

7-18-2023

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### Recommended Citation

Loomis G, Rhodes R, Bujold E, Sharafsaleh G, Collett E, Irwin M, Staton EW, Westfall JM. COVID-19 proactive disease management using COVID Virtual Hospital in a rural community. *J Patient Cent Res Rev.* 2023;10:104-10. doi: [10.17294/2330-0698.1998](https://doi.org/10.17294/2330-0698.1998)

Published quarterly by Midwest-based health system Advocate Aurora Health and indexed in PubMed Central, the Journal of Patient-Centered Research and Reviews (JPCRR) is an open access, peer-reviewed medical journal focused on disseminating scholarly works devoted to improving patient-centered care practices, health outcomes, and the patient experience.

# COVID-19 Proactive Disease Management Using COVID Virtual Hospital in a Rural Community

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<b>Purpose</b>	A community teaching hospital serving a rural population established an intensive “hospital at home” program for patients with COVID-19 utilizing disease risk stratification and pulse oximeter readings to dictate nurse and clinician contact. Herein, we report patient outcomes and provider experiences resulting from this “virtual” approach to triaging pandemic care.
<b>Methods</b>	COVID-19-positive patients appropriate for outpatient management were enrolled in our COVID Virtual Hospital (CVH). Patients received pulse oximeters and instructions for home monitoring of vital signs. CVH nurses contacted the patient within 12–48 hours. The primary care provider was alerted of the patient’s diagnosis and held a virtual visit with patient within 2–3 days. Nurses completed a triage form during each patient call; the resulting risk score determined timing of subsequent calls. CVH-relevant patient outcomes included emergency department (ED) visits, mortality, and disease-related hospitalization. Additionally, a survey of providers was conducted to assess CVH experience.
<b>Results</b>	From April 22, 2020, to December 21, 2020, 1916 patients were enrolled in the CVH, of which 195 (10.2%) had subsequent visits to the ED. Among those 195 ED visits, 102 (52.3%) were nurse-directed while 93 (47.7%) were patient self-directed; 88 (86.3%) nurse-directed ED visits were subsequently admitted to inpatient care and 14 were discharged home. Of the 93 self-directed ED visits, 3 (3.2%) were admitted. A total of 91 CVH patients (4.7%) were ultimately admitted to inpatient care. Seven deaths occurred among CVH patients, 5 of whom had been admitted for inpatient care. Among 71 providers (23%) who responded to the survey, 94% and 93% agreed that the CVH was beneficial to providers and patients, respectively.
<b>Conclusions</b>	Proactive in-home triage of patients with COVID-19 utilizing a virtual hospital model minimized unnecessary presentations to ED and likely prevented our rural hospital from becoming overwhelmed during year one of the pandemic. ( <i>J Patient Cent Res Rev.</i> 2023;10:104-110.)
<b>Keywords</b>	COVID-19; virtual hospital; COVID Nursing Questionnaire; pulse oximeter; virtual visits; primary care

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The COVID-19 pandemic accelerated implementation and adoption of changes in public health interventions, particularly related to health care models focused on preventive measures, remote care, and technology.<sup>1</sup> Early in the pandemic, hospitals were faced with the challenge of high volumes, high acuity levels, and limitations in resources including infection control equipment, personal protective equipment, health care

workers, medical equipment, and hospital bed availability. Some authors suggested that patients with COVID-19 could be managed remotely, mostly via outpatient telehealth visits or inpatient care via “remote ICU.”<sup>2-4</sup>

Evidence prior to the COVID-19 pandemic suggests lower costs, lower 6-month mortality, and greater satisfaction among patients enrolled in trials designed to avoid hospital admissions via use of “hospital at home,” meaning virtual hospital approaches that provide care via a health care outreach team.<sup>5</sup> An update of that meta-analysis concluded that hospital-at-home interventions may provide an effective alternative to inpatient care for a select group of elderly patients usually requiring hospital admission.<sup>6</sup>

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We at UNC Health Blue Ridge (UNCBR) in Morganton, North Carolina, were first apprised of the virtual hospital idea by viewing an order set in our electronic medical records (EMR) shared with Atrium Health, one of the nation's largest integrated health systems. Atrium's virtual hospital, detailed elsewhere,<sup>7</sup> involved proactive home monitoring and hospital-level care through a virtual observation unit and a virtual acute care unit in the home setting. The Atrium model harnessed a preexisting hospital transition program and telemedicine program; however, it was determined to be impractical in our situation given our resources, size, and rural location.

Providing medical care for patients with COVID-19 at home had the potential to minimize unnecessary presentations to our emergency department (ED) and prevent the hospital from becoming overwhelmed. It was hoped that virtual monitoring through touchpoints based on disease risk stratification would reduce unnecessary visits to the ED. Early in the pandemic, UNCBR constructed a plan to address a patient surge that had the potential to overwhelm hospital capacity, creating an at-home COVID Virtual Hospital (CVH).

The purpose of this descriptive case study is to detail features of the virtual hospital program and summarize

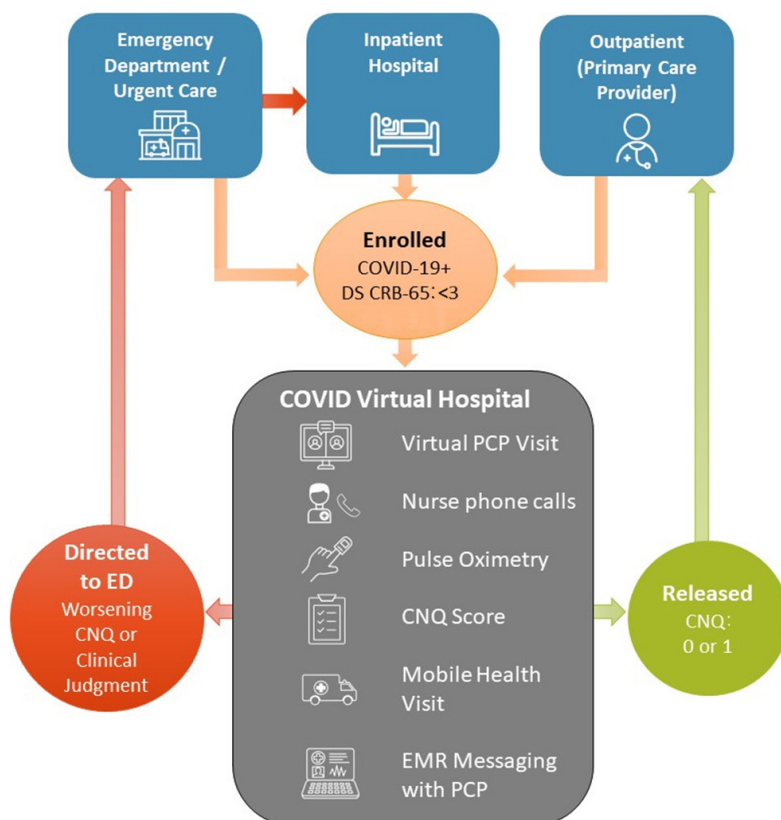
the treatment and outcomes for patients with COVID-19 enrolled from April 22, 2020, to December 21, 2020.

## METHODS

UNCBR is a nonprofit rural community teaching hospital with 2 campuses, 145 staffed beds, and more than 55,000 ED visits annually. Blue Ridge Medical Group is the hospital's network of providers, owned by the same parent company, Blue Ridge HealthCare Hospitals, Inc., and comprises 60 primary care physicians. The hospital has 13 outpatient primary care offices in 4 counties. The main hospital campus is situated in Morganton in central Burke County. The population of Burke County is estimated at 90,000;<sup>8</sup> it is categorized by the North Carolina Department of Commerce as Tier 1, the most economically distressed status.<sup>9</sup> In Burke County, 13.9% of residents are members of a minority group, and 18.4% live in poverty.<sup>8</sup>

UNCBR convened a group of outpatient clinicians, nurses, and administrators to address the COVID-19 pandemic and develop strategies for preserving hospital capacity for the most severely ill patients who were experiencing complications from COVID-19 infection. This led to the creation of the at-home CVH, through which patients were connected to virtual care, including home monitoring

equipment, nursing calls and virtual visits with a primary care provider (PCP), and would receive the necessary home care and guidance for supportive disease management and decrease the likelihood of requiring higher level of care in a hospital setting. Figure 1 provides an overview of the CVH.



**Figure 1.** Schematic of the COVID Virtual Hospital (CVH) and patient flow. Patients with a positive COVID-19 test and DS CRB-65 score of <3 can be enrolled in the CVH. DS CRB-65 is a scoring tool for assessing severity of pneumonia and determining whether the patient requires inpatient or outpatient treatment.<sup>10</sup> Once enrolled, patients receive a pulse oximeter, have a virtual visit with their primary care provider (PCP), and have regular phone calls from nurses who assess COVID-19 Nursing Questionnaire (CNQ) score. Based on the CNQ score and clinical judgment, nurses may order mobile health visit or direct the patient to visit the emergency department (ED). Extensive messaging and documentation through the electronic medical record (EMR) keep the patients' health care providers informed.

## Enrollment in CVH

To qualify for enrollment in the CVH, the patient had to be COVID-19-positive and receive primary care from a clinician with admitting privileges at Blue Ridge Medical Group. Patients could be discharged from inpatient care and be enrolled in the CVH or could be directly enrolled from outpatient care, ED, or urgent care. Enrollment occurred via documentation in the EMR. The hospital, ED, and Blue Ridge Medical Group clinicians all utilized the same EMR. The CVH enrolled the first patient on April 22, 2020. The institution initiated regular all-provider conference calls early on during the pandemic to share emerging knowledge about COVID-19 care, and during these calls the CVH was explained and promoted.

Upon COVID-19 diagnosis, patients were risk stratified based on an existing pneumonia assessment tool, DS CRB-65,<sup>10</sup> used to determine inpatient vs outpatient initial management. The DS CRB-65 is a scoring tool that modifies the existing and widely used CRB-65 scoring tool to provide better prognostic accuracy by adding underlying disease and peripheral blood oxygen saturation to the measured risk factors.<sup>10</sup> Patients not requiring inpatient level of care, with a DS CRB-65 score of <3, were enrolled in the CVH via EMR messaging to the CVH nurses and documentation in the patient's EMR. Enrollment in the CVH could occur when patients tested positive at urgent care, the ED, or outpatient clinics, or upon discharge from inpatient care for COVID-19. Patients were given a pulse oximeter and instructions for how to operate the oximeter. Pulse oximeters were initially supplied by donation from the Blue Ridge HealthCare Foundation, Inc. The cost of subsequent inventory was assumed by the hospital's COVID-19 emergency management funds. Pulse oximeters were kept in abundant supply at all point-of-care COVID-19 testing sites including outpatient offices, urgent cares, and EDs for distribution to every COVID-19-positive patient.

For patients discharged from inpatient or emergency care and enrolled in the CVH by the hospitalist or ED physician, the PCP was alerted via EMR messaging of the patient's diagnosis, clinical status, and CVH enrollment. A virtual visit with the PCP was arranged within 2–3 days. If the patient did not have a PCP, a new provider was assigned through the CVH enrollment process.

## CVH Care Protocol

A CVH nurse contacted the patient within 12–48 hours and completed patient calls 7 days per week from 8 am to 6 pm. A patient symptom triage form, the COVID-19 Nursing Questionnaire (CNQ, adapted for local needs from that used by Sitamagari and colleagues<sup>7</sup>), was completed during each patient call. The CNQ score

was calculated and recorded in the EMR (Table 1). The recommended actions based on the score are shown in Figure 2. CVH nurses provided extensive education on supportive care, symptom management, pulse oximeter parameters, and warning signs of decompensation. Nurses played a vital role in education regarding quarantine, isolation, return to work guidance, vaccine guidance, and monoclonal antibody therapy and addressed social needs like food insecurity and medication assistance. For patients who spoke languages other than English, the team utilized interpreter services.

The CNQ provided a risk score to determine the interval for the next call (Figure 2). CNQ score was forwarded to the PCP for review via the EMR. The CVH nurses and PCPs maintained direct communication via EMR messaging for any patient needs.

A PCP virtual visit was completed for each COVID-19-positive patient, 2–3 days after CVH enrollment. During the virtual visit, the clinician obtained real-time objective data from the patient including resting oxygen level, ambulatory oxygen level, and heart rate. Utilizing video platforms gave the additional ability to visualize respiratory effort and calculate a respiratory rate. Only one virtual visit was conducted unless a CVH nurse believed another was warranted due to patient condition.

For outpatient care escalation, the CVH mobile health team, comprised of an emergency medical technician-paramedic (EMT-P) and registered nurse, were deployed to the patient's home for face-to-face assessment. After patient evaluation and implementation of medical interventions (qualification for home oxygen, providing home oxygen, intravenous [IV] fluids, medication administration, electrocardiogram, and labs), a CVH physician completed a virtual visit

**Table 1.** COVID-19 Nursing Questionnaire (CNQ)

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Do you have a fever?
Do you feel cold or have chills?
Are you in pain?
How is your energy?
How is your thinking?
Do you feel lightheaded?
Do you have a hard time catching your breath?
Have you had nausea, vomiting or diarrhea?
O <sub>2</sub> saturation?
Heart rate?

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0	1	2-3	4	>4	Acute level	High risk and/or O <sub>2</sub> of ≤94%
Call every 96 hours (4 days)	Call every 72-96 hours (3-4 days) Use clinical judgment	Call every 48-72 hours (2-3 days) Use clinical judgment	Call every 24-48 hours (1-2 days) Use clinical judgment	Call every 24 hours (daily)	Call twice a day Consider mobile health visit	Call at least every 48 hours or sooner indicated by CNQ score

**Figure 2.** COVID Virtual Hospital nurse call frequency based on COVID Nursing Questionnaire (CNQ) score (top row).

with the patient and the mobile team. Together, the team determined if the patient was safe to remain at home under CVH care or the patient required ED visit.

Patients were released from the CVH when their CNQ score was 0 or 1 and on clinical judgment of the CVH nurses.

### Experience Survey

In May 2021, a survey was distributed by email to 307 clinician members of the active Blue Ridge Medical Group with questions regarding their respective experience with the CVH. Simple descriptive analysis was conducted.

The CVH is still operational at the time of this writing. Outcomes data (ED visits, hospitalizations, readmissions, and deaths) are presented for all patients enrolled through December 21, 2020 (date selected to roughly coincide with the end of the first calendar year of the pandemic).

The UNC Health Blue Ridge institutional review board approved the protocol for the survey and for reviewing and reporting patient outcomes herein.

## RESULTS

From April 22, 2020, to December 21, 2020, 1916 patients were enrolled in the UNCBR CVH. Table 2 describes patient characteristics. In brief, 86.3% of patients identified as White/Caucasian, which correlates approximately with the race/ethnicity of Burke County; 1623 (84.7%) patients were insured while 293 (15.2%) were uninsured; and 1497 (78.1%) patients already had a PCP while 419 (21.8%) patients had no PCP.

### CVH Patient Outcomes

Outcomes are shown in Table 3. Of the 1916 CVH-enrolled patients, 195 (10.2%) made visits to the ED; 102 (52.3%) of these ED visits were directed by the CVH nurses while 93 (47.7%) were self-directed by the patient. Of the 102 patients who made nurse-directed visits, 88 (86.3%) were subsequently admitted to inpatient care and

only 14 were discharged home. Of the 93 patients who made self-directed ED visits, 3 (3.2%) were admitted. A total of 91 CVH patients (4.7%) were ultimately admitted to inpatient care and 1825 (95.3%) remained at home for illness management.

During the noted time frame, UNCBR had 86 inpatient readmission (defined as admission of patient for the same reason within 30 days of discharge from inpatient care) associated with a COVID-19 diagnosis. Of the 86, 75 (87.2%) of the COVID-19 readmissions were patients not enrolled in the CVH program while 11 (12.8%) were patients enrolled in the CVH program.

Among all CVH-enrolled patients, 7 deaths occurred, 5 of which occurred after the patient was admitted for inpatient care. Of the 2 deaths that occurred among outpatient CVH enrollees, 1 chose hospice care instead of being admitted to the hospital.

### Clinician Survey Results

Surveys were sent to 307 providers, and 71 responses (rate: 23%) were received. Of all respondents, 99% had knowledge of the CVH and 76% referred COVID-positive patients; 94% agreed that the CVH was beneficial to the health care providers; and 93% felt it was beneficial for the patients. The two most helpful CVH resources were nursing calls to the patient (82%) and the pulse oximeter for the patient (83%).

## DISCUSSION

This paper describes a rapid transformation of existing systems to address the threat of a hospital reaching capacity during a pandemic. By reallocating existing resources, the hospital was able to dedicate staff and equipment to patients outside the hospital walls — a classic example of a hospital at home or “virtual hospital” designed to prevent inpatient admissions.<sup>5,6</sup> The CVH nurses were derived from the hospital’s transitional care nurse team. This team was already well versed in direct patient care, nursing triage,

**Table 2.** COVID Virtual Hospital Patient Characteristics, April–December 2020 (N=1916)

Characteristic	n (%)
Sex	
Male	905 (42.2%)
Female	1011 (52.8%)
Payor source	
Insured	1623 (84.7%)
Uninsured	293 (15.3%)
Medical home	
Established primary care provider	1497 (78.1%)
No primary care provider	419 (21.9%)
Race	
White or Caucasian	1654 (86.3%)
Black or African American	91 (4.8%)
Asian	30 (1.6%)
American Indian/Native American	1 (0.05%)
Native Hawaiian or Pacific Islander	44 (2.3%)
Declined	96 (5.0%)
Ethnicity	
Hispanic	292 (15.2%)
Non-Hispanic	1572 (82.0%)
Declined/Unable to obtain	52 (2.7%)
Age	
10–19 years	98 (5.1%)
20–29 years	331 (17.3%)
30–39 years	311 (16.2%)
40–49 years	317 (16.5%)
50–59 years	345 (18.0%)
60–69 years	290 (15.1%)
70–79 years	163 (8.5%)
80+ years	61 (3.2%)

coordination of care, and quality initiatives for decreasing readmissions. This expertise allowed the nurses to use clinical judgement in determining each patient’s needed monitoring frequency. The high admission rate (86.3%) of patients directed to the ED by the CVH nurse team demonstrates the excellent clinical judgment of the CVH nurses in determining the need for a higher level of care.

As of this writing (February 2023), CVH has enrolled more than 8700 patients with COVID-19 infection. Over time the enrollment criteria for the CVH shifted, first to include only patients unvaccinated for COVID-19 and vaccinated patients who were at increased risk of severe disease, and more recently to include patients with non-COVID-19 diagnoses for which a provider desired such monitoring at home.

**Table 3.** Patient Outcomes

Outcome	Total N: 1916 patients
CVH escalations	
ED visits	n=195
Self-directed visit to ED	93 (47.7%)
CVH nurse-directed visit to ED	102 (52.3%)
Inpatient admissions	91 (4.7%)
CVH mortality	
Died in outpatient setting	2 (0.10%)
Died after transfer to inpatient setting	5 (0.26%)
Total CVH deaths	7 (0.37%)
COVID-19-related hospital readmissions	
Hospital readmissions for COVID-19	n=86
CVH patient	11 (12.8%)
Non-CVH patient	75 (87.2%)
COVID-19 patient average length of stay	
CVH	11.3 days
Inpatient	5.2 days

*CVH, COVID Virtual Hospital; ED, emergency department.*

Through funding assistance from the hospital’s foundation and COVID-19 emergency funds, every COVID-19-positive patient was provided a pulse oximeter at the time of diagnosis, free of charge. Having objective data was extremely helpful for nurses to make a confident clinical assessment of the COVID-19 patient. There is some evidence that COVID-19 patients’ respiration rate may mask underlying hypoxia.<sup>11</sup> We believe pulse oximetry was imperative to successfully engage with sick patients via virtual platform; however, we acknowledge concerns raised about the use of pulse oximetry among patients with more skin pigmentation.<sup>12</sup>

Broad, frequent, and direct communication with health care teammates likely contributed to the success of the CVH. The communication that occurred during the institution’s all-provider conference calls helped introduce the concept of CVH to an attentive physician audience looking for ways to manage an influx of COVID-19-positive patients. Patients readily accepted the CVH and appeared happy to stay home and avoid hospitalization. Providers, as indicated in our follow-up survey, found the CVH valuable for themselves and their patients. Success also was dependent on exemplary coordination of care, education, and collaboration across the health system. Primary care clinicians interacted with the CVH nurse staff regularly. Creating 3-way communication between patient, nurse, and

provider yielded a streamlined, coordinated approach for each patient. Engaging our ED physicians provided them a guarantee of close clinical outpatient follow-up and often influenced their decision regarding hospital admission vs outpatient management. Hospitalists were able to discharge patients with COVID-19 sooner than they might otherwise have due to close clinical outpatient follow-up with CVH, reducing financial burden for patients and the hospital.

The CVH mobile health team was deployed for the most acutely ill CVH patients each day and visited, on average, 4 patients per day in the home. A more robust field program utilizing EMT-P and registered nurses to provide meaningful interventions (eg, IV fluids, IV antiemetics) safely in the home would likely yield fewer hospitalization escalations. There have been some reports of specialized use of EMT-P personnel in the community yielding lower rates of ED use, and therefore, hospitalizations.<sup>13</sup>

Proactive disease management yielded improved access to care for many who would not have received care otherwise. Notably, of the first 700 patients enrolled, 255 patients did not have a primary care physician and were assigned to a medical home through their enrollment in the CVH. The vast majority of these came from minority groups or had detrimental social determinants of health.

On December 23, 2020, amid a COVID-19 omicron surge, two hospitals in surrounding counties reached capacity and were on diversion. Inquiries were made to offload patients to UNCBR. CVH success was indicated by low inpatient COVID-19 census and requests to transfer patients to UNCBR. The goal of reserving inpatient hospital beds for the most critically ill patients was achieved.

Our results compare favorably with Atrium's virtual hospital.<sup>7</sup> The Atrium Hospital at Home provided two levels of care, with one level (the virtual observation unit, or VOU) providing daily telemedicine-supported symptom monitoring by registered nurses, and the other level (the virtual acute care unit, or VACU) providing services closer to what our CVH provided — oxygen, medical treatments, daily virtual physician rounds, vital sign monitoring, twice-daily nursing assessments, and daily paramedic visits. The majority of Atrium's enrolled patients (n=1293; 88%) received care via the VOU; of these, 40 (3%) required inpatient hospitalization; 184 (12%) patients were treated via the VACU, with 24 (13%) admitted to inpatient care. Average length of stay was nearly identical to our study population: 11 days.

## Post-Data Analysis Update

Today, the CVH remains viable and a cornerstone in UNC Health Blue Ridge's COVID-19 pandemic response. The increase in COVID-19 cases in 2022 necessitated expansion from 4 to 5 CVH nurses, a more robust CVH mobile health team, and clinicians who are engaged in the process. There is consensus throughout our hospital administration, ED, and inpatient clinicians that the hospital system would have experienced a dire situation without CVH. Patients in the CVH program who had monitoring through touchpoints based on risk had fewer self-directed visits to the ED, a low rate of hospital readmission (for those enrolled after inpatient stays), and low outpatient mortality. Connecting our patients to virtual care, including home monitoring equipment, nursing calls, and virtual visits with a primary care provider has provided COVID-19 patients with the necessary home care and guidance for supportive disease management. Consequently, patients who received the proactive disease management discussed herein appeared to have lowered the likelihood of needing a higher level of care in a hospital setting.

## Study Limitations

We recognize several limitations of this descriptive case study. The UNCBR CVH experience may not reflect the potential outcomes of other communities. However, customizing a program using resources and processes already present within a community or health system may have benefits, especially for small, rural systems that have resources comparable to UNCBR in Burke County. Another limitation is that the CVH relied heavily on pulse oximetry for triage. This approach may work less well among populations that are not majority White.<sup>12</sup>

## CONCLUSIONS

The COVID Virtual Hospital achieved its goal of providing community members with a safe, reliable, and efficient program for COVID-19 infection. This model may be applied to other rural community hospital systems to provide high quality patient-centered care to everyone, mitigate system overuse, and minimize health care provider burnout, thus achieving the Quadruple Aim.<sup>14</sup> The CVH model could be easily expanded to other respiratory illnesses, including community-acquired pneumonia, chronic obstructive pulmonary disease, and asthma, and it has created the groundwork for the development of virtual chronic disease management for diseases like congestive heart failure and diabetes. Putting home monitoring equipment (blood pressure cuffs, pulse oximeters, thermometers, incentive spirometers, scales) into the hands of the patients has the potential to radically change how we deliver care utilizing virtual platforms and engaging patients with proactive disease management at home.

## Patient-Friendly Recap

- Localized surges of COVID-19 forced hospitals to face high patient volumes with limited resources, including health care workers, hospital beds, and protective equipment.
- In anticipation of this challenge, a rural North Carolina hospital developed a “COVID Virtual Hospital” model designed to determine an appropriate level of care for each patient who presented with COVID-19 infection.
- By proactively engaging patients with COVID-19 in their home, unnecessary visits to the emergency department were minimized, which helped prevent the hospital from becoming overwhelmed early in the pandemic.
- This COVID Virtual Hospital achieved its goal of providing community members with a safe, reliable, and efficient program for COVID-19 infection and has the potential to be used to manage other respiratory illnesses.

## Author Contributions

Study design: all authors. Data acquisition or analysis: all authors. Manuscript drafting: Loomis. Critical revision: Rhodes, Bujold, Sharafsaleh, Collett, Irwin, Staton, Westfall.

## Conflicts of Interest

None.

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