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COVID-Care – a safe and successful digital self-assessment tool for outpatients with proven and suspected coronavirus-2019

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Abstract

Introduction: The coronavirus-2019 (COVID-19) pandemic and restrictions placed on movement to prevent its transmission have led to a surge in demand for remote medical care. We investigated whether COVID-Care, a patient-reported, telehealth, symptom monitoring system, was successful at delivering safe monitoring and care for these patients leading to decreased hospital presentations.

Methods: We performed a single centre, prospective, interventional cohort study with symptomatic outpatients who presented for COVID-19 screening at Austin Health, Australia. Participants were invited to take part in the COVID-Care programme, entering common COVID-19 symptoms on a purpose-built, online survey monitored by infectious diseases physicians, and matched with clinical data including date of symptom onset, hospital admission, and screening clinic presentations.

Results: 42,158 COVID-19 swabs were performed in 31,626 patients from March to October 2020, with 414 positive cases. 20,768 people used the COVID-Care survey at least once. COVID-Care users were significantly younger than non-users. Of the 414 positive cases, 254 (61.3%) used COVID-Care, with 160 (38.6%) non-users. Excluding presentations on the same day or prior to the COVID-19 swab, of the positive cases there were 56 hospital presentations. 4.3% (11) of COVID-Care users and 28.1% (45) non-users were admitted to hospital or the emergency department ($p < 0.001$), with 3.9% (10) versus 22.5% (36) requiring inpatient admission ($p < 0.001$). There were no deaths in COVID-Care users versus 2 deaths in non-users.

Conclusion: COVID-Care, a digitally integrated, outpatient, symptom tracking and telemedical service for patients with COVID-19, was safe and successful at reducing hospital and emergency department admissions, suggesting a strong role for telemedicine for future healthcare delivery in this logistically challenging setting.

Keywords

Telehealth, digital health, coronavirus, severe acute respiratory syndrome coronavirus 2, outpatient, symptoms

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Introduction

The COVID-19 pandemic has placed restrictions on movement in order to prevent transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, and has led to a surge in demand for remote medical care by providers, health care services and patients.[1] The previous track record of telemedicine services in SARS, Middle East Respiratory Syndrome, and Ebola epidemics,[2] led to the implementation of similar services for all stages of COVID-19 care, from screening and surveillance, through to detection of cases, treatment, and prevention of further spread.[3]

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The vast majority of patients with SARS-CoV-2 infection do not require hospitalization,[4] but requirements for home isolation provide challenges in caregiving and early detection of clinical deterioration. The COVID-Care programme at Austin Health is a digitally-integrated symptom tracking and telemedical service that prospectively follows outpatients with confirmed or suspected COVID-19 (SCOVID) from their diagnosis through to resolution of illness. We investigated the COVID-Care dataset to determine the impacts on preventing hospital presentations and describe the longitudinal symptomatology of COVID-19 positive outpatients.

Methods

A single centre, prospective, interventional cohort study was conducted with symptomatic outpatients who presented for COVID-19 screening at Austin Health, Victoria, Australia from 27 March to 8 October 2020. After attending the COVID-19 screening clinic, participants were electronically invited to participate in the COVID-Care programme, receiving daily text messages directing them to enter their symptoms into a purpose-built, symptom-tracker, online survey (Supplemental Figure 1), available at a designated web address. Patients with confirmed COVID-19 (deep nasal and throat swab polymerase chain reaction (PCR) positive for SARS-CoV-2) and SCOVID (deep nasal and throat swab PCR negative for SARS-CoV-2) were both invited to use COVID-Care. Survey questions were developed using lay language adapted from two meta-analyses[5,6] and additional resources,[7–9] with a goal to identify the following patient cohorts: (i) severe COVID-19 respiratory disease or severe secondary complications, as defined by severe pneumonitis, thrombotic and thromboembolic disease, and secondary bacterial pneumonia, (ii) severe non-respiratory symptoms of COVID-19 or non-COVID pathologies (e.g. severe diarrhoea, vomiting, meningism) and (iii) non-severe disease. Survey responses were saved to a secure online platform, only accessible to those trained and entitled to access the linked patient information. Responses were monitored by a team of COVID-Care trained medical and nursing staff, overseen by specialist Infectious Diseases physicians. Reports of moderate symptoms triggered a follow-up phone consultation, and severe symptoms required discussion with the supervising Infectious Diseases physician. Patients of concern who were unable to be completely assessed via telephone were referred to the COVID-19 screening clinic for further clinical assessment, where discharge disposition was dependent on clinical review.

Basic clinical data including date of symptom onset, hospital admission, and screening clinic presentations were collected. If date of symptom onset was unknown or the patient remained asymptomatic, the date of first COVID-19 swab was recorded. Symptoms were classified as early (0–5 days from symptom onset), intermediate (5–10 days), late (10–15 days) and very late (>15 days). Outcome data including presentation and admission to hospital and death were collected via cross-matching to hospital electronic medical records.

Statistical analysis was performed using Stata MP 16.1 (StataCorp, College Station, TX). Data were summarised using median and interquartile range (IQR) for continuous variables, and count and percentage for categorical variables. Chi square and rank sum tests were used for univariate analysis.

(Ethics approval: Austin Health; Audit 20/147).

Results

Cohort demographics and use of COVID-Care

There were 42,158 COVID-19 tests performed in 31,626 patients, with 414 (1.3%) SARS-CoV-2 positive results. 20,768 (65.7%) patients used the COVID-Care survey at least once, with median 9 days duration of survey use (IQR 0–14 days). Of COVID-Care users, 276 (1.4%) people returned a positive swab result, and 234 (84.7%) commenced using COVID-Care subsequent to their positive swab collection (median 3 days post swab, IQR 2–5 days). There was no difference in swab positivity between survey users and non-users (1.4% vs. 1.2%). Survey users were less likely to be hospitalized or attend the emergency department (ED) ($p < 0.001$) and were less likely to die ($p < 0.001$) (Supplemental Table 1). Of patients who presented to hospital, those that used COVID-Care were more likely to have a single emergency visit ($p < 0.001$), less likely to be admitted as a hospital inpatient ($p < 0.001$), and were less likely to die ($p < 0.001$). However, COVID-Care survey users were significantly younger than non-users (median 44 years vs. 67 years, $p < 0.001$).

COVID-Care use and clinical outcomes amongst those with confirmed SARS-CoV-2 infection

Of the 414 patients who returned positive swab results, 254 (61%) used COVID-Care, and 160 (39%) did not (Table 1). Minimal demographic data were collected for the survey respondents, although we found a significant age difference between COVID-Care survey users (median age 33 years) and non-users (median age 64 years). More COVID-Care non-users (45, 28%) compared with COVID-Care users (11, 4.3%) were admitted to hospital or the ED (age adjusted odds ratio (OR) 0.12, $p < 0.001$). Both ED and inpatient admissions for COVID-19 were significantly more frequent in non-users compared with users (ED 18.7% vs. 2.8%, age adjusted OR 0.11, $p < 0.001$;

Table 1. COVID-19 positive patients. Comparison of COVID-Care users vs. non-users.

	COVID-Care non-user[a]	COVID-Care user		
	$N = 160$	$N = 254$	OR (95% CI) (age adjusted)	p-value
Age, years (median, IQR)	63.6 (36.6, 82.8)	33 (23, 52)		
Admitted to ED/hospital	45 (28.1%)	11 (4.3%)	0.12 (0.06, 0.26)	<0.001
Admitted as inpatient	36 (22.5%)	10 (3.9%)	0.17 (0.08, 0.39)	<0.001
Admitted to ED	30 (18.7%)	7 (2.8%)	0.11 (0.04, 0.26)	<0.001
Admitted to ED SSU	4 (2.5%)	0 (0%)		
Deceased in hospital	2 (1.2%)	0 (0%)		

[a]Patients who were admitted *prior* to their first use of COVID-Care are included as non-users in this analysis.
ED: emergency department; SSU: short stay unit; CI: confidence interval; IQR: interquartile range.

Inpatient admission 22.5% vs. 3.9%, age adjusted OR 0.17, $p < 0.001$). There were two deaths of COVID patients in the non-user group, and no deaths in those who were being symptom-tracked with COVID-Care during their COVID illness.

Statistically significant differences between admitted versus non-admitted patients in reports of dyspnoea (78.8% vs. 36.7%, $p < 0.001$), malaise (84.1% vs. 58.7%, $p < 0.001$), headache (37.7% vs. 20%, $p < 0.001$), myalgia (37.7% vs. 20%, $p < 0.001$), fatigue (80.1% vs. 40.6%, $p < 0.001$), chest pain (11.3% vs. 5.7%, $p = 0.005$), lightheadedness (48.4% vs. 25.5%, $p = 0.006$) and fever (9.3% vs. 2.9%, $p < 0.001$) were reported.

COVID-19 symptoms over time

In the COVID-19 positive group, symptomatology was analysed over time. All symptoms, excluding diarrhoea, decreased in frequency over time. Low mood, malaise and myalgia, fatigue, cough, and headache were the most commonly reported symptoms in the first 15 days of symptoms. Low mood remained frequent at all time points, with two-thirds (65%) still reporting mood symptoms after 15 days of illness. Cough was reported in 45% of 'early' questionnaires, reducing to 30% in the 'intermediate' group without further improvement thereafter.

Dyspnoea was reported in 25% of questionnaire responses in the first 5 days of illness, reducing to 12% by 10–15 days. Sore throat and rhinorrhoea were reported in approximately 20% of 'early' responses, with gradual resolution over time. Chest pain was reported in 10%, anosmia was reported in 9%, and haemoptysis in 4% of 'early' responses, with gradual reduction over time. Fever was reported in 6% of responses. No responses reported anosmia more than 15 days after symptom onset. Diarrhoea was not reported in the first 5 days of illness, but was reported in 5% of questionnaires between 5–15 days after symptom onset. Vomiting was uncommon (1%).

The severity of symptoms uniformly decreased over time. Malaise, fatigue, and poor mood were the symptoms most commonly reported as more severe initially. All symptoms had resolved or plateaued by 10–15 days, with minimal change thereafter.

Discussion

Our study has demonstrated the safety and efficacy of a telehealth-based digital monitoring system for outpatients with confirmed COVID-19, with substantially reduced hospital admissions in the COVID-Care users, and no deaths due to COVID-19 in this cohort. In total, 365 patient reports of severe symptoms, and 2367 reports of moderate symptoms were made, which likely reflects the survey design's inclusive designation of symptom severity. Nevertheless, these symptoms may have been expected to result in presentation at an ED, or a primary care provider consultation prior to COVID-19 restrictions.

The admission rate of patients with confirmed COVID-19 who did not use the symptom-tracker app was 28%, which is relatively high compared to international data,[4] likely reflective of the older population in the non-user group. However, with symptom tracking, phone-call follow-up consultation, and escalation as required, only 4.3% of patients under the COVID-Care framework required hospital admissions or ED presentation – an impressive rationalisation of vital hospital inpatient resources in this context. The infection control benefits of this result should be highlighted: the use of the COVID-Care app prevented

infectious COVID-19 patients presenting to the ED, likely resulting in decreased risk of Sars-CoV-2 transmission to staff, patients, and the wider community. Our findings are comparable to a Maltese study that demonstrated telemedicine follow-up was successful in managing 90% of COVID-19 patients in a community setting, with only 6% requiring hospital follow-up.[10]

Most patients reported considerably improved symptomatology by the end of the second week of illness. Cough and dyspnoea continued to be relatively frequently reported beyond this time (28% and 15% respectively), although the severity of dyspnoea decreased. This tool could be used to further examine the developing phenomenon of 'long COVID', assessing symptoms over a longer time period.

Telemedicine is increasingly being used to monitor COVID-19 positive patients in an outpatient setting, and now includes the use of use of wearable technology, including electrochemical sensors and smartphone technology to aid in diagnosis of COVID-19 in a community setting.[11] It has proven to be a cost-effective intervention in many COVID-19 related settings, including for the observation of patients in quarantine.[12] Previous concerns about the usability and technological challenges of telemedicine for older practitioners and patients have been found to pose less of a barrier than expected,[13] and practitioner perceptions about the utility of telemedicine in clinical practice have improved since the beginning of the pandemic with the increased exposure to telemedical practice that has entailed.[14] There have also been some unexpected changes to surgical practice in relation to telemedicine since the pandemic began, with an increase in conservative management of appendicitis with telemedical follow-up, compared to operative management.[15]

Our study is limited by its relatively small size and single centre, non-randomised design, as well as an absence of objective clinical data (e.g. pulse oximetry, measured temperature). Nevertheless, our data still provide a unique assessment of a digital health COVID-19 solution that is scalable and offers insight into symptoms over time with SARS-CoV-2 infection.

Conclusion

COVID-Care, a digitally integrated symptom tracking and integrated telemedical service for patients with proven or SCOVID, was safe and effective at reducing hospital and ED admissions at a large tertiary hospital during Victoria's first- and second-waves, reducing unnecessary hospitalizations.

Our study also demonstrated the natural symptomatology and time-course of COVID-19 in outpatients, demonstrating the relative persistence of cough and dyspnoea into at least the third week of illness, suggesting a role for monitoring and follow-up over the medium term.

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