

A Digitally Capable Mobile Health Clinic to Improve Rural Health Care in America: A Pilot Quality Improvement Study

Asif Iqbal, MBA; Gokhan Anil, MD; Pawan Bhandari, PhD, MS;
Eric D. Crockett, FACMPE; Victoria M. Hanson, PhD; Bhushan S. Pendse, MS, PMP;
Jonathan S. Eckdahl, MBA; and Jennifer L. Horn, MD

Abstract

Objective: To address the problem of limited health care access for patients in rural southern Minnesota, a digitally capable mobile health clinic (MHC) quality improvement initiative was launched in a rural community-based health system.

Methods: This project was designed and implemented according to our institutional strategic plan, guiding principles for virtual community care, and existing approved standards of care. A quality improvement development and pilot implementation framework was rapidly developed using Agile methodology.

Results: The resulting technology and equipment selection, overall clinic design, vehicle vendor selection, clinical schedule and workflows, staffing model, equipment and technology selection, and testing were achieved in 12 months. The pilot site communities were chosen on the basis of size, interest, and lack of existing access. Four underserved rural communities now have access to telehealth consultations, laboratory testing, and in-person primary care examinations. By April 30, 2022, the MHC had provided 1498 patient appointments while maintaining our standards of care. Newly established broadband internet access for these communities and their residents was a valuable secondary outcome.

Conclusion: By designing and implementing an MHC quality improvement intervention that provides both in-person and advanced telehealth options for patients in rural communities, our institution rapidly provided a potential solution for the rural health care crisis. The MHC not only replaces traditional brick-and-mortar facilities but also expands service offerings and access to technology for rural communities and the people who live and work in them.

© 2022 THE AUTHORS. Published by Elsevier Inc on behalf of Mayo Foundation for Medical Education and Research. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>) ■ Mayo Clin Proc Inn Qual Out 2022;6(5):475-483

Providing access to quality health care across a wide geographic location is an immense challenge. Identifying solutions to this challenge is particularly difficult in rural settings with sparse populations. Rural communities across southern Minnesota rely on Mayo Clinic Health System (MCHS) for their health care. Many patients in this region have comorbid conditions that require regular monitoring by qualified health care teams and transportation to their primary medical center, which can often be a barrier for these patients. Furthermore, as value-based payment models gain momentum in the United States,¹ access will be critical for quality and cost containment. However, brick-and-mortar models in rural communities, even those with filled

schedules, are not financially sustainable. This is a crisis that is unfolding nationally.

The coronavirus disease 2019 (COVID-19) pandemic confirmed and enhanced our institution's strategic direction to drive the future of health care with virtual and digital models. Similar plans for many health care organizations became realized sooner than anticipated because of the global pandemic, which rapidly reshaped the culture and policy of technology use in health care. Indeed, our institutional 2030 virtual initiatives came to fruition in 2021 because of increased patient demand for telemedicine, development of wearable technologies, and application of machine learning and artificial intelligence in health care.² The guiding principles of virtual

From the Department of Mayo Clinic Health System Administration (A.I.), and Strategy Department (P.B., B.S.P., J.S.E.), Mayo Clinic, Rochester, MN; Clinical Practice (G.A.) and Administration (V.M.H.), Mayo Clinic Health System—Southwest Minnesota region, Mankato, MN; and Administration (E.D.C.) and Clinical Practice (J.L.H.), Mayo Clinic Health System—Southeast Minnesota region, Rochester, MN.

community care at MCHS include 5 key components: (1) accurate diagnosis can happen anywhere, anytime; (2) the patient will see you now; (3) virtual interactions will outpace physical interactions; (4) research, education, and collaborations will increase; and (5) existing traditional business models will be disrupted by digital initiatives (Figure 1).

To address the challenge of rural access and meet the goal of increasing our virtual footprint, MCHS launched a quality improvement initiative to redesign health care delivery for vulnerable populations in these rural communities by using a flexible, scalable model that can nimbly expand our digital footprint. The aim of this initiative was to design, acquire, and implement a digitally capable mobile health clinic (MHC) that can efficiently serve rural sites. Additionally, the MHC can be used for occupational health screenings, immunizations, and outreach programs that connect our institution with local communities and businesses in an innovative manner.

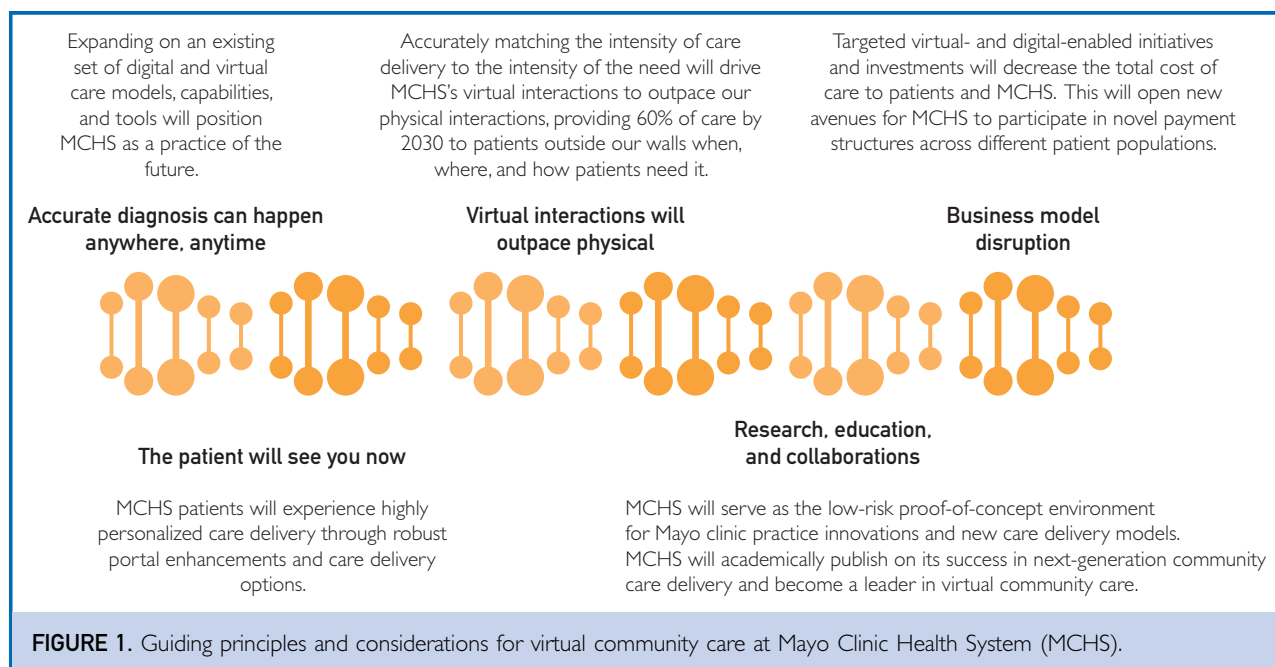
METHODS

Study Context

Mayo Clinic Health System is the community-based, practice-focused branch of our institution. Mayo Clinic Health System is committed

to transforming rural population and community care and serves 44 communities with 16 hospitals and 46 clinics. A 2017 survey³ performed in a partnership between the Minnesota Department of Health and the University of Minnesota School of Public Health showed that more than 50% of surveyed Minnesotans stated that they could not schedule an appointment with a primary care clinician as soon as they needed. The same survey also showed that rural Minnesotans were more likely than urban Minnesotans to be told that a clinic or clinician's office was not accepting new patients. Rural Minnesotans were also more likely to have more chronic conditions, poorer health status, and higher rates of frequent mental distress and suicide.³

Because of the COVID-19 pandemic—related directive mandated by the State of Minnesota,^{4,5} MCHS deferred or cancelled nonessential medical and surgical specialty appointments and procedures in the first quarter of 2020. Ambulatory clinic staff was redirected to inpatient units because of the increased number of hospitalizations related to the COVID-19 pandemic; therefore, nonurgent clinic appointments were also cancelled or deferred, and some MCHS clinics were temporarily closed. Patients were given options of receiving care via virtual visits (ie, telemedicine) or clinic visits at other MCHS sites.⁶



This led to the initiation and piloting of a digitally capable MHC as a quality improvement intervention to address the immediate and ongoing concerns for smaller MCHS clinics in rural Minnesota.

A formal project team was created to brainstorm the idea of a *clinic on wheels* (ie, an MHC vehicle). This project team consisted of key stakeholder groups representing various multidisciplinary teams with a shared goal of establishing a digitally capable MHC. The project team consisted of practice leaders, nursing leaders, operations leaders, a project manager, and a health systems engineer.

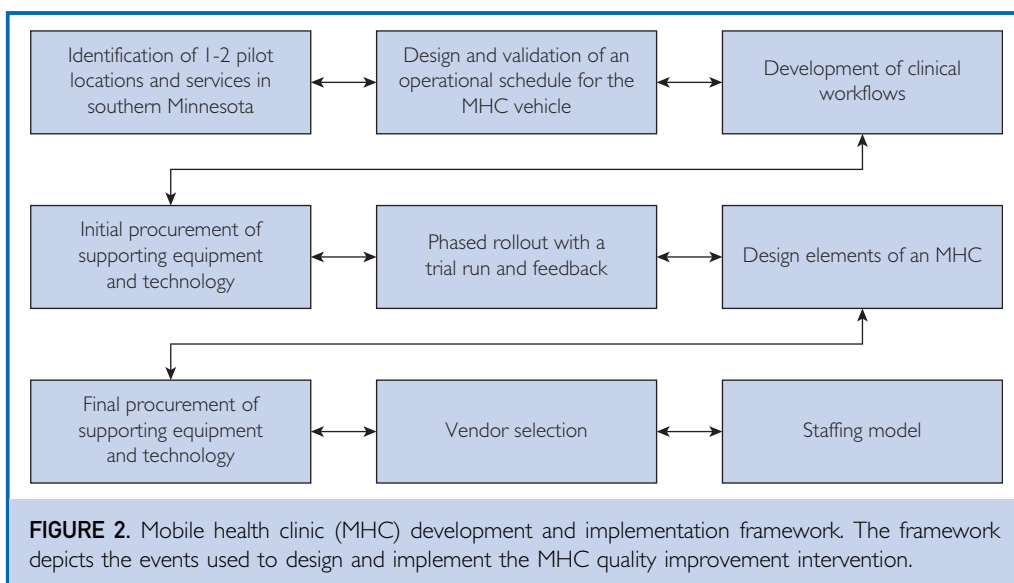
Project Implementation Process

Because the COVID-19 pandemic accelerated the closure of many brick-and-mortar clinics in rural southern Minnesota, MCHS pursued the fast-tracking of a complex quality improvement initiative with unknown obstacles and uncertain outcomes. The project planning began in the fourth quarter of 2020, in which preliminary endorsements from various committees were sought. A financial estimation analysis was conducted to determine initial capital expenses, operational expenditures for successive years, return on investment, and an exit strategy. Benchmarking was conducted, and requests for proposals from various vendors were made to finalize the provider of the MHC vehicle.

The project officially began June 30, 2021, with a completion date June 30, 2022. Because of this expeditious timeline and to ensure the project's successful completion, Agile methodology was used.⁷ The use of Agile methodology also enabled the team members to make calculated assumptions regarding the unknown aspects of the project and validate these assumptions via rapid iteration. This facilitated better response times for minimum viable product delivery, which enabled faster value addition than that of conventional waterfall methods.

Development and Pilot Implementation Framework

The development and pilot implementation framework consisted of an outline of the 9 steps used to develop a digitally capable MHC at MCHS (Figure 2). It specifically provided a step-by-step breakdown of the project stages from initiation to execution of the MHC in the Southeast Minnesota (SEMN) and Southwest Minnesota (SWMN) regions. Because the framework was created with Agile methodology, the steps of the framework were not necessarily completed in consecutive order, and backward movement between steps was possible. The primary goal of the quality improvement project outlined by this framework was to redesign health care delivery to serve the vulnerable population in rural



communities with a flexible and scalable model. The overarching goals of the MHC generated from this project were to maintain existing services in underserved areas, increase the flexibility of MCHS to respond to rural patient needs, maintain stable fixed expenses, and optimize costs for patients and MCHS.

RESULTS

Identification of 1-2 Pilot Locations and Services in Southern Minnesota

Mayo Clinic Health System operates in a hub-and-spoke model, in which each health system region has a central location (hub). Both the SEMN and SWMN regions contain brick-and-mortar mini-hubs that would serve as the MHC center of operations, which are located in Owatonna and Fairmont, Minnesota, respectively.⁸ Site characteristics were collected from each region in southern Minnesota, including weekly schedules, proximity of nearest alternative facilities, and primary competitors. Additional data defining visit characteristics, which included the number of distinct patient visits and total visits, fill rate (ie, the number of scheduled appointments divided by the number of available appointments), and nurse triage use, were collected to determine the pilot locations. The specific pilot locations were then selected based on, interest, and lack of existing access. The project team evaluated the top *Current Procedural Terminology* codes and *International Classification of Diseases, Tenth Revision, Clinical Modification* primary diagnoses reported to determine the most common care needs in those communities.

Design and Validation of an Operational Schedule for the MHC Vehicle

The project team designated a weekly rotational schedule for each region to minimize interregional travel. The vehicle would be initially used Monday through Thursday in 1 region, with Friday used as a travel day between regions and for other uses. Within the Monday through Thursday weekly schedule, the MHC would rotate between 2 site locations, such that the MHC would be located at 1 site on Monday and Wednesday and at another site on Tuesday and Thursday. This

rotation design minimized the number of days between site visits.

Development of Clinical Workflows

Initial clinical workflows were modeled after current telehealth and virtual visit practices in the region. This included preparatory work by desk operations staff and nursing support for previsit intake, such as medication and allergy reconciliation and vital signs assessment. The onboard clinician modeled a standard clinical workflow to best replicate that of a brick-and-mortar appointment. The onboard equipment, routine vehicle operations, and clinical equipment (eg, phone systems, telehealth tools, and laboratory equipment) were also modeled to match specifications according to clinical and regulatory needs. Design and workflow modifications were made to ensure patient privacy and ease of use, including the addition of privacy screens at workstations, increased curtain coverage for doors, and resupply methods.

Procurement of Supporting Equipment and Technology

The procurement process was managed in 2 steps—an initial and final process. In the initial procurement process, supplies that would be needed in the MHC vehicle were identified and documented. Regional practices were consulted to determine the appropriate supply levels and equipment needs for the MHC. In the final procurement process, the MHC was outfitted with the actual supplies and technologies to provide appropriate care to the patients, which was optimized according to our institution's specifications. Vehicle equipment also included 4 workstations, a laboratory fully equipped for collection-only services, printing and scanning capabilities, and telehealth equipment.

Phased Rollout With a Trial Run and Feedback

Trial runs were conducted with team members from each region who would be providing clinical care in the MHC. These trial runs occurred approximately 2 weeks before the MHC launch to provide time to incorporate feedback from the clinical care team members during team huddles, as necessary. The trial runs consisted of 2 scenarios: (1) 1 patient

arriving for an onboard clinician visit and (2) multiple patients arriving in a staggered fashion (according to calendar slots) for telehealth or clinician visits.

Vendor Selection

We assessed several different vendors and vehicle models and narrowed our selection to 3 vendors. The criteria for vendor selection are summarized in the Table. On the basis of these criteria, we determined that the MHC proposed by vendor 1 was specifically tailored for our needs.

Design Elements of an MHC

The MHC external design elements were simple and aligned with the brand language of the institution. Similarly, internal aspects of the design supported the inclusion of 2 examination rooms on either side of the clinic with the technology to provide virtual care (Figure 3).

Staffing Model

The MHC was designed to allow for flexible staffing models, including in-person and virtual care staff. The MHC design facilitated both primary and specialty care visits, with opportunities to address other occupational and community needs. An onsite laboratory would

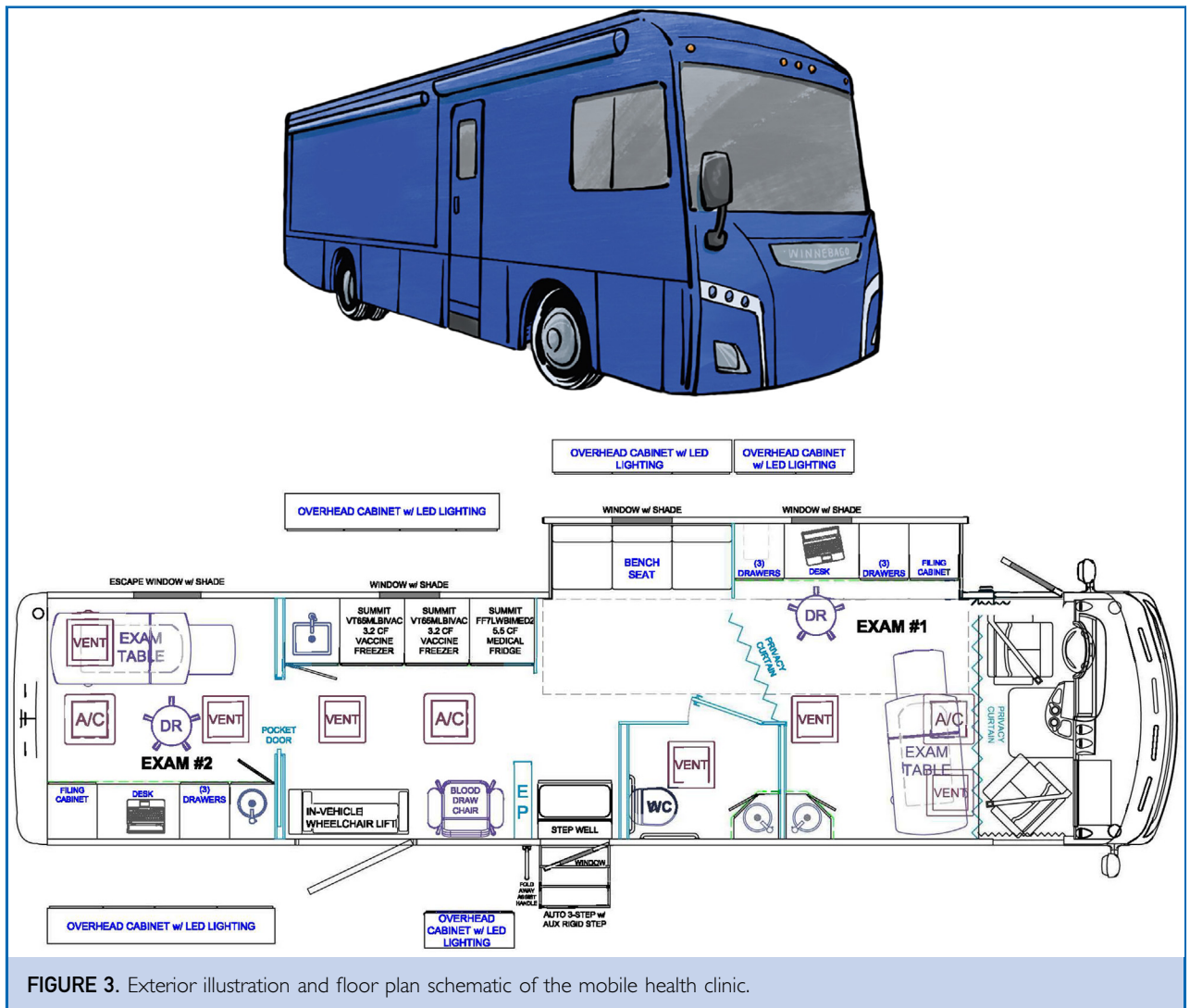


FIGURE 3. Exterior illustration and floor plan schematic of the mobile health clinic.

TABLE. Summary of Mobile Health Clinic Vehicle Vendor Selection Criteria

Criteria	Vendor 1	Vendor 2	Vendor 3
Vehicle type	Mobile unit	Mobile unit	Trailer unit
Purchase cost	\$571,000	\$510,000	\$850,000
Projected first-year operational expenses	\$657,000	\$642,000	\$1,135,000
Build time, mo	4-6	6-8	6
Warranty period, y	2	1	1
Reliability rating ^a	Better	Good	Good
Accessibility rating ^b	Good	Good	Better

^aDetermined by vendor availability for vehicle service and support, including during winter conditions.

^bDetermined by ceiling height, interior space, and lift access.

permit a limited range of point-of-care studies and more comprehensive studies that will be performed at our institution's laboratories. Staffing model teams included various combinations of nurse practitioners, physician assistants, nurses, a desk operations specialist, and virtual clinicians.

Pilot Site Outcomes

The MHC phase 1 launch established primary care services at 4 rural sites: Blooming Prairie, Kenyon, Sherburn, and Butterfield, Minnesota (Figure 4A). These communities each have an approximate population of 3000 or less. Partnerships were also established with regional schools to provide sports physical examinations. By April 30, 2022, the MHC had provided 1498 patient appointments while maintaining our standards of care. Of the 1498 patients, 57.4% were women and 42.6% were men. The mean (SD) patient age was 47.9 (26.6) years. Most patients were White (95.4%) and not Hispanic or Latino (93.5%). Most health insurance payers were government programs (61.8%), whereas 38.2% of payers were private commercial plans.

Of the patients seen at the MHC during the pilot period, 68.6% were seen for primary care and family nurse visits, 22.8% were seen for blood and urine laboratory testing, 5.3% were seen for well-child visits, 2.6% were seen for COVID-19 and influenza immunizations, and 0.7% were seen for telemedicine

and other health issues. The MHC was able to serve patients who lived not only in the towns where the MHC had scheduled stops but also in the surrounding communities (Figure 4B). Patients in the surrounding communities contributed to more than 45% of appointments. Therefore, the MHC is estimated to have saved hundreds of hours of drive time for the patients. These phase 1 launch outcomes led to the expansion of virtual and speciality care services and additional partnerships and locations for phase 2 in 2022.

Internet Access Outcomes

The MHC used a wireless network architecture provided by a gateway that received cellular-based internet from multiple existing networks/providers. The cellular internet signal then provided internet connectivity throughout the MHC and a secure connection to the institution's internal network via the gateway. This strategy helped to bring high-speed internet, via a combination of 4G, 4G LTE, and 5G network connections, to rural communities in which broadband internet access was not previously available. Because of the telehealth capability of the MHC, the patients in these rural settings now have access to primary care and specialists via onboard telemedicine in their hometown. This allows MCHS to provide the right care at the right time. This also prevents unnecessary costs incurred by emergency department visits and hospitalizations resulting from exacerbated illnesses caused by delayed examinations.

Patient Feedback

Initial patient feedback obtained from focused questions by clinical care team members indicated that the MHC was well received by patients at the pilot sites in southern Minnesota. Patients expressed positive feedback regarding the vehicle itself and its proximity. For example, at the Kenyon site, many patients stated that they avoided a trip to Owatonna or Faribault and instead were able to travel just down the block. They also provided positive feedback about the larger-than-anticipated clinical space and the convenience of onboard laboratory services. Many also shared that they were anxious before being seen in the clinic but were delighted after their appointment was completed. Patients seen at

the Blooming Prairie and Kenyon sites specifically stated, “The clinical space was much larger than anticipated.” Patients seen at the Sherburn and Butterfield sites stated, “It is very close to our home”; “The clinic space was quite large”; and “We were unsure about the care and experience we would receive but were pleased by the time the appointment was completed.”

DISCUSSION

The residents of rural communities face considerable socioeconomic challenges. Health care disparities lead to a higher incidence of diseases, increased mortality rates, and lower life expectancies.⁹ This problem has been exacerbated by a population decreasing in size and increasing in age, lack of economic growth, and inadequate infrastructure to support broadband internet access in rural areas. Health care delivery and access to primary and specialty care has substantially declined in rural communities over the past few years, further increasing health outcome disparities for their residents.¹⁰ Traditional brick-and-mortar clinics providing health care access in rural communities have been challenged by staffing shortages and inadequate funding and reimbursement resources.

Our quality improvement intervention addressed 2 fundamental challenges facing health care systems that serve diverse communities in rural settings. The first challenge was providing cost-effective, timely, efficient, and high-quality care to rural residents while addressing and resolving health care disparities. The second challenge was bringing resilient, nimble, and iterative health care solutions that can pivot as the needs of the community change.

Many health care organizations have established MHCs to address gaps in health care related to the inability of patients to travel to the clinic because of a lack of time or transportation.^{11,12} Mobile health clinics are important for addressing the medical and social determinants of health because they provide care at a community level. Mobile health clinics also provide considerable cost savings and, thereby, cost-effective care to patients in rural and underserved communities.¹¹ Mobile health clinics can be costly at first but are an effective method

to address the health care disparities in underserved populations.

A 2016 survey conducted by the Harvard Medical School Mobile Health Map showed that approximately 2000 MHCs were present in the United States, with an estimated 6.5 million MHC visits annually.¹¹ Preventive screenings, primary care, and dental services were the most common services offered by MHCs.¹³ Early findings have shown promising health care outcomes for patients who use MHCs, which include increased access to health care, reduced emergency department cost and use, lower hospital readmission rates, improved patient quality of life from expanded preventive services, diminished barriers to health care access, enhanced chronic disease management, and increased health literacy.¹⁴ Mobile health clinics also provide convenient access for an increasing population of older patients who may have transportation and connectivity challenges.

Although the use of an MHC to address various health care needs is not completely new, expansion of an MHC to include specialty services via virtual care options or broadband internet access to rural communities has not been extensively reported.^{15,16} Telemedicine capabilities and remote use of Bluetooth peripheral devices for diagnoses, such as Bluetooth-enabled stethoscopes and otoscopes, can provide substantial advantages for specialist visits and improve patient outcomes, mortality rates, and health disparities.¹⁷ An MHC affords the ability to efficiently move between locations, attend to the preventive care needs of communities, and bridge internet deserts in rural communities.

Thorough assessments of the feasibility of proposed MHC projects should be conducted before they are implemented. These assessments should include consideration of practice structure, cost, proposed visit models and workflows, literature reviews, and benchmarking of similar models. We used Agile methodology to create a phased approach with work chunks and minimally viable products to support the development of the intervention. This approach was important to our overall strategy and allowed us to engage team members from many fields, seek and implement input, and iterate and add services within a relatively short 7-month period from decision to implementation. We recommend further

studies to assess the effectiveness of MHCs in addressing health care disparities. We also suggest that a framework produced with Agile methodology be considered for health care innovations that yield scalable products.

CONCLUSION

The preliminary findings of this study showed that a digitally capable MHC can provide flexibility and reach in rural communities. A lack of required technology, infrastructure, and equipment can hinder the implementation and sustainability of similar innovative solutions in rural communities in the United States and around the world.¹⁸ Our quality improvement initiative to design and implement a digitally capable MHC helped to expand access to in-person health care and specialty care via advanced telehealth for patients living in rural southern Minnesota. This initiative represents an innovative solution to the rural health care crisis that replaces traditional brick-and-mortar facilities and expands service offerings and access to technology.

SUPPLEMENTAL ONLINE MATERIAL

Supplemental material can be found online at <http://www.mcpiqjournal.org>. Supplemental material attached to journal articles has not been edited, and the authors take responsibility for the accuracy of all data.

Abbreviations and Acronyms: COVID-19, coronavirus disease 2019; MCHS, Mayo Clinic Health System; MHC, mobile health clinic; SEMN, Southeast Minnesota; SWMN, Southwest Minnesota

Correspondence: Address to Asif Iqbal, MBA, Department of Mayo Clinic Health System Administration, Mayo Clinic, 200 First St SW, Rochester, MN 55905 (Iqbal.Asif@mayo.edu).

ORCID

Asif Iqbal:  <https://orcid.org/0000-0001-6871-8279>;
Gokhan Anil:  <https://orcid.org/0000-0002-0247-7211>;
Eric D. Crockett:  <https://orcid.org/0000-0001-5305-6399>

REFERENCES

- Conrad DA, Grembowski D, Hernandez SE, Lau B, Marcus-Smith M. Emerging lessons from regional and state innovation in value-based payment reform: balancing collaboration and disruptive innovation. *Milbank Q*. 2014;92(3):568-623.
- Forliti M. Platform revolution: curing more people, reaching more lives, anytime, anywhere. Mayo Clinic News Network. Published July 2, 2020. <https://newsnetwork.mayoclinic.org/discussion/platform-revolution-curing-more-people-reaching-more-lives-anytime-anywhere/>. Accessed March 9, 2022.
- Rural health care in Minnesota: data highlights. Minnesota Department of Health. Published November 18, 2021. <https://www.health.state.mn.us/facilities/ruralhealth/docs/ruralhealthcb2021.pdf>. Accessed April 14, 2022.
- Anil G, Hirisave Krishna B, Johnson CC, Richards SL, Bhandari P. Outpatient practice reactivation in an integrated community practice during the COVID-19 pandemic. *Telemed J E Health*. 2022;28(4):583-590.
- Emergency Executive Order 20-20. Directing Minnesotans to stay at home. State of Minnesota, Executive Department. Governor Tim Walz. https://mn.gov/governor/assets/3a.%20EO%2020-20%20FINAL%20SIGNED%20Filed_tcm1055-425020.pdf. Accessed March 17, 2022.
- Gooch K. Mayo Clinic Health System to temporarily close clinics amid COVID-19 surge. Published December 4, 2020. <https://www.beckershospitalreview.com/patient-flow/mayo-clinic-health-system-to-temporarily-close-clinics-amid-covid-19-surge.html>. Accessed March 9, 2022.
- Beck K, Beedle M, van Bennekum A, et al. Manifesto for Agile software development. <http://agilemanifesto.org/>. Accessed March 10, 2022.
- Mayo Clinic Health System. 2016-2017 clinical faculty resource manual. https://clinicalcoordination.org/wp-content/uploads/2016/08/Mayo-F16_2016-2017-Faculty-Packet.pdf. Accessed March 9, 2022.
- National Academies of Sciences Engineering and Medicine, Health and Medicine Division, Board on Population Health and Public Health Practice, Committee on Community-Based Solutions to Promote Health Equity in the United States. The state of health disparities in the United States. In: Weinstein JN, Geller A, Negussie Y, Baciu A, eds. *Communities in Action: Pathways to Health Equity*. National Academies Press; 2017:57-97.
- Rural health disparities. Rural Health Information Hub. <https://www.ruralhealthinfo.org/topics/rural-health-disparities>. Accessed April 14, 2022.
- Tynrell R, Sullivan D, Wirth C, Ogundimu T, Yasunaga M. Mobile health clinics: improving access to care for the underserved. Published March 2017. https://www.mobilehealthmap.org/sites/default/files/uploads/PHA_Mobile%20Clinic%20Brief_0317_General.pdf. Accessed March 9, 2022.
- Yu SWY, Hill C, Ricks ML, Bennet J, Oriol NE. The scope and impact of mobile health clinics in the United States: a literature review. *Int J Equity Health*. 2017;16(1):178.
- Porter ME, Lee TH. The strategy that will fix health care. Published 2013. Harvard Business Review. <https://hbr.org/2013/10/the-strategy-that-will-fix-health-care>. Accessed March 9, 2022.
- Heath S. How do mobile health clinics impact patient access to care? Published 2018. PatientEngagementHIT. <https://patientengagementhit.com/news/how-do-mobile-health-clinics-impact-patient-access-to-care>. Accessed March 9, 2022.
- Cornell S. Satellite facilitates network of mobile health clinics. Faronics. Published 2013. <https://www.faronics.com/news/blog/satellite-facilitates-network-of-mobile-health-clinics>. Accessed March 9, 2022.
- Mupela EN, Mustarde P, Jones HL. Telemedicine in primary health: the virtual doctor project Zambia. *Philos Ethics Humanit Med*. 2011;6:9.
- Rheuban KS. Telemedicine: connect to specialists and facilitate better access to care for your patients. American Medical Association. Published 2018. <https://louisville.edu/medicine/tech/telehealth-files/AMA%20Telemedicine%202017-Stepsforward.pdf>. Accessed March 9, 2022.
- Kruse C, Betancourt J, Ortiz S, Valdes Luna SM, Bamrah IK, Segovia N. Barriers to the use of mobile health in improving health outcomes in developing countries: systematic review. *J Med Internet Res*. 2019;21(10):e13263.