



Short Communication

Addressing silent hypoxemia with COVID-19: Implementation of an outpatient pulse oximetry program in Vermont

Marlowe Galbraith^{a,b}, Patsy Kelso^a, Mark Levine^a, Richard C. Wasserman^{a,c}, Jessica Sikka^{a,c}, Jennifer S. Read, MD, MS, MPH, DTM&H^{a,c,*}

^a Vermont Department of Health, Burlington, VT, USA

^b Pennsylvania State University, University Park, PA, USA

^c Larner College of Medicine, University of Vermont, Burlington, VT, USA



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ABSTRACT

Objectives: We initiated an outpatient pulse oximetry program to facilitate more rapid detection of clinical deterioration of persons with COVID-19.

Methods: Vermont residents in non-congregate settings with laboratory-confirmed SARS-CoV-2 infection were eligible for inclusion.

Results: Acceptance of pulse oximetry occurred more frequently among those who were older or symptomatic, spoke English, or who had underlying medical conditions.

Conclusions: We provide the first description of an outpatient pulse oximetry program for COVID-19 by a state health department in the U.S.

A clinical review on April 21, 2020 characterized deaths among Vermont residents testing positive by real-time reverse transcription polymerase chain reaction (PCR) assay for serious acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [1]. In this review, approximately a third (5/16) of persons who died had a history of syncopal episodes or falls at home prior to hospitalization, with associated confusion and/or somnolence, in the absence of dyspnea, and the assessment was that these persons likely had hypoxemia prior to arrival at a medical facility where pulse oximetry was available [1]. Based on these cases, and in light of early reports of COVID-19-related hypoxemia prior to the onset of dyspnea [2], the Vermont Department of Health (VDH) initiated a public health program [3] intended to allow more rapid detection of clinical deterioration of COVID-19 patients through the use of pulse oximetry at home. Earlier detection of hypoxemia in COVID-19 patients could prompt earlier medical evaluation and, as indicated, supportive care such as provision of supplemental oxygen. In turn, more rapid initiation of supportive care for COVID-19 patients could result in better clinical outcomes, including decreased mortality. This report describes the initial implementation of this program in Vermont and changes made to the program in response to challenges encountered.

The results of all SARS-CoV-2-related laboratory testing in Vermont

are reported to the VDH. In turn, the VDH case follow-up team attempts to contact those with SARS-CoV-2 infection by telephone within approximately 24 h of receiving the positive test result. Eligibility criteria for inclusion in the pulse oximetry program were: Vermont resident; laboratory-confirmed SARS-CoV-2 infection (positive PCR assay); and not a resident of or an inpatient in a healthcare facility or an inmate in a correctional facility.

Eligible persons who were able to be contacted were offered enrollment into the pulse oximetry program and, if choosing to enroll, were sent a pulse oximeter (if they did not already have one for monitoring of a pre-existing medical condition, e.g., asthma) along with instructions for use. The following pulse oximeters were utilized by the VDH pulse oximetry program (both U.S. Food and Drug Administration-approved): Jumper model JPD-500E (ages 6 years and older) and Medline model HCSM70P (ages 2–5 years). Persons otherwise eligible for the pulse oximetry program who were under the age of two years were not enrolled due to lack of availability of an outpatient/finger pulse oximeter for this age group. Each person received the recommendation to contact their primary care provider if they experienced shortness of breath or difficulty breathing and/or had an oxygen saturation value of less than 90%. On a daily basis, the list of persons who enrolled into the pulse oximetry program was compiled along with their

* Corresponding author. Infectious Disease Epidemiology, Vermont Department of Health, 108 Cherry Street, Suite 304, Burlington, VT 05401, USA.

E-mail address: jennifer.read@vermont.gov (J.S. Read).

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mailing address and telephone number. VDH staff arranged delivery of the pulse oximeters and instructions. Same-day or overnight delivery was used for each enrollee. Enrolled persons were contacted daily by telephone (by physician or medical student volunteers), email, or text message. All data were reviewed on a daily basis to ascertain if anyone reported an oxygen saturation value less than 90% and/or difficulty breathing or shortness of breath. Any such persons were contacted by telephone to ascertain current symptoms and oxygen saturation values, and to remind the person to contact their primary care provider or the nearest emergency department. Among those offered the pulse oximetry program, those who did or did not accept the program were compared according to characteristics such as age and whether or not underlying medical conditions were present utilizing the Genlin procedure, SPSS version 21. Since this work was undertaken as part of the Vermont Department of Health's public health response to the COVID-19 pandemic, informed consent from individuals whose characteristics are described in this paper was not required.

Of the 3538 persons who tested positive for SARS-CoV-2 by PCR between June 2 and December 2, 2020, 3116 were eligible for the pulse oximetry program and were reached by the case follow-up team (Table 1). Of the 378 ineligible persons, 166 were not Vermont residents, 203 were residents of or inpatients in a healthcare facility, and nine were inmates in a correctional facility. Of the 3116, 3000 (96%) were offered the program. Among those offered the pulse oximetry program, some accepted enrollment into this program and some did not. Acceptance refers to agreement to be enrolled in the program, such that a pulse oximeter with instructions would be sent to the enrolled person and that person would receive daily monitoring (by email, text message, or telephone call). Of the 3116, 599 (19%) agreed to enroll in (accepted) this program. The case follow-up team included over 40 interviewers. The proportion of people interviewed who accepted pulse oximetry ranged from 0 to 100% according to interviewer.

Of the 599 persons with COVID-19 enrolled in the program, most (82%) preferred daily reporting of oxygen saturation values by email or text message, with the rest preferring contact by telephone. Of these 599, 335 (56%) reported at least one oxygen saturation value over the study period (of whom 17 reported oxygen saturation values of less than 90%). All values for these 17 individuals were 85–89% (except one value of 78% in a person who was subsequently hospitalized) and 107 (18%) reported difficulty breathing or shortness of breath. Characteristics of the 17 persons with lower oxygen saturation values are as follows: the age range was 26–70 years (47% over the age of 60 years), 76% were female, 70% had one or more underlying medical conditions, 29% had chronic lung disease, and 29% were current or former smokers. All of these 17 were contacted by telephone to ascertain current symptomatology and oxygen saturation values, and to ensure each was in contact with the primary care provider. These 17 persons had a range of symptoms including: fever, chills, fatigue, headache, sore throat, ageusia and/or anosmia, loss of appetite, nausea, abdominal pain, diarrhea, cough, chest pain, myalgia, wheezing, and dyspnea. One of the 17 was hospitalized: a 26-year-old who initially presented to an emergency department with fatigue, nausea, cough, chest pain, and dyspnea. He received supplemental oxygen and subsequently was hospitalized. None of these 17 people died.

Offering and acceptance of the program varied by characteristics of the person with COVID-19 (Table 1). Among those offered enrollment into the program, the acceptance was significantly lower among those whose preferred language was other than English. When compared to those aged 60 years or more, those less than 18 years old and those in the 18–34 year age category were less likely to accept enrollment into the pulse oximetry program. Conversely, those with underlying medical conditions (including chronic lung, liver, or kidney disease; current or former cigarette smoking; hypertension; cancer; asthma; diabetes mellitus; obesity; and HIV infection) were more likely to accept enrollment into the program.

At this time, the VDH continues to fund the pulse oximetry program.

Table 1

Characteristics of persons with COVID-19 in Vermont who were eligible for the pulse oximetry program, overall and according to offering and acceptance of the program, June 2–December 2, 2020 (N = 3116).

Characteristic	Eligible Persons with COVID-19	Pulse Oximetry Program		P value*
		Offered	Accepted	
	3116	3000 (96%)	599 (19%)	
Time Period				
June–July 2020	371 (12%)	343 (92%)	69 (20%)	reference
August–September 2020	296 (10%)	284 (96%)	54 (19%)	0.73
October–December 2020	2449 (79%)	2358 (96%)	452 (19%)	0.68
In an Outbreak				
Yes	609 (20%)	584 (96%)	117 (20%)	0.55
No	2507 (80%)	2416 (96%)	458 (19%)	reference
Preferred Language				
English	2949 (95%)	2847 (97%)	557 (20%)	reference
Other ^a	167 (5%)	153 (92%)	18 (12%)	0.02
Sex				
Female	1598 (51%)	1539 (96%)	298 (19%)	reference
Male	1518 (49%)	1461 (96%)	277 (19%)	0.78
Race				
White	2479 (80%)	2394 (97%)	465 (19%)	reference
Black or African American	205 (7%)	195 (95%)	31 (16%)	0.23
Asian	153 (5%)	149 (97%)	27 (18%)	0.70
Other or Unknown	279 (9%)	262 (94%)	52 (20%)	0.87
Ethnicity				
Hispanic	62 (2%)	60 (97%)	12 (20%)	0.88
Non-Hispanic	2857 (92%)	2754 (96%)	529 (19%)	reference
Age (years)				
<18	404 (13%)	388 (96%)	25 (6%)	<0.001
18–34	1127 (36%)	1088 (97%)	184 (17%)	0.001
35–59	1050 (34%)	1006 (96%)	241 (24%)	0.94
≥60	535 (17%)	518 (97%)	125 (24%)	reference
Underlying Medical Conditions				
Yes	1431 (46%)	1388 (97%)	319 (23%)	<0.001
No	1685 (54%)	1612 (96%)	256 (16%)	reference
Asymptomatic or Symptomatic				
Asymptomatic	283 (9%)	259 (92%)	38 (15%)	0.06
Symptomatic	2833 (91%)	2741 (97%)	537 (20%)	reference

*P value for comparison of acceptance of the pulse oximetry according to characteristics of persons (among those offered enrollment into the program); Genlin procedure, SPSS version 21.

^a Other languages were Arabic, Bosnian, Burmese, Chinese, French, Hindi, Karen, Kirundi, Lingala, Nepali, Somali, Spanish, Swahili, Tibetan, and Vietnamese.

Interest in the program increased substantially over the first six months of its implementation. Our findings stimulated changes to the implementation of the program, including: 1) additional training was provided to the case follow-up team; 2) a VDH-contracted interpretation service was utilized during telephone interviews with persons who did not speak English; and 3) the pulse oximeter instructions were translated into multiple different languages based on each person's preferred written language.

Multiple hospitals and other health care facilities have begun supplying outpatient pulse oximeters to patients with suspected COVID-19 (i.e., before testing has been performed or, if testing has been performed, before results are available). Provision of pulse oximeters to outpatients at the time of initial evaluation for COVID-19 (and before lab confirmation of SARS-CoV-2 infection) results in patients receiving pulse oximeters much sooner than if lab confirmation of SARS-CoV-2 infection is required first. Whether VDH will continue this program may depend on coverage achieved with hospital programs providing pulse oximeters to ill patients in the emergency department or other outpatient medical facility who are suspected of having COVID-19.

To our knowledge, this is the first description of the implementation of an outpatient pulse oximetry program for COVID-19 by a state or local health department in the U.S. and includes the largest population of COVID-19 patients using outpatient pulse oximetry described to date. A study in Chicago, IL described the experience of 209 persons with suspected (77 actual) COVID-19 [4]. In this study, a resting home oxygen saturation of less than 92% was associated with an increased likelihood of hospitalization, intensive care unit admission, adult respiratory distress syndrome, and septic shock. Another study in Italy enrolled 37 outpatients with suspected or confirmed COVID-19 [5]. This study demonstrated the feasibility of home oxygen saturation monitoring. A study in Cleveland offered a home monitoring program consisting of telephone interviews to persons who either tested positive for SARS-CoV-2 or had symptoms consistent with COVID-19 [6], and compared those enrolled in the program with those who did not. Enrollment in the program was associated with less hospitalization [6]. Previously, relatively low cost and easy to use outpatient (finger) pulse oximeters have been utilized for monitoring people with chronic pulmonary disease [7,8]. The potential utility of self-monitoring of oxygen saturation among COVID-19 persons is being increasingly recognized [9, 10].

Despite having the largest population of COVID-19 patients using outpatient pulse oximetry described to date, one of the limitations of this study is the relatively low enrollment into the program. Although Vermont is a rural state with a small overall population and the total number of laboratory-confirmed cases of SARS-CoV-2 infection during the initial implementation period of this intervention was 3538, only 599 agreed to enroll in the pulse oximetry program. Possible reasons that enrollment was not higher include the purpose of program may not have been completely or accurately conveyed by the contact tracers who interviewed all persons with positive SARS-CoV-2 PCR assays (and a general lack of awareness of the public regarding how and why outpatient pulse oximetry might be useful). Another potential limitation is that we had no control group, and neither were persons testing positive

for SARS-CoV-2 and reported to the Vermont Department of Health randomized to be enrolled or not enrolled into the program. That being said, our objective was to conduct (and describe) a public health program and not a research study.

In conclusion, we have demonstrated the feasibility of implementing a statewide public health program for home monitoring of oxygen saturation values among confirmed COVID-19 patients. Feedback from both patients and health care workers throughout the state has been very positive, and we anticipate the program will remain in place for the foreseeable future.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhip.2021.100186>.

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