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EXPERIENCE REPORT

Learning Health Systems

A regional learning health system of congregate care facilities for COVID-19 response

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Abstract

Introduction: The COVID-19 pandemic disproportionately affected congregate care (CC) facilities due to communal living, presence of vulnerable populations, inadequate preventive resources, and limited ability to respond to the pandemic's rapidly evolving phases. Most facilities function independently and are not organized for collaborative learning and operations.

Methods: We formed a learning health system of CC facilities in our 14-county metropolitan region, coordinated with public health and health care sectors, to address challenges driven by COVID-19. A CC steering committee (SC) was formed that represented diverse institutions and viewpoints, including skilled nursing facilities, transitional care facilities, residential facilities, prisons, and shelters. The SC met regularly and was guided by situational awareness and systems thinking. A regional CC COVID-19 dashboard was developed based on publicly available data and weekly data submitted by participating facilities. Those experiencing outbreaks or supply shortages were quickly identified. As the pandemic progressed, the role of the SC shifted to address new and forecasted needs.

Results: Over 60 facilities participated in data sharing. The SC shared new guidelines, regulations, educational material, and best practices with the participating facilities. Information about testing sites, supplies, vaccination rollout, and facilities that had the capacity to accept COVID-19 patients was regularly disseminated. The SC was able to direct resources to those facilities experiencing outbreaks or supply shortages.

Conclusions: A novel learning health system of regional CC facilities enabled preparedness, situational awareness, collaboration, and rapid dissemination of best practices across pandemic phases. Such collaborative efforts can play an important role in addressing other public and preventive health challenges.

KEYWORDS
congregate care, COVID-19 response, learning health system, nursing homes

1 | BACKGROUND

Despite decades of preparation for pandemic threats, many regions around the world lacked the infrastructure needed for an integrated, adaptive, cross-sector response to COVID-19.[1-4] In the United States, absent an effective framework for sharing data and information and disseminating learning across local, state, and federal levels, local leaders often organized and worked together to create systems enabling situational awareness and rapid learning to minimize COVID-19 morbidity and mortality.[5,6] The State of Ohio, for example, organized into several response zones and regions, each coordinating response within its area of responsibility. In the Greater Cincinnati region, this response structure formed an emergent learning system supported by cross-sector data sharing and analytics, which promoted rapid learning and the broad sharing of best practices to occur.[7,8]

The COVID-19 pandemic significantly affected those living in congregate care (CC) facilities.[9-11] By the end of 2022, more than 725 000 nursing home residents had been infected by COVID-19, and at least 140 000 had died, with a mortality rate of 19%. Additionally, nearly 700 000 staff members had been infected, and more than 2100 had died.[12] CC facilities include diverse settings, organizations, agencies, and institutions, like skilled nursing facilities (nursing homes and assisted living), transitional care facilities (sober living, reentry, and transitional facilities), residential facilities (group homes, senior living, affordable housing), correctional facilities (prisons and jails), and shelters for the homeless. During the early phases of the pandemic, the skilled nursing facilities were receiving guidelines from federal and state agencies. At times, it was hard for individual sites to keep up with the rapidly changing instructions. On the other hand, residential facilities, transitional care facilities, and shelters lacked guidance.

Prior to the availability of safe and effective vaccines, CC facilities were especially vulnerable to COVID-19 due to communal living of high-risk susceptible populations, limited preventive resources (such as personal protective equipment [PPE] and infection control expertise), and lack of clear guidance for how to respond to rapidly changing, uncertain situations across the COVID-19 pandemic's many phases. This lack of clear guidance, and ready answers, has been magnified by differences between CC facilities themselves. For example, differing supervision models across facility types require differing prevention processes. Indeed, certain skilled nursing facilities involve constant supervision of residents. Other independent living facilities, or shelters, have very little supervision and resident mixing. Similarly, the resources and medical training among staff are highly variable. Moreover, CC facilities typically function independently and are not organized for collaborative learning and operations. These differences, and vulnerabilities, were particularly stark during the early phases of the pandemic, catching our health system depleted and unprepared.

The National Academies of Science, Engineering, and Medicine describes Learning Health Systems (LHSs) as organizations in which care, science, informatics, and incentives are aligned for continuous improvement and innovation.[13] Knowledge and evidence are captured in the process of daily operations and applied seamlessly into caregiving.[14] Such characteristics of LHSs have found application in COVID-19.[7,15,16] To respond to limitations and to better optimize our regional response to COVID-19, we organized CC facilities in the Greater Cincinnati region with the goal of enabling them to share important data, enhance informatics capabilities for action and learning, and align incentives to achieve continuous improvement and innovation to better care for their patients and workforces. This collaboration of CC facilities was under the wider organization of a multi-sector LHS in the Greater Cincinnati region.[7] In this article, we depict the work of the CC LHS to respond to the evolving phases of the pandemic during its first year. We focus on efforts from initiation (May 2020) through February 2021.

2 | METHODS

2.1 | Context

Metropolitan Cincinnati is a 14-county region with a population of 2.2 million people. The region stretches across Southwestern Ohio, Southeastern Indiana, and Northern Kentucky. It includes more than 200 skilled nursing facilities with approximately 17 000 residents, more than 30 correctional facilities with approximately 8000 inmates and 2500 staff, and more than 100 shelters, halfway houses, and group homes. This LHS was closely associated with the regional multiagency coalition (MAC) that was established under the direction of the state (Ohio) department of health. The MAC was comprised of representatives from hospitals, public health departments, and the CC sector.[7,8] Greater Cincinnati's regional health information organization (The Health Collaborative), which also operates the region's Disaster Preparedness Coalition, and academic hospitals (Cincinnati Children's Hospital Medical Center and University of Cincinnati Health) provided data support, project management, and strategy to the MAC and its sub-teams.

2.2 | Steering committee

A CC steering committee (SC) was formed in May 2020 under the regional MAC (Figure 1). The SC included 13 members representing leaders of different CC facility types (skilled nursing, assisted living, group homes, senior living, affordable housing, transitional care, jail, correctional facility/prison, and shelter), a physician with expertise in skilled nursing facilities, a physician with quality improvement expertise, and a project manager. The diverse membership was essential for understanding the context, needs, and challenges of each setting. Additionally, the SC members provided strategies, contacts, and leverage for engaging similar facilities within the region. The SC met weekly from May through November 2020. The frequency of the meetings was reduced to every 2 weeks subsequently. The SC was led by two co-chairs who also represented CC in the MAC. Through this framework, the MAC was updated with the situation of CC facilities in the region, and vice versa, and it provided an opportunity for escalation of CC concerns to regional leaders in health care and public health.

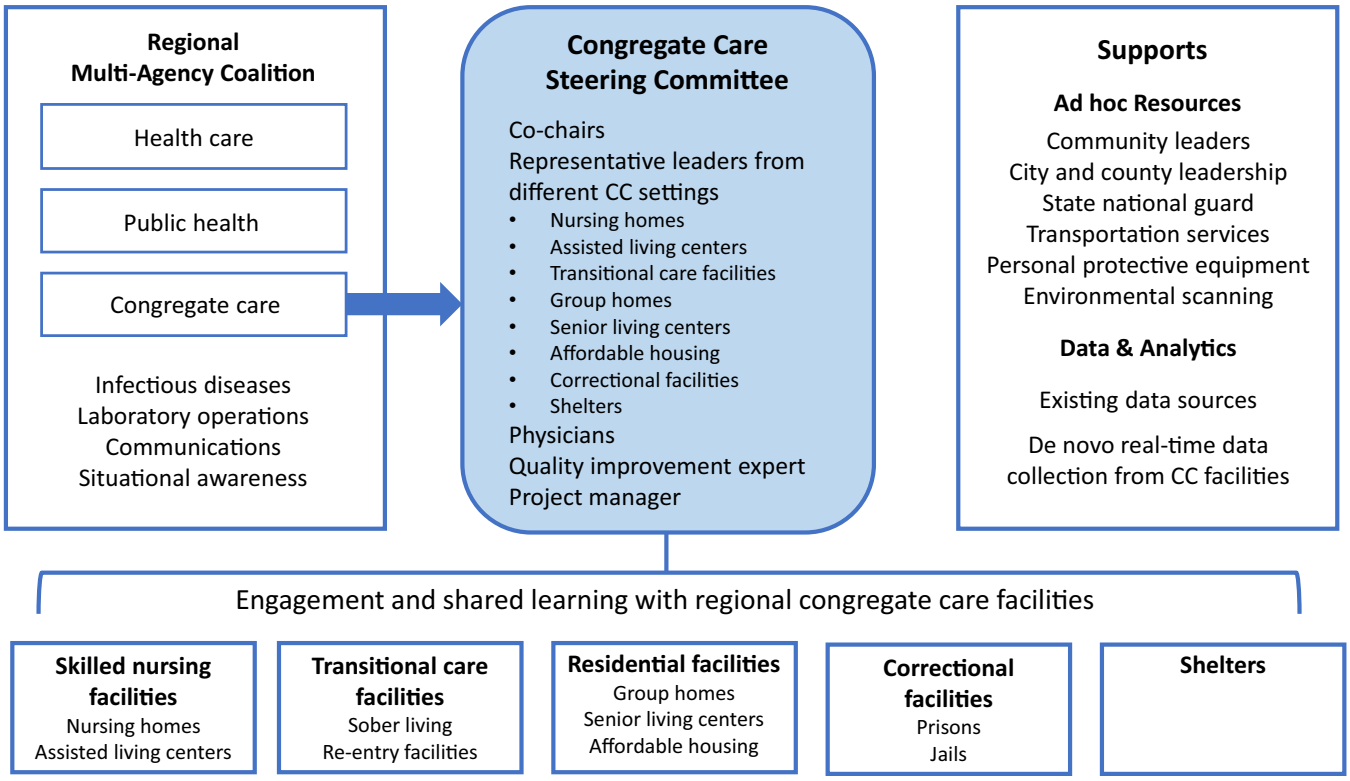

FIGURE 1 Framework of regional congregate care learning health system for COVID-19 response.

2.3 | Setting aims

The primary aim of this CC-focused LHS was to minimize the burden of COVID-19 outbreaks and impact among the residents and staff of CC facilities. An outbreak was defined as a new case of a resident that tested positive for COVID-19 and was attributable to intra-facility transmission. Thus, an admission or an accepted transfer of a known COVID-19 positive resident was not considered an outbreak. An outbreak was self-reported by the facility, either in the form of weekly data submission or reports made directly to the Ohio Department of Health.

2.4 | Theory of change and interventions

The CC LHS rapidly evolved with the evolving needs and uncertainties of the pandemic. It provided an opportunity to respond to rapidly changing conditions and to new guidelines and regulations. Figure 2 provides the key driver diagram of our working theory near the end of the first year, February 2021. Our primary drivers were: (a) timely, relevant, and accessible regional data; (b) equitable and easy engagement of CC facilities in the LHS; (c) access to COVID-19 testing and screening for residents and staff; (d) effective and reliable infection control practices; (e) adequate access to PPE for residents, staff, and visitors; and (f) clear and effective communication.

Information about testing sites, PPE supplies, and facilities that had the capacity to accept COVID-19 patients was regularly updated and disseminated. Educational sessions were regularly conducted by medical and operational experts to share evolving knowledge such as: updates on COVID-19, infection control practices, federal and state regulations, CC operations, visitor policy and management, etc. Ad hoc educational sessions were also arranged in a just-in-time fashion for urgent needs identified by the SC. Best practices from one CC facility were quickly shared with others. Specifically, the learnings from skilled nursing facilities were shared with non-nursing CC facilities. This was especially useful as skilled nursing facilities often experienced COVID-19 outbreaks much earlier than other CC facility types and had been provided with more robust guidance from the United States Centers for Disease Control and Prevention (CDC) and state agencies. Additional interventions deployed by the CC SC are listed in the shared key driver diagram. These interventions helped facilities to be better prepared to manage outbreaks, maintain safe visitation policies, deploy evidence-based staff testing practices, and introduce vaccinations to residents and staff more effectively as vaccines became available.

2.5 | Data acquisition and sharing

To maintain situational awareness, timely and accurate data feedback was essential for this LHS. The CC SC relied on a regional dashboard created by the MAC's situational awareness team for the burden and prediction of COVID-19 trends in the community and hospitals.[7] Members of SC developed a consensus on a set of measures that

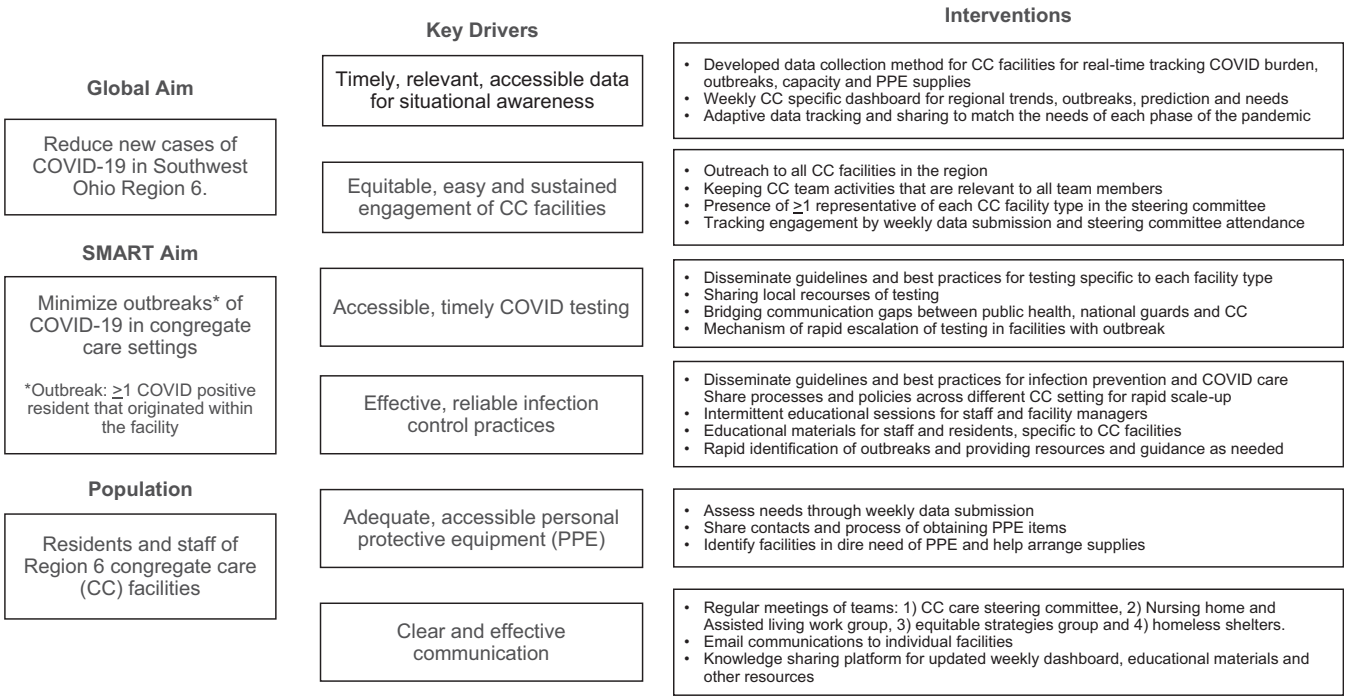

FIGURE 2 Key driver diagram for the congregate care learning health system.

would provide essential information for CC facilities, without making the process of measurement laborious. The measures included: (a) the burden of COVID-19 among residents and staff; (b) weekly incidence of new cases in their facility; (c) number of new cases attributable to intra-facility COVID-19 transmission; and (d) availability of PPE. Most CC facilities did not have an existing structure to capture and report real-time data. The data team worked with the SC to create a CC-specific data collection tool for weekly data capture using REDCap.[17,18] When applicable, we utilized the measures that were already reported to the state by certain facilities (skilled nursing and correctional facilities) for the CC dashboard. Publicly accessible measures included COVID-19 case burden across such facilities.[19,20] Although these public data included many facilities, reporting was often delayed by at least 2 weeks, hindering real-time assessments and responses.

In addition to facility-specific measures, the SC also monitored the participation of CC facilities in data sharing. Participation in the CC SC and data contribution was voluntary. The data team analyzed data weekly and created two dashboards, one for public access with exclusion of facility names, and the other for SC and public health leaders via the MAC that included specifics of facilities affected by COVID-19 outbreak or PPE shortage. This enabled rapid and targeted responses such as load balancing of PPE supplies and providing resources for outbreak management.

2.6 | Participant feedback

After 1 year of participation in the CC LHS, we conducted an informal, anonymous online survey with CC SC members about their experience with working collaboratively during the regional COVID-19 pandemic response. We also inquired about other public health challenges that could benefit from a similar collaborative approach.

2.7 | Ethics statement

This work was undertaken to assess and improve ongoing COVID-19 response activities in a specific region, and not to produce generalizable knowledge. As such, it constituted operational improvement activities that are exempt from ethics review. The primary purpose of this report is to share lessons learned from operational implementation and discuss implications for addressing other public and preventive health challenges.

3 | RESULTS

Within 6 weeks of CC SC formation and with the help of MAC and CC SC members, we developed a comprehensive list of the CC facilities in our region. Soon thereafter, resource documents, invitations to educational sessions, weekly data submission forms, and a prototype public CC-specific dashboard were disseminated to all facilities. Individual CC facilities began submitting weekly data in July 2020. During peak surge (November and December 2020), more than 60 facilities submitted data for 17 consecutive weeks, with a maximum of 82 regional CC facilities submitting data for shared use in 1 week. Data submission decreased as cases dropped after the first major surge, facilities developed improved capabilities, PPE supplies increased, and

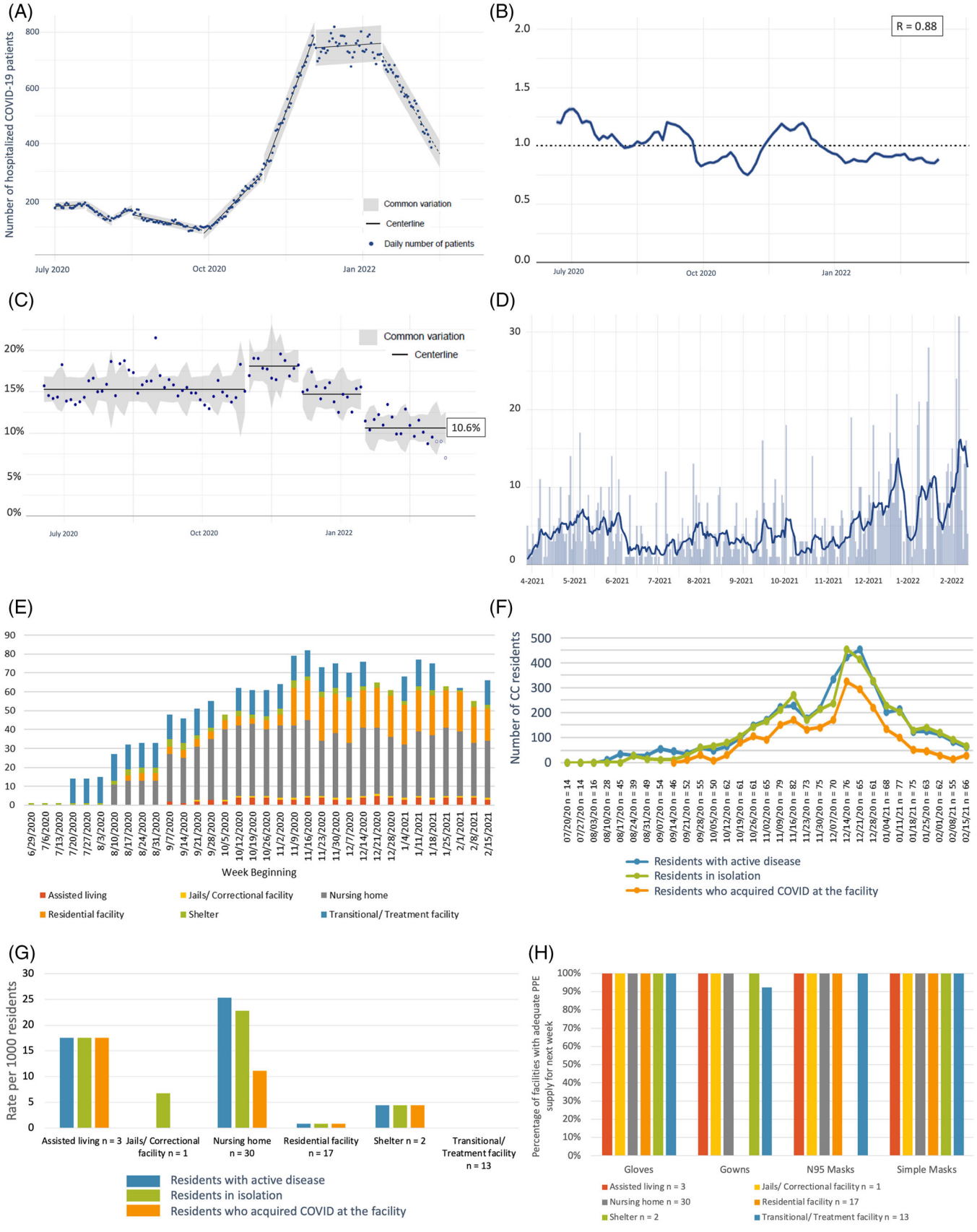

FIGURE 3 Legend on next page.

efforts shifted toward vaccination. The weekly survey was stopped in May 2021; however, CC facilities continue to receive a regional dashboard shared with all MAC members. Figure 3 provides representative visualizations from the CC dashboard.

Multiple instances of collaborative learning and sharing of resources took place that would otherwise have been rare or impossible. Facilities with surplus PPE sent supplies to those with critical shortages. De novo policies and practices related to infection control, COVID-19 testing, and visitor guidance were developed and shared across sites. Through participation in the MAC, CC representatives had access to infectious disease and public health experts who provided insight into evolving guidelines and how they could be applied to varying contexts. System-wide data allowed CC leaders to see trends in community cases and strains on hospitals. Coordination between acute care facilities and CC facilities was improved to allow for better load sharing and forecasting. The number of CC facilities that were ready to accept COVID-19 patients from acute care facilities was increased by providing them appropriate tools. The acute care facilities were informed of the CC facilities experiencing a COVID-19 outbreak to anticipate new admissions. This fuller picture enabled adaptations to operations, making hospital-to-CC facility and inter-facility transitions faster and easier.

Given the rapidly changing conditions and limited data on CC facilities in other regions, it is not possible to directly evaluate the

TABLE 1 Qualitative feedback from congregate care steering committee members regarding collaborative regional COVID-19 pandemic response (n = 10).

Theme	Representative responses/summary of responses
Taking a systems view, shared learning, and building trust	"I received up-to-date information about the COVID-19 pandemic trends in our region when there were a lot of voices and distracting information. I was able to participate and learn from other sectors experiencing a heavier burden of pandemic at first, like nursing homes. We were able to anticipate potential barriers and issues as cases later increased in our setting of affordable housing." "It was true collaboration because we had a common enemy: COVID-19. Members were committed to working together, even if it meant outside their comfort zone. The team included diverse congregate care settings. The group was very open and democratic." "The information sharing was practical and useful as it was coming from people who are doing the work. The pandemic required a lot of interpretation because there was a lack of guidance to how services could be safely provided in many congregate care settings."
Sharing of resources	A list of all value-added resources mentioned in responses: Connection with other people, regional data, shared understanding of regional trends and challenges, learning from other facilities, better anticipation and preparedness in our own facilities, information about testing sites and processes specific to each facility, transport to testing sites, information and resources for vaccination, educational content, access to medical experts, understanding of what is going on in community and in hospitals, a platform to voice concerns and challenges.
Using data to guide decisions	"Data is critical. Having the ongoing situational awareness helped guide us in the decisions we made as an organization and within our facilities." "Initially, PPE data was most helpful as we could see who needs what and figure out a system to respond. As the pandemic went on, the larger community data was more helpful." "The dashboards were very helpful to see trends with infection spread and hospitalizations. This helped us proactively prepare and strategize." "Trends and status of congregate care cases over time, hospitalizations and ICU occupancy due to COVID-19 and community *R*-effective values[a] were helpful in proactive planning."
Opportunities for further collaborations	List of all opportunities mentioned in responses: Developing a closer relationship between different congregate care facilities for better care at transition of residents, affordable and safe housing, food insecurity, health literacy, work on the Ohio Department of Health's state health improvement plan, future pandemics, other public emergencies (like natural disasters, electricity outage), staffing shortage in congregate care and other health care settings.

Abbreviations: ICU, intensive care unit; PPE, personal protective equipment.
[a]*R*-effective: average number of secondary infections resulting from a primary infection at a point in time.

FIGURE 3 Representative graphs from the congregate care (CC) dashboard. (A) Number of positive COVID-19 patients in hospitals of the 14-county region. The dashed line indicates a temporary centerline that will change over time. *Source*: Ohio Hospital Association (https://ohiohospitals.org/covid19data). (B) Estimated effective reproduction ratio (*R*) value for COVID-19 spread in the 14-county region. Data for individual counties were also available. An *R* value above 1 means cases are increasing. Based on data drawn from The New York Times (https://raw.githubusercontent.com/nytimes/covid-19-data/master/us-states.csv). (C) Percentage of test results returned positive in the 14-county region. Data for individual countries were also available. Open circles indicate incomplete data. *Source*: The Health Collaborative. (D) Number of COVID-19 deaths in the 14-county region with a 7-day moving average. *Source*: The New York Times. (E) Number of CC facilities providing weekly data. *Source*: Weekly data from CC facilities. (F) COVID-19 burden of disease among CC residents. *Source*: Weekly data from CC facilities. (G) COVID-19 rates of COVID-19 disease per 1000 CC residents based on facility type. *Source*: Weekly data from CC facilities. (H) Adequacy of personal protective equipment supply in CC facilities. *Source*: weekly data from CC facilities.

impact of this LHS in CC-related COVID-19 outcomes. However, the informal anonymous survey of SC members provided insights to the perceived value of being a part of this LHS for the COVID-19 regional response. Ten out of 13 CC SC members completed the survey. Table 1 provides a summary of representative responses. Key themes from these responses related to: (a) taking a systems view, shared learning, and building trust; (b) sharing of resources; (c) using data to guide decisions; and (d) opportunities for further collaboration.

4 | DISCUSSION

With the shared goal of improving health outcomes, participants in a LHS collaborate to understand and solve complex problems by sharing data, knowledge, and best practices in real time.[21-23] Individuals organize into learning communities focused on one or more common goals while developing standards, processes, policies, and infrastructure to enable collaboration and sensemaking.[15] LHS members are thus able to learn rapidly and efficiently from shared knowledge and experience, a capability needed broadly throughout health care and in pandemic response.

This report describes a just-in-time organization of CC facilities into a LHS within Greater Cincinnati's 14-county region in response to the COVID-19 pandemic. The CC SC and the MAC were formed to address the pandemic's rapidly evolving and uncertain threats. The fear of the unknown and the unprecedented challenge to community and public health necessitated this bottom-up collaborative response. The CC SC and the MAC were maintained based on the value provided to its stakeholders, including the trust and durable relations that developed over time. Having a clear common goal and understanding the importance of the system that determines everyone's outcome—the realization that individual facilities were "in this together"—has resulted in CC leaders thinking beyond their traditional boundaries, collaborating to better protect the health of their residents and staff. The use of regional data to understand the trends within the noise of day-to-day variation were essential for adequate situational awareness and data-driven decisions. Optimizing coordination and communication within and between sectors is critical if multisector systems are to function effectively. In this work we have described how this took place within the CC committee and other works describe how the MAC facilitated this across sectors.[7,8]

COVID-19 and the day-to-day needs for CC stakeholders have evolved. In the early phases of the pandemic, as described in this report, the focus was on rapid learning, sharing of experiences and best-practices, access to COVID-19 testing, adequate PPE supplies, capacity building to implement infection control practices, creating CC-specific guidelines, understanding the information overload pertinent to our local context, and building trust. As the pandemic progressed, certain interventions such as data submission, meetings, and educational seminars were scaled down as facilities developed experience, capability, and capacity. Actions that were initially focused on testing, load sharing and PPE, pivoted to focus more on vaccinations. Such dynamic adjustments were a cornerstone of this LHS.

Complex public health challenges cannot be addressed by public health personnel alone. They can benefit from the support of a self-organizing, local LHS. Many residents and staff of CC facilities required care in overburdened hospitals and infected others in the community. Considering CC facilities separately from one another, and the CC system as distinct from health care and public health, propagates an incomplete, insufficient picture. The CC LHS integrated within our region's MAC provided cross-setting learning and sharing of expertise. Connecting those facilities regulated and guided by state and federal agencies (e.g., CDC, Centers for Medicare & Medicaid Services) with those that were "on their own," such as group homes, senior living, and shelters, accelerated shared learning and action. Expanding the health system to include CC alongside health care and public health was similarly impactful.

The US health system is fraught with many challenges that cross the boundaries of different health sectors—community, hospitals, public health jurisdiction, and the wide range of CC facilities. Unfortunately, such intentional cross-sector collaboration is lacking. It takes a deliberate effort—bottom-up and top-down—to "rally the herd" around common goals and reward the whole system for regional success.[11] We believe that the primary drivers of success of the collaborative described here were having clear common goals, feeling a sense of urgency to improve, modeling servant leadership, ensuring perceived value by stakeholders, providing real-time situational awareness, and maintaining a general sense of service. As highlighted by the qualitative feedback, some examples of such opportunities for similar efforts directed toward similarly complex challenges could include approaches to homelessness, food insecurities, health inequities, preparedness and response to natural disasters, future outbreaks, or climate change.

One of the limitations of this report is that we were unable to objectively measure the impact on specific outcomes in comparison to CC facilities in comparable regions. There was no comparison data available that could be used to assess the differential impact related to our efforts. However, our survey results demonstrate the added value perceived by CC leaders in our region. Consistent with the findings of our work, a recent study surveyed key tools and processes for using data and learning system structures in different phases of the pandemic and highlighted the importance of, inter alia, infrastructure to create systems for data and rapid learning; cohesive coalitions with shared alignment and goals; and working within an atmosphere of trust.[6]

5 | CONCLUSION

Our experience with just-in-time development and evolution of a LHS of CC facilities for our regional response to COVID-19 pandemic illustrates the power of a systems approach to responding to complex public health emergencies. We found power in alignment on a common aim, sense of urgency of change among stakeholders, and real-time situational awareness facilitating learning.[24] We hope that such collaboration will become a common practice, rather than a rare

occurrence. Such collaborative efforts can play an important role in enhancing our capability and capacity to address other public health challenges.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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