC. The initiating EMS MAC group member would need to log in to the MACC Zoom account. This approach would allow other MAC group members to find the MACC Zoom meeting after receiving the MACC activation notification without an additional, specific Zoom invitation being sent. Key assumptions are that all EMS MAC group members have their own existing, current, unlocked Zoom accounts; know and have access to the MACC Zoom host account and Personal Meeting ID; and are trained in and able to remember the procedure for standing up and joining the MACC Zoom meeting. Also, Zoom meetings in plans below the Business level have time limits,[15] which could be disruptive in long incidents if the meeting has to be stood up a second time. Curing the time limitation will likely add expense to maintaining the NCR HCC's Zoom service.

Zoom screen sharing offers a way for one user to display a file or whiteboard and for multiple users to potentially join in updating that file or whiteboard. These features appear to be untested under incident conditions in the NCR, especially as a virtual analog for the way the EMS MACC real-life whiteboard was used in the 2019 Coalition Surge Test. Another approach might be to use Zoom video conferencing and point a webcam at a real-life whiteboard so other MACC members could visualize a designated scribe making updates in response to their requests and reports. This method imposes the additional requirements that the MACC scribe can get to a workable location with a physical whiteboard and that the video portion of the Zoom conference is working with complete reliably throughout the incident. Also, if there is any possibility that protected health information might be shared by these methods or text chat, a HIPAA-compliant Zoom instance may be required.[16]

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14. *See, e.g.,* Zoom Blog, *Responding to Disasters With Zoom* (Jan. 16, 2014), https://blog.zoom.us/wordpress/2014/01/16/respondingtodisasters/.

15. Zoom, Zoom Meeting Plans for Your Business, https://zoom.us/pricing (last visited Jun. 30, 2019).

16. Slack might be another technology worth considering, especially as Slack and Zoom become increasingly integrated and Slack has begun offering a HIPAA-compliant version. However, Slack is making major changes around the integrations in early July 2019. We should wait until we have more direct experience with those changes and features. *See*, Slack, Using Slack, https://get.slack.help/hc/en-us/articles/115003498363-Slack-Calls-the-basics- (last visited Jun. 30, 2019).

Because Zoom alone does not address the activation notification, incoming direct-dialed phone number routing, or shared EMS agency contact list requirements of the EMS MACC, MACC members will be required to sign into other software systems at the same time as Zoom. The Zoom Business Plan does support single sign-on methods which might allow it and some other systems to be logged in to by entering a user's name and password only once.

Google Sheets

The EMS MACC requirement for a shared, ubiquitously available, resilient online EMS agency and dispatch center contact list is partially meet by the current Google Sheets implementation. The main limitation is that some potential EMS MAC group members have complained about the Google service being blocked on their employers' networks. There are other spreadsheet file sharing providers, such as Office365 and Dropbox, which might be blocked on fewer networks—MAC group members will have to be polled before making a final choice. It is unclear if one service is demonstrably more resilient than the others. All three services have roughly equivalent timestamped change logging, with Google's probably being the most detailed and easiest to reconstruct.

The Google Sheet would probably be logged into independently by all the EMS MACC members after activation. This is a supported use: each Google Sheet allows 100 simultaneous individual editors and 200 simultaneous individual viewers.[17] A key assumption is that all EMS MAC group members have existing, current, unlocked Google accounts with which the Google Sheet has been correctly shared. Alternatively, one of the MACC members on a Zoom call could share her screen with the Google Sheet loaded and allow the other MACC members on the Zoom call to view and edit the Google Sheet via her screen share.

Both options are untested under incident conditions. Both offer the possibility of using the single EMS agency list Google Sheet as a foundation to be built upon by amending as the incident progresses. However, they both pose challenges if protected health information is entered into a Google Sheet, either accidentally or deliberately, without a G Suite paid instance and appropriate HIPAA business associate agreements in place.

Because Google Sheets does not address the activation notification, virtual conferencing, or incoming direct-dialed phone number routing requirements of the EMS MACC, MACC members will be required to sign into other software systems at the same time as Google. Google supports single sign-on, allowing it and some other systems to be logged in to by entering a user's name and password only once.

ReadyOp

ReadyOp is a highly configurable, integrated resilient communications and incident management platform. It is able to meet the EMS MACC activation notification, virtual conferencing, EMS agency and dispatch center contact list, and tracking whiteboard requirements. The only requirement ReadyOp does not currently meet is for permanent incoming phone numbers and call routing (the call center requirement). While there are a

17. Google, *Docs Editors Help Center: Share Files from Google Drive*, https://support.google.com/docs/answer/2494822?co=GENIE.Platform%3DDesktop&hl=en (last visited Jun. 30, 2019).

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number of other ReadyOp instances in the NCR (offering the possibility of later integrations), the EMS MAC group or NCR HCC would likely need its own instance to meet the EMS MACC requirements.

A single NCR HCC-supported ReadyOp instance could be configured to support a broad range of other NCR HCC resilient notification, communications, and coordination needs along with those of the EMS MAC group. ReadyOp is HIPAA-compliant and has detailed timestamped recording and logging of every action taken in the system—especially useful for incident reconstruction and reimbursement.

Each member of the EMS MAC group would have ReadyOp training and an individual login, as would any others authorized to send the MACC activation notification. Once a MAC group member or other authorized person decided the MACC activation criteria had been met, she would log in to ReadyOp and send the pre-configured notification by whatever methods the MAC group had agreed upon (SMS, phone, and email; usually about four mouse clicks to send). The message to EMS MAC group members would ask them to log in to ReadyOp and Nextiva and have links back to both those systems. The message to everyone else who wanted to be notified (e.g., hospital emergency managers) would be a simple heads-up.

ReadyOp does not support single sign-on, so there would be separate logins into Nextiva and ReadyOp. On logging in to ReadyOp, an EMS MAC group member would find a webpage of boxes like an organization chart, one labeled for each MAC group member. Again, in about four mouse clicks, a member would stand up a secure video, audio, and text chat conference with all the logged-in MAC group members to form the virtual EMS MACC for the duration of the incident.

On another ReadyOp tab, there would be a box for each agency on the NCR EMS agency list. A button in each of those boxes would allow EMS MACC members to initiate a phone call directly to that agency's dispatch center and start the ambulance inventory process. The MACC member could then type the number of available ambulances directly into that agency's ReadyOp box so it would be visible to all the other MACC members in real time. Figure 2 is a mock-up of what the tab might have looked like at this stage of the incident if the 2019 Surge Test EMS MACC had used ReadyOp. All the NCR hospitals would be represented as boxes as well, with contact buttons and updatable statuses available throughout the virtual MACC. These ReadyOp boards would be a true virtual version of the 2019 Coalition Surge Test EMS MACC whiteboard but have integrated communication pathways and be better organized from the start.

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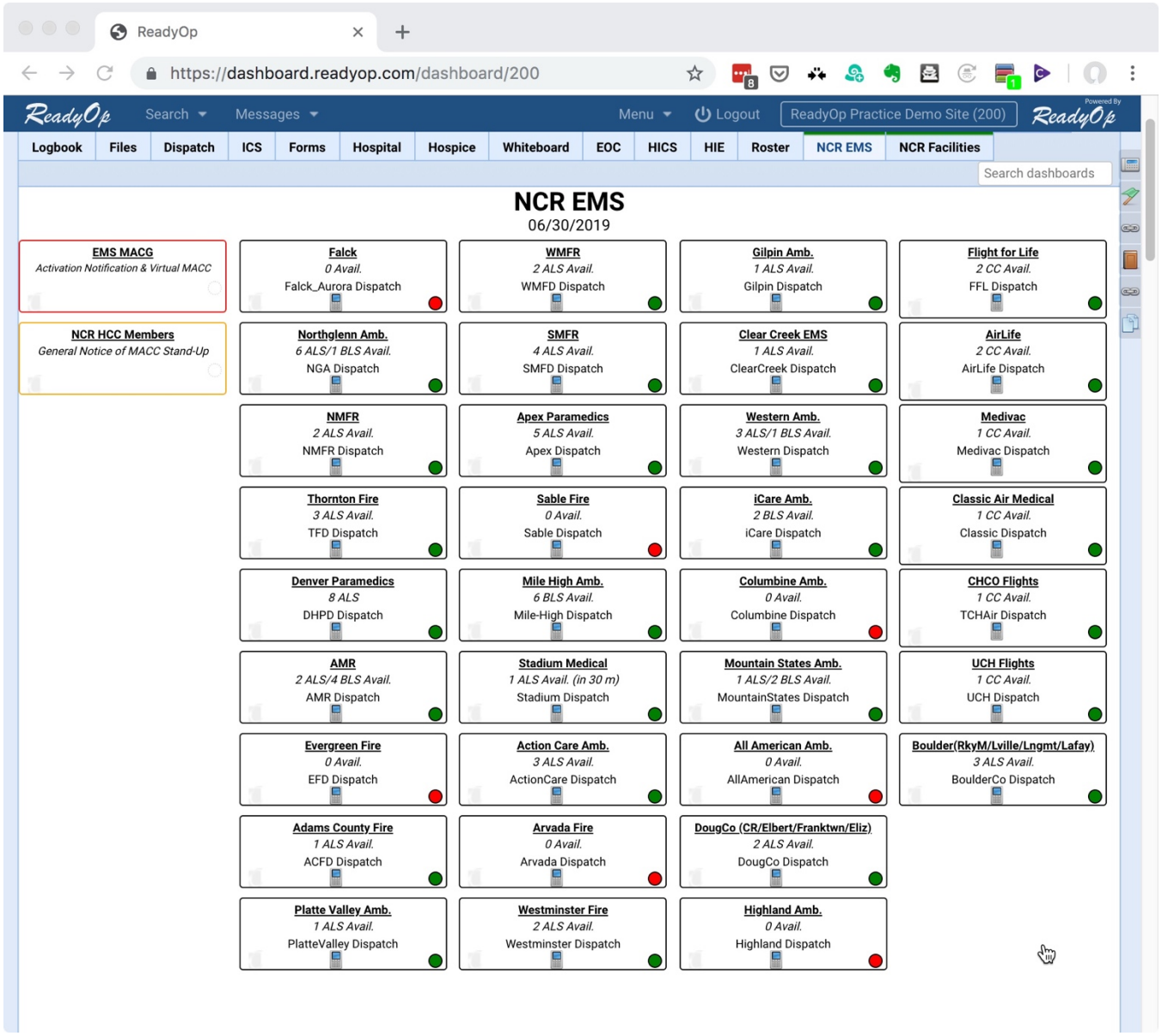
Figure 2. Mock-up of 2019 CST available ambulances using ReadyOp instead of EMS MACC whiteboard.



Finally, the ReadyOp API offers the possibility that the situational awareness views being created and manually updated today might someday be updated automatically from sources like the CORHIO HIE or EMResource. ReadyOp is also capable of land mobile radio–IP integration, offering potential EMS MACC incident monitoring or integrated two-way communication alternatives to phone calls with facility and EMS incident command.[18]

18. ReadyOp, *ReadyOp Help & User Manual*, https://www.readyop.com/documentation-dashboard/ (last visited Jun. 30, 2019).

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Table 2. Comparison of how technologies at hand meet virtual EMS MACC minimum requirements.

Technology	MACC Activation Notification	Incoming MACC Phone Numbers and Calls	EMS Agency and Dispatch Phone List	Tracking Whiteboard	Virtual Conferencing
Nextiva	No	Yes	No	No	No
Zoom	No	No	No	Maybe	Yes
Google Sheets	No	No	Yes	Maybe	No
ReadyOp	Yes	No	Yes	Yes	Yes

Suggested Next Steps

The Combined Regional EMS Planning and Preparedness Meeting should be used to identify the NCR EMS MAC group from among its members and create a work plan and work groups to create the MACC activation criteria and lists of those authorized to request activation and be notified of activation. As needed, the EMS MAC group should go beyond the usual attendees of the Combined EMS Meeting to ensure all relevant NCR disciplines are involved in creating the criteria and activation notification lists.

The NCR HCC Governance Board should investigate the possibility and cost of extending CORHIO's Nextiva and other call center services to provide the EMS MACC incoming phone numbers and call routing service.

The NCR HCC Governance Board should consider purchasing a ReadyOp instance because ReadyOp meets all the remaining EMS MACC technology requirements in a single platform and offers the best potential of the technologies at hand for extension and integration.

The NCR HCC may want to partner with another organization to configure and maintain ReadyOp for the EMS MACC and other NCR HCC member uses. This could be an existing public safety or healthcare ReadyOp user. Or if CORHIO is already providing call center services and researching HIE–ReadyOp integrations, a partnership where CORHIO becomes the single point of contact for EMS MACC technologies could be explored.

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