ORIGINAL RESEARCH ARTICLE

Description and Early Results of the Kaiser Permanente Southern California COVID-19 Home Monitoring Program

Dan Ngoc Huynh, MD[1]; Alyssa Millan, MPH[2]; Earl Quijada, MD[3]; Deborah John[4]; Shariq Khan[5]; Tadashi Funahashi, MD[6]

Perm J 2021;25:20.281

E-pub: 07/28/2021

https://doi.org/10.7812/TPP/20.281

ABSTRACT

Introduction: The Southern California region of Kaiser Permanente developed a COVID-19 Home Monitoring program as an alternative to hospital admission to decrease hospital bed days and mitigate the adverse effects of a surge. To date, more than 15,000 patients have been enrolled and approximately 10% of enrolled patients have been escalated to hospital care for timely treatment. Our objective is to describe our COVID-19 Home Monitoring program and present early results.

Methods: We conducted an observational retrospective study of all patients enrolled in the COVID-19 Home Monitoring program between April 13, 2020 through February 12, 2021. Data analysis conducted includes patient demographics, enrollment, entry points, length of stay, mortality, additional treatment, utilization, adherence, satisfaction, and alert triggers.

Results: A total of 12,461 of 13,055 patients (95.5%) recovered and completed the program, 1387 patients (10.6%) were admitted to the hospital, and 20 patients (0.2%) died while they were being monitored at home. The mortality rate at 30 days from enrollment was 1.6%. Hospital length of stay for ambulatory patients receiving oxygen only was 5.4 days compared to 3.1 days for those ambulatory patients receiving oxygen, dexamethasone, and remdesivir.

Conclusion: COVID-19 home monitoring appears to be safe and effective. Initial data suggest it can serve as an alternative to hospitalization, decreasing hospital length of stay when patients receive therapies in the ambulatory setting otherwise reserved for the hospital. Initial results of this Home Monitoring program appear to be promising, and a longer term prospective study is warranted.

INTRODUCTION

The COVID-19 pandemic presented challenges to all health systems, including an anticipated strain on hospital capacity. The unpredictable nature of the disease progression posed additional challenges for clinical teams to manage patients. In response to the predicted surge, Kaiser Permanente Southern California rapidly developed a COVID-19 Home Monitoring program to reduce the burden on the health system while keeping patient safety at the forefront. In this way, patients were provided an alternative to admission, or offered early discharge, reducing COVID-19 exposure to the patient, family members, and health-care workers. In addition, timely clinical detection was intended to provide a safety net for our patients. The program was designed to provide safe, high-quality care to patients at home, and to allow medical professionals to identify signs of worsening illness early so they can intervene. This is aligned with national guidelines that suggest most mildly ill patients can be managed in an ambulatory setting or at home through telemedicine, and patients with moderate disease should be monitored closely.[1] Other systems in the US have reported similar virtual monitoring programs, but little outcome data have been reported.[2–6]

METHODS

Setting

Kaiser Permanente is a nonprofit integrated health system with an insurance plan, a network of owned and contracted hospitals, and eight independent and physician-led Permanente Medical Groups, providing care to more than 12.4 million Kaiser Permanente members. Kaiser Permanente's Southern California region serves more than 4.7 million members and provides care at more than 230 medical offices, 15 hospitals, and 13 medical centers. We conducted a study of all patients enrolled in the COVID-19 Home Monitoring program between April 13, 2020 through February 12, 2021.

Study Population and Program Description

Starting in mid-April 2020 during the height of the first surge of the pandemic, patients identified in the urgent care, emergency department, or hospital setting were evaluated and considered for home monitoring (Figure 1). At program inception, eligible patients included confirmed COVID-19-positive patients or patients under investigation with oxygen

Author Affiliations

[1] Regional Assistant Medical Director, Hospital Quality, Regional Chief, Hospital Medicine, Regional Physician Director, Home Care Services, Southern California Permanente Medical Group
[2] Senior Manager, Health Innovation Studio, Southern California Permanente Medical Group
[3] Physician, Geriatric, Palliative, Continuing Care, Southern California Permanente Medical Group
[4] Consultant, Health Innovation Studio, Southern California Permanente Medical Group
[5] Principle Data Consultant, Health Innovation Studio, Southern California Permanente Medical Group
[6] Chief Innovation Officer, Health Innovation Studio, Southern California Permanente Medical Group

Corresponding Author

Alyssa Millan (alyssa.tjajadi-millan@kp.org)

Keywords: COVID-19, remote patient monitoring, telehealth

Abbreviations: ASCVD = atherosclerotic cardiovascular disease; BMI = Body Mass Index; CDC = Centers for Disease Control and Prevention; CHF = congestive heart failure; CKD = chronic kidney disease; COVAS = Comorbidities, Obesity, Vital Signs, Age, Sex; DEX = Dexamethasone; DM = diabetes mellitus; HTN = hypertension; REM = Remdesivir Treatment

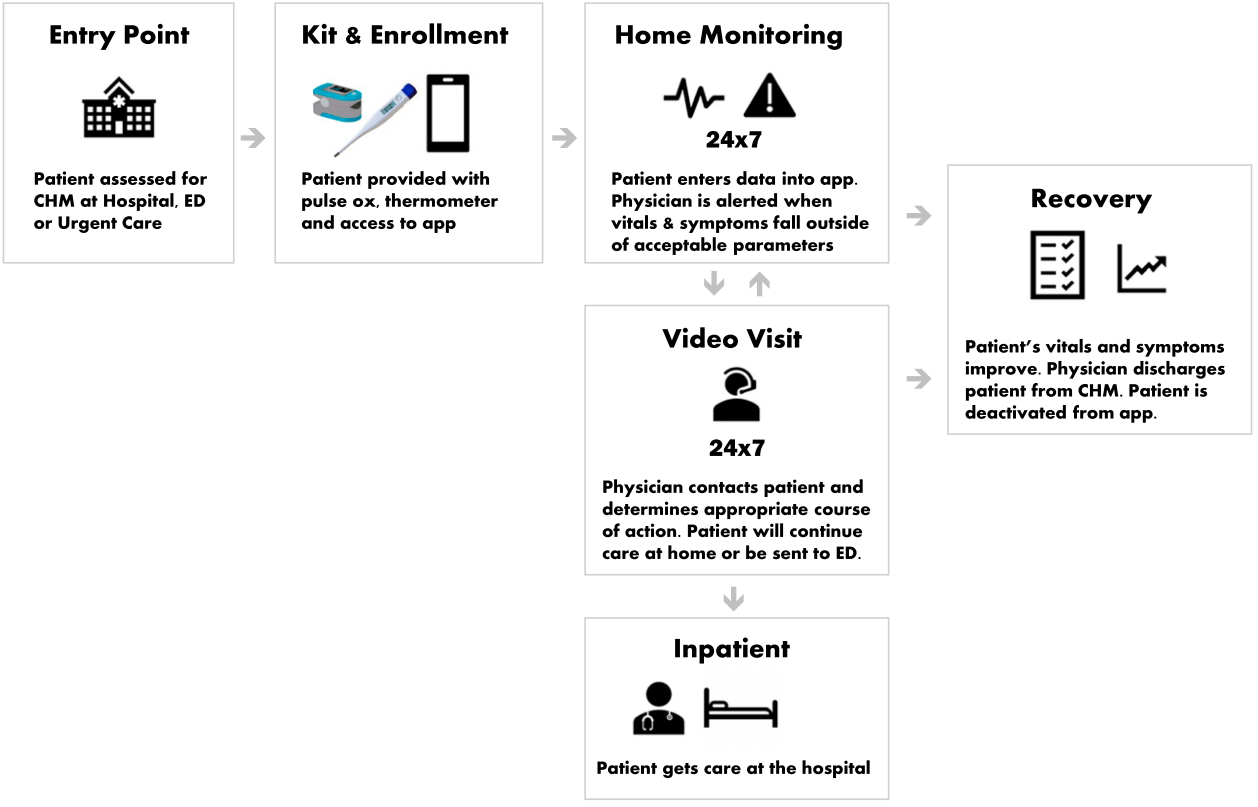

Figure 1. High-level workflow. CHM = COVID-19 Home Monitoring; ED = emergency department; ox = oximeter. Source: Kaiser Permanente

saturation ≥ 92%, heart rate < 100 bpm, respiratory rate ≤ 20 breaths/min, mild symptoms, low disease burden, age ≤ 60 years, and a body mass index < 40. Existing research indicated that respiratory symptoms, diabetes, coronary artery disease, and age were strong predictors for hospitalization.[7,8] From this information, criteria were developed to target patients predicted to have mild to moderate risk for hospitalization and, after gaining confidence from direct experience, the team calibrated the program actively to "risk-stratify" patients more precisely. As the program progressed, a predictive tool was built by our emergency medicine experts and was integrated into our electronic medical record system to help frontline staff better identify patients who may be appropriate for home monitoring (Figure 2).[9] Descriptive tables report the percentage of patients with 7-day adverse events, and risk-stratified groups were developed. Those with a comorbidities, obesity, vital signs, age, gender (COVAS) score between 11 and 13 were considered moderate risk and were eligible for COVID-19 home monitoring.

During enrollment, patients were educated and provided with clear instructions and what to expect while on the program. Enrolled patients were provided a pulse oximeter, thermometer, and access to an application that allowed them to enter their daily vital signs and symptoms. The home monitoring application was designed to run on a smart mobile device or over the Internet on a computer. Patients with limited access were given the option of having a care team member enter their daily information on their behalf. The symptom survey included cough, shortness of breath, confusion, and other indicators. The program was also available in Spanish to support the region's large Hispanic population. In addition, access to our standard interpreter services was available to support health equity further for our diverse membership. Patients and caregivers were provided registration and education support before being monitored. Handouts and patient videos were developed to allow patients and caregivers to review instructions they may have missed or might wish to revisit. Patients were also prompted to learn about COVID-19; they were provided access to the Centers for Disease Control and Prevention and other information through the app. A "Take a Break" applet also encouraged patients to view meditation and relaxation videos to help with anxiety.[10]

The information the patients or caregivers reported was monitored by a care team for appropriate action. Technology enablement that integrated into and supported clinical

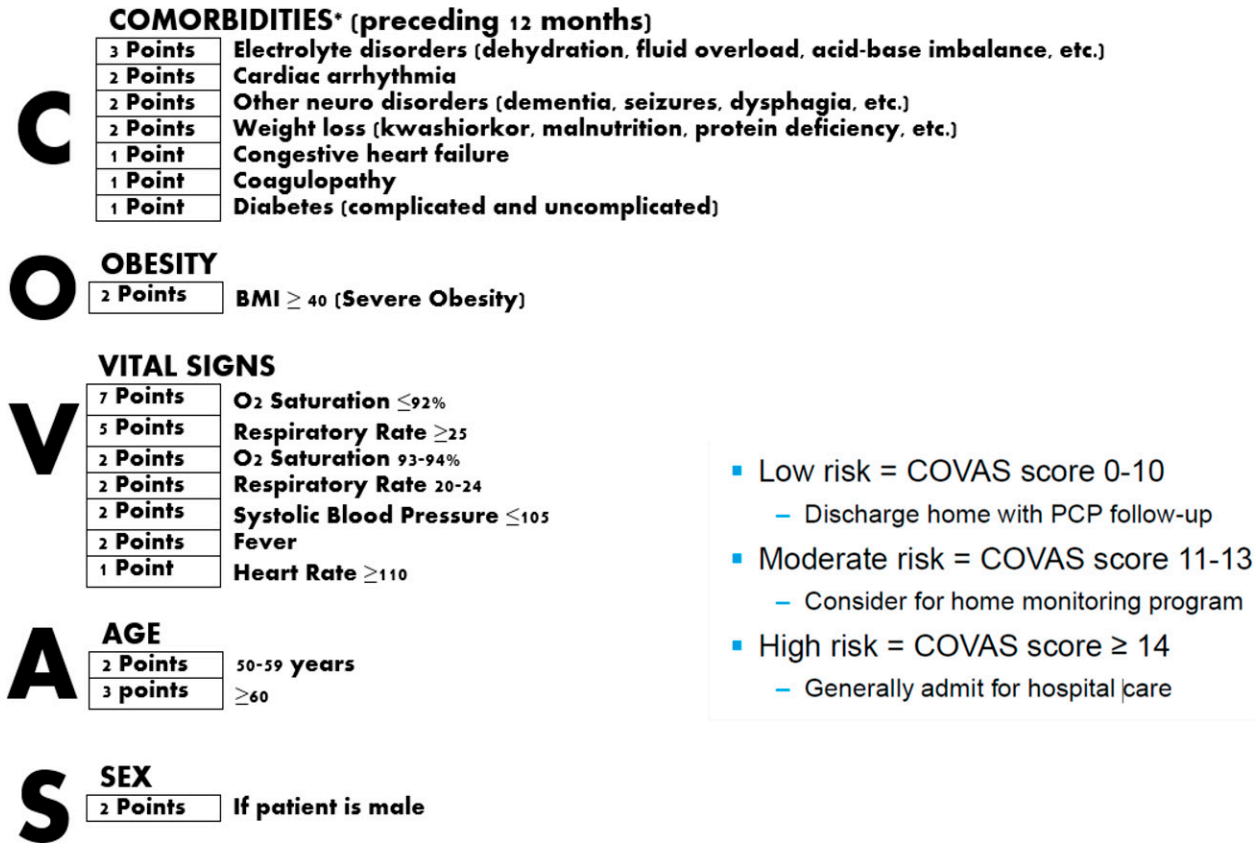

Figure 2. Comorbidities, obesity, vital signs, age, gender (COVAS) score. BMI = body mass index; neuro = neurological; O_2 = oxygen; PCP = primary care provider. Source: Kaiser Permanente

workflows was crucial for this project. Clinicians were in daily contact with the patients and were able to use a video platform to discuss symptom details. While the patients were monitored, clinicians were alerted if survey answers or biometric readings fell outside defined parameters or if symptoms were worsening. Based on the patient's daily entry, a three-tiered alert protocol (green, yellow, or red) generated the appropriate task for the monitoring team. Depending on the patient's symptoms, additional diagnostic testing could be ordered. Some patients were provided with home oxygen and other treatment protocols as indicated, including remdesivir and dexamethasone. The program was designed to support a 24/7 coverage model with proactive outreach to patients who were nonadherent to their care plan. Medical centers provided coverage during the daytime, 7 days a week. A centralized clinical pool of nurses and Permanente physicians at the Virtual Medical Center were engaged to provide coverage for all participating sites after hours, 7 days a week. A strong relationship was built between the care team and the patient. Through feedback loops, the care team and the patient worked on building trust with one another, which helped to improve adherence.

Local areas mobilized an interdisciplinary team for the Home Monitoring program with the following clearly defined roles:

Program manager: coordination between local and regional teams; stakeholder engagement
Enrollers: patient registration and education
Patient advocates: patient adherence, including reminding patients to enter their vital signs into the system and helping with patient education
Clinical support team (nurses and physicians): receive and follow up on patient alerts; coverage 7 days a week
Deactivators: patient deactivation from program

Each local team established tight workflows among all the roles to ensure seamless care coordination for the patient.

Descriptive Statistics

We identified all patients enrolled in the COVID-19 Home Monitoring program from April 13, 2020 to February 12, 2021. Patients who were enrolled in the program but who decided to not participate were excluded from the analysis. Data were extracted from the program database and Kaiser Permanente's electronic medical record. Data analysis

Table 1. Clinical and demographic patient characteristics

Characteristic	*n* (%)
Age, y	
< 50	4424 (33.9)
50–59	3152 (24.1)
≥ 60	5479 (42.0)
Gender	
Female	5933 (45.4)
Male	7122 (54.6)
Race	
Asian	1171 (9.0)
Black	990 (7.6)
Hispanic/Latino	7700 (59.0)
Native American	176 (1.3)
Other/unknown	573 (4.4)
White	2445 (18.7)
BMI category	
Very severely underweight	5 (0.0)
Severely underweight	5 (0.0)
Underweight	41 (0.3)
Normal	1341 (10.3)
Overweight	3576 (27.4)
Obese	3655 (28.0)
Severely obese	2062 (15.8)
Very severely obese	1982 (15.2)
Unknown	388 (3.0)
Comorbidity	
Atherosclerotic cardiovascular disease	772 (5.9)
Asthma	1291 (9.9)
Congestive heart failure	733 (5.6)
Chronic kidney disease	2001 (15.3)
Diabetes mellitus	4648 (35.6)
Hypertension	5903 (45.2)
Total	13,055

conducted includes patient demographics (age, gender, race, body mass index, and comorbidities); weekly enrollment volumes and entry points; length of stay in the program; treatments administered while on the program (oxygen, remdesivir, dexamethasone); emergency department, urgent care, and hospital use; patient adherence; patient satisfaction; alert triggers; and mortality rate. Patient adherence was defined as the percentage of times patients submitted their daily vital signs and symptom surveys as assigned.

RESULTS

From the COVID-19 Home Monitoring program's inception on April 13, 2020 until February 12, 2021, 13,055 patients were monitored remotely. A total of 9 patients were enrolled before February 12, 2021 and were still active in the program after the follow-up date of March 12, 2021, so they were not included in our analysis. Clinical and demographic patient characteristics are provided in Table 1; recovery, hospitalization, and mortality outcomes are provided in Table 2.

Approximately 42% of patients in the program were 60 years of age or older, 24.1% were between the ages of 50 and 59 years, and 33.9% were younger than 50 years of age. There was a greater percentage of male patients enrolled in the program (54.6%) than female patients (45.4%). Most of the patients enrolled were Hispanic/Latino (59.0%), followed by white (18.7%), Asian (9.0%), and black (7.6%).

Approximately 84% of enrolled patients had one or more chronic diseases, 31% had one comorbidity, and 53% had two or more comorbidities. The most common comorbidity type was obesity (59%), followed by hypertension (45.2%), diabetes mellitus (35.6%), chronic kidney disease (15.3%), asthma (9.9%), atherosclerotic cardiovascular disease (5.9%), and congestive heart failure (5.6%). Of the 13,055 patients enrolled in the program, 47.2% were enrolled from an inpatient setting, 25.1% from an emergency department, and 27.7% from an urgent care or outpatient setting. A total of 12,461 patients (95.5%) recovered and completed the program, 1387 patients (10.6%) were admitted to the hospital, and 20 patients (0.2%) died while enrolled in this program. Patients could have been enrolled in the program more than once. The mortality rate at 30 days from enrollment was 1.6%. Of the patients who died or were hospitalized, a greater percentage was found to have existing comorbidities. Patients older than 60 years and male patients were more likely to have been hospitalized and had greater 30-day mortality rates.

The average length of stay on the COVID-19 Home Monitoring program was 9.2 days and patient adherence was high (94%). Patients triggered an average of 3.39 alerts during daytime hours and 1.05 alerts during afterhours throughout their length of stay on the program. Oxygen saturation readings fell below 90% for 8.6% of patients during daytime hours and 2.6% of patients during afterhours.

Supplemental oxygen treatment was provided to 46% of patients monitored on the program. Approximately 60% of patients enrolled from the hospital and 51% of patients enrolled from the emergency department required oxygen treatment, compared to 18% of patients from the urgent care or outpatient settings. Other treatment included dexamethasone (38%) and remdesivir (11%). We analyzed the impact of these different therapies on key outcomes (Table 3). More specifically, we split the population into patients who received oxygen only; oxygen and dexamethasone; and oxygen, dexamethasone, and remdesivir while on the program. The average hospital length of stay of patients who received oxygen, dexamethasone, and remdesivir while on the program was 3.1

Table 2. Study outcomes				
Characteristic	**Recovered, *n* (%)**	**Hospitalized, *n* (%)**	**Deceased, *n* (%)**	**30-Day mortality, *n* (%)**
Age, y				
< 50	4317 (33.1)	344 (2.6)	1 (0.0)	14 (0.1)
50–59	3060 (23.4)	280 (2.1)	3 (0.0)	17 (0.1)
≥ 60	5084 (38.9)	763 (5.8)	16 (0.1)	177 (1.4)
Gender				
Female	5700 (43.7)	558 (4.3)	7 (0.1)	65 (0.5)
Male	6761 (51.8)	829 (6.4)	13 (0.1)	143 (1.1)
Race				
Asian	1101 (8.4)	156 (1.2)	0 (0.0)	17 (0.1)
Black	931 (7.1)	123 (0.9)	2 (0.0)	16 (0.1)
Hispanic/Latino	7377 (56.5)	786 (6.0)	14 (0.1)	121 (0.9)
Native American	162 (1.2)	24 (0.2)	0 (0.0)	3 (0.0)
Other/unknown	560 (4.3)	31 (0.2)	0 (0.0)	2 (0.0)
White	2330 (17.8)	267 (2.0)	4 (0.0)	49 (0.4)
BMI category				
Very severely underweight	4 (0.0)	1 (0.0)	0 (0.0)	0 (0.0)
Severely underweight	4 (0.0)	2 (0.0)	0 (0.0)	0 (0.0)
Underweight	37 (0.3)	8 (0.1)	0 (0.0)	1 (0.0)
Normal	1234 (9.5)	192 (1.5)	3 (0.0)	42 (0.3)
Overweight	3423 (26.2)	386 (3.0)	4 (0.0)	50 (0.4)
Obese	3499 (26.8)	393 (3.0)	7 (0.1)	54 (0.4)
Severely obese	1989 (15.2)	207 (1.6)	2 (0.0)	31 (0.2)
Very severely obese	1897 (14.5)	177 (1.4)	4 (0.0)	28 (0.2)
Unknown	374 (2.9)	21 (0.2)	0 (0.0)	2 (0.0)
Comorbidity				
Atherosclerotic cardiovascular disease	710 (5.4)	127 (1.0)	3 (0.0)	27 (0.2)
Asthma	1269 (9.7)	75 (0.6)	0 (0.0)	4 (0.0)
Congestive heart failure	641 (4.9)	153 (1.2)	2 (0.0)	39 (0.3)
Chronic kidney disease	1798 (13.8)	346 (2.7)	10 (0.1)	99 (0.8)
Diabetes mellitus	4367 (33.5)	579 (4.4)	14 (0.1)	120 (0.9)
Hypertension	5538 (42.4)	787 (6.0)	15 (0.1)	152 (1.2)
Total	12,461 (95.5)	1387 (10.6)	20 (0.2)	208 (1.6)

days compared to 4.1 days for patients on oxygen and dexamethasone only, and 5.4 days for patients on oxygen only.

Post-enrollment in the program, the 7-day utilization rate of inpatient, emergency, or urgent care services ranged from 3.5% to 5.7%, 14-day utilization ranged from 6.8% to 8.1%, and 30-day utilization ranged from 8.9% to 12.1%. Patients enrolled in COVID-19 Home Monitoring from the emergency department had the greatest return rate to the emergency department, with 10.0% within 7 days, 13.3% within 14 days, and 17.4% within 30 days.

Overall patient satisfaction data was high. Many patients (56%) responded to a patient satisfaction survey, with 94%

Table 3. Hospitalization outcomes for supplemental oxygen, dexamethasone, and remdesivir treatment				
Cohorts	**Total, *n***	**Hospitalized, *n* (%)**	**Recovered, *n* (%)**	**Average length of stay, d**
O_2	5939	702 (11.8)	5228 (88.0)	5.4
O_2 + DEX	3673	577 (15.7)	3091 (84.2)	4.1
O_2 + DEX + REM	1097	381 (34.7)	714 (65.1)	3.1

DEX = dexamethasone; O_2 = oxygen; REM = remdesivir.

of respondents stating they would recommend the Home Monitoring program to a family member or friend and were pleased with the quality of care they received. Patient adherence to the administered care plan was also high at 94%.

DISCUSSION

At the onset of program development, the goal was to provide safe and high-quality monitoring for mild to moderate patients with COVID-19. Our program reports a hospitalization rate of 10.6%, a mortality rate of 0.2% while on the program, and a 30-day mortality rate of 1.6%. During the preparation of this article, three separate COVID-19 virtual monitoring programs reported similar initial outcomes. Driver et al.[4] reported a COVID-19 outpatient monitoring system developed by the Veterans Affairs in Boston, which included 120 patients and reported a mortality rate of 1.7%. Another study monitored 208 patients remotely and reported no patient deaths.[5]

The largest study, by Kaiser Permanente of the Mid-Atlantic States, recently reported 13,508 COVID-19-positive patients enrolled in a slightly different telemonitoring program than our own.[6] Hospitalization and mortality rates were 8.2% and 1.33%, respectively. Although these rates were slightly less than ours, there were differences in clinical and demographic patient characteristics. Our study actively enrolled patients with greater rates of comorbidities, including obesity, diabetes, and hypertension.

Men and patients 60 years and older had a greater mortality risk than females or younger patients, respectively. Comorbid diseases were associated with greater rates of hospitalization, and mortality included cardiovascular disease, diabetes, and hypertension. This is consistent with findings from previous studies.[7,8,11] The demographic breakdown of age and comorbidities validates that we were indeed enrolling patients into the program who had significant risk for hospitalization and for whom monitoring would be beneficial.

We quickly learned that the best alert to signal a clinical intervention was patients' oxygen saturation levels.[12] Approximately 25% of our patients triggered an alert for an oxygen saturation $\leq$ 92% (16% with an oxygen saturation of 91%–92% and 9% with an oxygen saturation $\leq$ 90%). This allowed our care teams to make the appropriate clinical intervention in a timely manner. We were able to catch silent hypoxia cases through this monitoring capability as some patients reported feeling fine but were desaturating.

The COVID-19 Home Monitoring program was built as an alternative to hospitalization. As the program evolved over time, we learned we could monitor moderately ill COVID-19 patients at home by supporting them with oxygen therapy, managing the oral medications described previously, and providing reassurance. When the large COVID-19 surge hit from December 2020 to February 2021, our hospitals were overwhelmed. We executed our surge crisis plans and began offering intravenous remdesivir and dexamethasone in nonacute settings. The COVID-19 Home Monitoring program enabled us to do this safely by monitoring these patients closely throughout their treatment course. The average hospital length of stay of patients who received oxygen, dexamethasone, and remdesivir while on the program was 3.1 days, compared to 4.1 days for patients on oxygen and dexamethasone only, and 5.4 days for patients on oxygen only. The group that received oxygen, dexamethasone, and remdesivir included patients who were older and who had a greater prevalence of hypertension. Despite having greater risk factors for disease progression, the COVID-19 Home Monitoring program enabled us to discharge these patients safely and home sooner. These findings are notable for the institution because it suggests that COVID-19 home monitoring is safe, effective, and can serve as an alternative to hospitalization, effectively reducing hospital length of stay and reducing the burdens associated with COVID-19 on the health system.

Preliminary findings prior to the December 2020 to February 2021 surge suggested there was no difference in hospital utilization for patients entering the COVID-19 Home Monitoring program from the emergency department or urgent care. This matches our clinical observations, as patients from the emergency department or urgent care did not receive disease-modifying therapy and were early in their disease. When clinical deterioration occurred, patients had to return to the hospital for escalating therapy. Further analysis needs to be performed to determine how the introduction of ambulatory treatment of dexamethasone and remdesivir affects outcomes in this population subgroup.

Our results also demonstrated greater obesity, hypertension, and diabetes in patients who ended up being admitted to the hospital. A limitation of our monitoring system is that it did not include blood pressure and glucose measurements. Having these additional data points may have enhanced our ability to manage patients with these comorbidities and perhaps lead to better outcomes.

Study Limitations

This was a retrospective observational study with a short follow-up. Program protocols evolved rapidly over time throughout the COVID-19 pandemic, and these changes were not necessarily noted or analyzed in our study. As the program progressed, the predictive tool (COVAS) designed by emergency medicine experts was integrated into the electronic medical record system to help identify