Remote Home Monitoring of Patients with Cancer During the COVID-19 Pandemic

BY MARY STEIMER, NP; JESSICA LEABO, PA-C; HONGKUN WANG, PHD; DAVID HEYER, MD; NANCY BOWLES, BSN, MHA; LAURA MATTHEWS, MHA, MBA; TIMOTHY L. CANNON, MD; RAYMUND CUEVO, MD; WILLIAM B. ERSHLER, MD; DANIELLE SHAFER, DO; SEKWON JANG, MD; ANGELA PENNISI, MD, PHD; AMJAAD AL-HUSSAIN, MHSA; KIRBY FARRELL, BA; AND JOHN F. DEEKEN, MD

In Brief

The COVID-19 pandemic posed significant challenges in the healthcare world, especially in the care of patients with cancer. Patients with pre-existing health conditions and those with suppressed immune systems are especially vulnerable to the SARS-CoV-2 virus and are more likely to develop severe symptoms. One of the many questions under consideration in the oncologic sphere is how to manage patients who are treated on an outpatient basis and who have been exposed to or are COVID-19-positive but do not require hospitalization.

In an attempt to mitigate the risks of exposure to COVID-19, our cancer center developed outpatient screening methods and established a COVID-19 testing clinic to identify patients who may be COVID-19-positive. We also put in place a pilot program to remotely monitor patients with cancer who were either persons under investigation or COVID-19-positive with mild or no symptoms. This article describes our experience with this program.

The Inova Health System is based in Northern Virginia and comprises more than 100 outpatient clinics, including 5 acute care hospitals and 120 physician office locations. Part of this health system is the Inova Schar Cancer Institute that sees over 7,500 new cancer cases annually, with more than 850 patients receiving treatment daily across all sites.

The outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2 virus) and its infectious illness (COVID-19), has led to an ongoing pandemic that began in early 2020. At the time of this writing in December 2021, over 274 million people have been diagnosed with COVID-19, causing more than 5.3 million deaths worldwide.[1] Infection with COVID-19 can cause a wide range of symptoms, such as fever, cough, shortness of breath, and loss of smell and taste, with some individuals being asymptomatic. Severe COVID-19, which is most often observed in patients with comorbidities or various medical conditions, may eventually lead to multiple organ dysfunction and death.

The pandemic has been a major challenge for healthcare systems around the world. Healthcare providers and other hospital workers who face daily exposures are at risk of contracting the virus, which can lead to a shortage of healthy, available workers to care for patients. In addition, the personal protective equipment required to protect these workers has not always been readily available, which has further increased their risk of exposure. The strain placed on the healthcare system to care for patients with COVID-19 has sometimes delayed the care of patients with other health conditions due to the risk of exposing them to the virus in the healthcare setting.

COVID-19 and Cancer Care

The global COVID-19 pandemic profoundly disrupted the diagnosis and care of patients with cancer. According to the Centers for Disease Control and Prevention, patients with cancer are among those who are at a particularly high risk of experiencing severe COVID-19 symptoms.[2] These patients who contract COVID-19 infection have higher mortality rates, are more likely to be hospitalized, and are more likely to die as a result of infection compared to the general population.[3]

Exterior shot of Inova Schar Cancer Institute

The reasoning behind a COVID-19 infection disproportionally affecting individuals with cancer is multi-factorial. In those with cancer, immune system function can be suppressed due to the disease itself or the therapies used to treat the disease. Some types of cancers can inhibit the immune system by suppressing bone marrow function, reducing the body's white blood cell count and, in turn, the ability to fight off infection. Cytotoxic chemotherapy and other immune-suppressing agents can have a similar effect and may increase the risk of infection by SARS-CoV-2 in these individuals. There is also ongoing research into the molecular pathways shared by oncogenesis and COVID-19 that may provide further insight into the susceptibility of this patient population.[4] For patients with risk factors for severe disease, it is recommended that they undergo close monitoring for clinical progression with a low threshold for additional evaluations.[5]

What Is Remote Patient Monitoring

The Department of Health and Human Services has defined remote patient monitoring as "the use of connected electronic tools to record personal health and medical data in one location for review by a provider in another location, usually at a different time."[6,7] The aim of remote patient monitoring is to improve the care of patients through digitally transmitted health data, which can be accomplished by early detection of disease symptoms. Data suggest that remote patient monitoring can maximize patient care and treatment effectiveness in multiple areas of healthcare specialties.[8,9] Recognizing the increased impact and potential for increased morbidity and mortality posed by the novel SARS-CoV-2 virus to our oncology patient population, our institution implemented a remote patient monitoring program for patients who were either persons under investigation or COVID-19-positive with mild or no symptoms.

Our Remote Patient Monitoring Pilot

During the early stages of the pandemic, questions arose related to the unique risks that COVID-19 posed to patients with cancer and the logistics of how to safely continue care for these patients in the outpatient clinic and infusion settings. In March 2020, our cancer center's clinical leadership team developed outpatient screening methods and established a COVID-19 testing clinic to identify patients who may be COVID-19-positive and to distinguish that from other causes of fever or respiratory symptoms.

Patients who presented to our institution with COVID-19-like symptoms and who were on active anti-cancer therapy were escorted to a COVID-19 testing clinic, separated from the rest of the cancer center and evaluated by a healthcare provider (Table 1, right). Patients were assessed and categorized as having mild symptoms if they were hemodynamically stable, with an oxygen saturation of at least 94 percent. Patients with more severe illness were ushered to the hospital's emergency department (Figure 1, right).

Persons under investigation or COVID-19-positive patients with mild symptoms were asked to take part in the pilot remote patient monitoring program. These patients continued in outpatient cancer care management in our COVID-19 clinic. This sequestered management continued until the patient had two

negative COVID-19 tests at least 24 hours apart, at which time the patient could return to the usual infusion and provider clinics.

For our pilot program, patients were offered free enrollment. Each patient was provided an iPad pre-loaded with the remote patient monitoring software. The iPads were connected to a broadband cellular network to ensure that patients without Wi-Fi could participate. Patients also had 24/7 access to the helpdesk. The entire solution (including clinical dashboards) was provided by Locus Health. Patients were educated on the program parameters and provided with the iPad and monitoring devices (Table 2, below). Patients were instructed to collect and record their data measurements into the dashboard three times daily. If patients had worsening symptoms at night, they were instructed to contact the on-call provider or come into the emergency department. The data entered by patients were available to clinicians at the cancer center and were monitored 12 hours a day, 7 days a week. If an abnormal value was entered, the patient was prompted to call their provider's office. The abnormal value was also automatically highlighted on the clinical dashboard and an alert was sent to the advanced practice provider team. The advanced practice provider and treating physician would make the clinical determination on the appropriate next step, and this communication and clinical recommendation was documented in the electronic health record (EHR). The institutional review board at Inova Schar approved our protocol to perform this retrospective study on the patients enrolled in this program.

Table 1. COVID-19 Testing Clinic Patient Workup

Vital signs
Blood tests: Complete blood count
Rapid flu swab
SARS-CoV-2 nasopharynx swab for a polymerase chain reaction test

Preliminary Results

Twenty-nine patients were asked to participate in the remote patient monitoring pilot program, and a total of 26 (93 percent) were enrolled between March and June 2020. Reasons for non-enrollment included the perceived complexity and stress of completing data collection/entry and the lack of a quality home internet connection. In the early days of the enrollment period, when COVID-19 tests could take 7 to 10 days to provide a result, participants were primarily persons under investigation, whose results later were negative (N = 11, 42 percent). Eventually, when test results were able to be obtained within 30 minutes, the patients who were offered remote patient monitoring were those who had

(Continued on page 24)

Figure 1. Process Workflow for Suspected COVID-19-Positive Patients

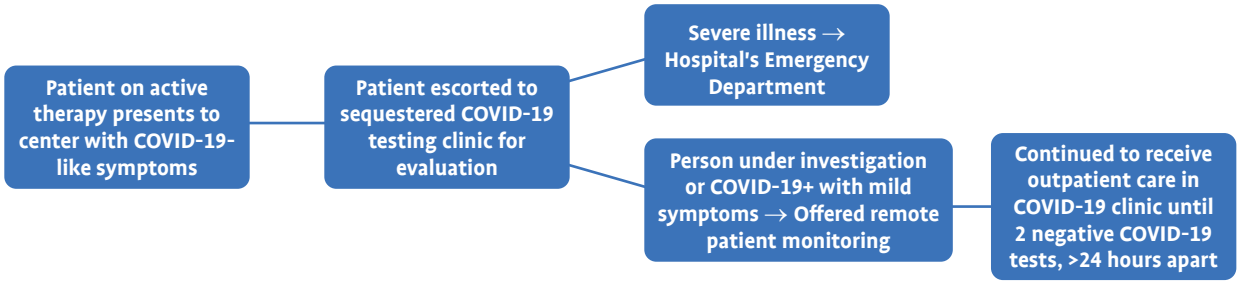


Table 2. Remote Patient Monitoring Program

Equipment Provided	Data Obtained (Three Times Daily)	Abnormal Results Prompting Alert
Automatic blood pressure cuff	Blood pressure	<100/60mm Hg
Oral thermometer	Temperature	>100.0°F
Finger pulse oximeter	Pulse Oxygen saturation	>100 bpm <93%
Configured iPad (available in English or Spanish)	Two symptomatology questions: 1. "Do you feel better, worse, or the same as yesterday?" 2. "Are you experiencing shortness of breath at this time?"	"Yes" response to the second question

(Continued from page 23)

tested positive (N = 12, 46 percent) or who were negative but where there was a high clinical suspicion given symptoms and history of close contact with a COVID-19-positive patient (N = 3, 12 percent).

A summary of patient demographics can be found in Table 3, right. The mean age of patients was 57 years old, with a range from 30 years to 88 years old. The majority were female (54 percent). The most frequent diagnoses were cancers of the gastrointestinal tract, breast, and lungs. The majority of patients were on active anti-cancer treatment (N = 22, 85 percent), including cytotoxic chemotherapy (N = 16), immunotherapy (N = 2), and targeted therapies (N = 4). In most cases, anti-cancer treatment was held until two negative COVID-19 tests were returned (N = 20, 91 percent). Two patients who were persons under investigation remained on systemic targeted therapy while awaiting their test results.

Patients remained on home monitoring for an average of 15.7 days (range, 2 to 63 days). One patient tested positive by nasal swab multiple times for more than seven weeks and was on monitoring for 63 days (or an additional 14 days after her last COVID-19-positive test). Two patients used the Spanish language version of the remote patient monitoring program. Figure 2, page 25, shows a representative example of the clinical trending dashboard of an individual patient that providers monitored centrally at our cancer center.

Patient engagement, with high compliance rates, was observed in the remote patient monitoring program. For all patients, the percentage of days during which at least one set of data was entered was 97.2 percent (range, 80 percent to 100 percent). For 65.7 percent of the days (range, 0 percent to 100 percent), data were entered all three times. No association was observed between the level of engagement and the demographic factors of age, gender, the reason for monitoring, or days in the program. When we compared patients who entered data all three times each day for every day they were in the program (N = 5) with those who did this for fewer than all of the days enrolled (N = 21), we found a relationship with age (42.2 days vs. 60.7 years; $p = 0.01$) and total days in the program (5.4 days vs. 18.1 days; $p = 0.04$).

Of the 26 patients enrolled, only 1 patient, who tested negative for COVID-19 twice, was admitted to the hospital for worsening symptoms. Two patients were admitted for reasons unrelated to their COVID-19 symptoms. Five patients reported feeling short of breath at some point during monitoring, and eight patients reported feeling worse than the day before. A total of 23 patients (88 percent) were able to be safely monitored at home and did not require hospital admission. Five patients developed worsening respiratory status (defined as 1 oxygen saturation measure below 93 percent) while on home monitoring. These patients remained hemodynamically stable on evaluation and were not sent to the emergency room or admitted to the hospital and later made a complete recovery.

Table 3. Patient Demographics

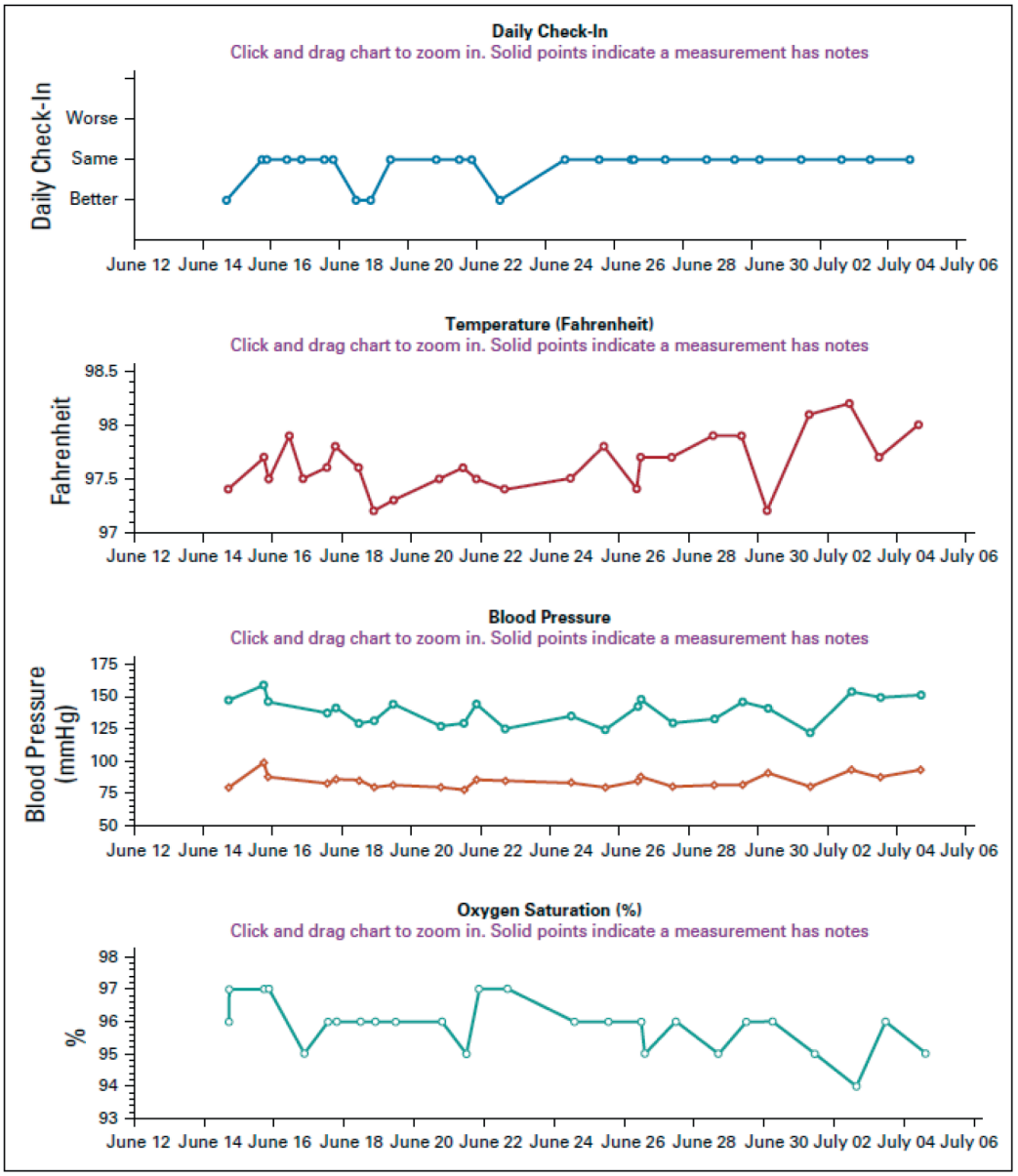
Characteristic	N = 26	Percentage
Age (years)		
Mean	57	—
Range	30-88	—
Gender		
Female	14	54
Male	12	46
Primary cancer		
Gastrointestinal	9	35
Breast	6	23
Lung	3	11
Other	8	31
Cancer therapy		
Cytotoxic chemotherapy	16	62
Immunotherapy	2	8
Targeted therapy	4	15
No treatment or not applicable	4	15
COVID-19 status		
Positive	12	46
Persons under investigation	11	42
Clinical suspicion	3	12
Days on remote patient monitoring		
Mean	15.7	—
Range	2-63	—

Remote Patient Monitoring Challenges

Our pilot study was not without a set of challenges. Though most patients were able to easily use the equipment and technology to remain compliant with entering their data into the dashboard, there may be selected patients who are not familiar with the technology and/or cannot operate the equipment on their own. This may be true particularly for older patients, who may not have a strong internet connection readily available. (We were able to address this by equipping the iPads with separate broadband cellular connectivity.)

Another challenge is with patients whose primary language is not English or Spanish. These two languages were available in the configuration of the iPads for patient use; however, language

Figure 2. Remote Patient Monitoring Dashboard Snapshot



interpretation was a challenge and may have prohibited the enrollment of some patients who would have otherwise participated in the program. Additionally, though levels of patient engagement generally were high throughout the program, we did see decreased participation, marked by missed repeat daily data entry points by those who were under home monitoring for longer periods of time.

At the beginning of our pilot study in the early stage of the pandemic, we faced the challenge of quickly integrating patient's entered data into the EHR system. At the time, a separate monitoring note was developed for documenting the program's data and patient contact into their medical chart to avoid delaying the release of the program to study participants. An additional obstacle to consider is that there is a cost associated with initiating and maintaining a remote patient monitoring program. Our cancer center was fortunate to have our program funded by a generous philanthropic donation.

Looking Ahead

Given that the COVID-19 pandemic does not appear to be ending in the near term, there are opportunities to expand the remote patient monitoring program and utilize this technology to benefit

more patients. Since the early days of the pilot program, we have been able to better integrate the patient data from the dashboard into the EHR system for improved data tracking and documentation. This documentation is important for optimal patient care, as well as being able to appropriately bill insurance and receive reimbursement for these services. Due to the COVID-19 pandemic, the Centers for Medicare & Medicaid Services fast-tracked the approval of reimbursement for remote patient monitoring and remote patient monitoring-enabled services.[10]

There are additional potential uses for remote patient monitoringto be explored outside the sphere of a pandemic, including managing outpatients with low-risk febrile neutropenia and monitoring individuals with leukemia during their consolidation treatments. Patients who are receiving intense chemoradiation therapy may also benefit from frequent tracking of their vital signs, weight, and calorie counts. Current existing technology, such as wearable fitness devices, which some patients may already possess, could be considered for use in the future, with built-in reminders for patients to collect and record their health data. We also plan to leverage the patient education and communication (text, video) capabilities of the platform. OI

Disclosure Statement

Kurby Farrell is employed by Locus Health. There are no other disclosures to report.

Author Roles

Conception and design: Mary Steimer, Jessica Leabo, David Heyer, Nancy Bowles, Kirby Farrell, John F. Deeken; Provision of study materials or patients: Timothy L. Cannon, Raymund Cuevo, William B. Ershler, Danielle Shafer, Sekwon Jang, Angela Pennisi, John F. Deeken; Collection and assembly of data: Mary Steimer, Jessica Leabo, John F. Deeken; Data analysis and interpretation: Hongkun Wang, David Heyer, Timothy L. Cannon, Raymund Cuevo, William B. Ershler, Danielle Shafer, Sekwon Jang, Angela Pennisi, Amjaad Al-Hussain, John F. Deeken; Manuscript writing: All authors; Final approval of manuscript: All authors; Accountable for all aspects of the work: All authors.

Acknowledgments

This intervention and retrospective study was made possible by the generous support of the Mather Family, whose philanthropic gift made it possible. This program was awarded the 2021 Innovator of the Year Award by the Association of American Cancer Centers.

Mary Steimer, NP, Jessica Leabo, PA-C, David Heyer, MD, Nancy Bowles, BSN, MHA, Laura Matthews, MHA, MBA, Timothy L. Cannon, MD, Raymund Cuevo, MD, William B. Ershler, MD, Danielle Shafer, DO, Sekwon Jang, MD, Angela Pennisi, MD, PhD, Amjaad Al-Hussain, MHSA, and John F. Deeken, MD, are with Inova Schar Cancer Institute, Inova Health System, Falls Church, Va.; Hongkun Wang, PhD, is with Georgetown University, Washington, D.C.; and Kirby Farrell, BA, is with Locus Health, Inc., Charlottesville, Va.

References

1. Center for Systems Science and Engineering at Johns Hopkins University. COVID-19 dashboard. Accessed December 19, 2021. https://coronavirus.jhu.edu/map.html

2. Centers for Disease Control and Prevention. People with certain medical conditions. Accessed December 15, 2021. https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html

3. Bakouny Z, Hawley JE, Choueiri TK, et al. COVID-19 and cancer: current challenges and perspectives. *Cancer Cell.* 2020;38:629-629-646. doi: 10.1016/j.ccell.2020.09.018

4. Zong Z, Wei Y, Ren J, et al. The intersection of COVID-19 and cancer: signaling pathways and treatment implications. *Mol Cancer.* 2021;20:76. doi: 10.1186/s12943-021-01363-1

5. Gandhi RT, Lynch JB, Del Rio C. Mild or moderate COVID-19. *N Engl J Med.* 2020;383:1757-1766. doi: 10.1056/NEJMcp2009249

6. Centers for Disease Control and Prevention. What is telemedicine in a non-U.S. setting. Published 2020. Accessed December 12, 2021.cdc.gov/coronavirus/2019-ncov/global-covid-19/telemedicine.html

7. The Office of the National Coordinator for Health Information Technology. Telemedicine and telehealth. Accessed December 14, 2021. www.healthit.gov/topic/health-it-health-care-settings/telemedicine-and-telehealth

8. Chen YY, Guan BS, Li ZK, et al. Effect of telehealth intervention on breast cancer patients' quality of life and psychological outcomes: a meta-analysis. *J Telemed Telecare.* 2018;24:157-167. doi: 10.1177/1357633X16686777

9. Farias FAC, Dagostini CM, Bicca YA, et al. Remote patient monitoring: a systematic review. *Telemed J E Health.* 2020;26:576-583. doi: 10.1089/tmj.2019.0066

10. Centers for Medicare & Medicaid Services. Trump administration proposes to expand telehealth benefits permanently for Medicare beneficiaries beyond the COVID-19 public health emergency and advances access to care in rural areas. Published August 3, 2020. Accessed December 15, 2021. www.cms.gov/newsroom/press-releases/trump-administration-proposes-expand-telehealth-benefits-permanently-medicare-beneficiaries-beyond