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The implementation and evaluation of the Ontario COVID@Home Clinical Primary Care Pathway

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Abstract

Background: The COVID@Home Clinical Care Pathway (the Pathway) was developed and implemented as an evidence-based remote monitoring clinical care pathway for the integrated management of coronavirus disease 2019 (COVID-19) in the province of Ontario, Canada. We examine its effectiveness and rapid large-scale implementation.

Methods: Using a prospective longitudinal study design, we used electronic medical record clinical data, provider and patient surveys, web analytics, healthcare and provincial utilization, and government holdings data to evaluate reach, effectiveness, adoption, implementation, and maintenance outcomes, including patient mortality and health equity.

Results: The Pathway was widely accessed (19 474 Ontario unique users), contributed 28 816 oxygen saturation monitors, and achieved coverage across income levels and geography. Two-thirds of patients had > 1 encounter, monitored for a median of 4 days (Range: 1–57). Fifty percent of patients had > 1 chronic condition. Patients receiving Pathway care were less likely to die by 0.44% (20/4556), two times lower compared to the total mortality of a population-based representative patient cohort over a parallel time period in Ontario of 0.86% (1820/212 326, $P = .0023$). Patients were very satisfied with their care, and felt care was accessible, safe, and clear. Providers were very satisfied with the Pathway resources and reported strengthened relationships across the health system.

Conclusions: Primary care (PC) rapidly implemented a clinical care pathway during the COVID-19 crisis. The Pathway demonstrated the beneficial role and effectiveness of PC when patients are provided with timely, accessible, and comprehensive care. Public health responses should explicitly collaborate with PC to address population health.

Keywords: primary care; implementation; virtual care; COVID-19 pandemic; remote monitoring programs; social determinants of health; patient experience; RE-AIM; population health

Introduction

The benefits of primary care (PC) to patients and their communities are widely recognized as including the triage and management of mild to moderate infectious diseases alongside comorbidities [1–3], and its role in healthcare delivery around the world demonstrating reduced mortality and morbidity, and enhanced equity of care [4]. During the coronavirus disease 2019 (COVID-19) pandemic, PC played a key role in maintaining continuity of care for patients by rapidly providing care by telemedicine and supporting public health measures [5]. However, the unique contribution of PC providers in the community was not cultivated during the pandemic despite primary care in jurisdictions around the world arguing for greater involvement of PC in different aspects of managing the COVID-19 pandemic [6].

During the COVID-19 pandemic, the evidence-to-practice gap in the PC setting was substantial due to a lack of systematic sources of trustworthy evidence or guidance for such care and monitoring, providers' uncertainty around management, non-evidence-based treatment options circulating on social media [7–10]. Innovations were being trialled to manage the waves which were hospital-centred and whose effect was fragmented and inequitable [11–16]. These predominating solutions undermined the role and potential for PC to improve patient health and promote greater health equity during the COVID-19 pandemic through its evidence-based functions for improving population health (access, continuity, comprehensive, coordinated, and person-focussed care) [17, 18]. There was a need for rapid evidence-based solutions grounded in sound science given a second rapidly accelerating

Key messages

- Primary care (PC) optimizes clinical care, population health and health equity.
- Evidence for the mechanisms of PC is well-understood: access, continuity, comprehensiveness.
- PC can rapidly develop and implement clinical care pathways leveraging one or more of these mechanisms to optimize health.
- We describe rapid, widespread and sustained delivery of an evidence-based COVID-19 clinical PC pathway.
- We found beneficial results spanning clinical, health system and population health including equity.
- Public health response to population challenges should leverage PC strengths.

delta variant wave of COVID-19 in 2021 and a third wave anticipated later that year, patients presenting with respiratory and other flu-like symptoms and some patients very rapidly deteriorating requiring hospitalization, and the volume of patients requiring hospitalization and intensive care unit care sometimes exceeding maximum capacity [19–21]. Implementation science is the field of inquiry that supports the study of evidence-based practices and is defined as 'the scientific study of methods to promote the systematic uptake of research findings and other evidence-based practices into routine practice, and, hence, to improve the quality and effectiveness of health services' [22]. To support PC taking on a larger role in COVID-19 care, an evidence-based clinical pathway (https://hfam.ca/clinical-pathways-and-evidence/) for comprehensive longitudinal PC management of COVID-19 patients was developed within the Department of Family Medicine at McMaster University, Hamilton, Ontario (Canada) called the COVID@Home Clinical Care Pathway (herein referred to as the 'Pathway'). The concept was informed by the first authors experience and involvement in HealthPathways in Canterbury, New Zealand [23].

We report on the development, implementation, and effectiveness of the Pathway in response to an emergent health crisis drawing upon an implementation science evaluation framework [24] and the Medical Research Council framework for the development of complex interventions [25].

Three of the authors' (DM, CR, and DP) hypotheses were that a clinical care pathway situated in the PC setting could be rapidly developed and implemented in the face of an emergent new clinical context such as COVID-19. Our second hypothesis was that by enhancing the core functions of PC through the components of the Pathway, there would exist a mechanism to effectively and efficiently care for patients with COVID-19 and other comorbidities, as well as enhance equity of care for this new population health challenge [16].

Initial pathway development and implementation

This clinical pathway was first locally implemented across the city of Hamilton (population of 569 000) and then rapidly scaled up across the province of Ontario, Canada (population of approximately 14 million) [26]. In late 2020, we piloted the Pathway first in one 12-physician clinic (McMaster Family Practice) with resources linked within the electronic medical record (EMR), then scaled to the whole McMaster Family Health Team (around 37 000 rostered patients) including a second local site (Stonechurch Family Health Centre) [27]. Within weeks, we purchased a web domain (hfam.ca) and created a 'living' Pathway with live links. Rapid evidence and resource updates were incorporated as new information emerged, and the Pathway was rolled out to the wider Hamilton and surrounding districts with the support and endorsement of the Hamilton Family Medicine primary care network through their regular and widely attended online pandemic meetings for family physicians. Pulse oximeters were purchased to lend to patients in support of the rollout. Volunteers supported contactless delivery of these where this was not possible via friends and family, and patients returned them to clinics for sanitization and re-loan. Feedback from users was actively sought, and each webpage of the Pathway had a feedback button. The target time for response and adaptations to the Pathway based on new evidence or user experience was 48 h.

The Pathway was rapidly implemented across the province, starting in 2021 with the partnership of Ontario Health. Ontario Health is a government agency that aims to optimize the health care planning and health care delivery for the province [28]. The stepwise scale up served as the basis for the evaluation of patients, providers, and practices (Fig. 1). We describe below the evaluation of the implementation of the Pathway to understand the questions in our original hypotheses: Could a clinical pathway be rapidly developed and implemented in primary care in the face of an emergent new clinical context? Could enhancing the core functions of primary care through the components of the Pathway, provide a mechanism to effectively and efficiently care for patients with COVID-19 and other comorbidities, as well as enhance equity of care for this new population health challenge?

Methods

We used a prospective longitudinal study design to evaluate the Pathway using the Reach, Effectiveness, Adoption, Implementation, Maintenance (RE-AIM) framework [29, 30]. RE-AIM is a widely used framework for planning, adaptation, and evaluation in implementation science. We chose it as it is suitable for multilevel assessment, including organizational/delivery and individual levels. It facilitates different evaluation types, using diverse data sources (e.g. surveys, quantitative data), and is pragmatic in its approach (i.e. all dimensions are considered but not required—the dimensions are well-defined for the individual and/or setting and promotes flexibility in the assessment metrics for the particular program and the data sources available). Additionally, it allows for adaptation to local context which was a core part of the Pathway design and implementation. These considerations and the face validity in mapping onto implementation in the primary care context underpinned our choice of this framework.

In our reporting, we followed STROBE for observational studies [31] and RECORD for routinely collected health data [32].

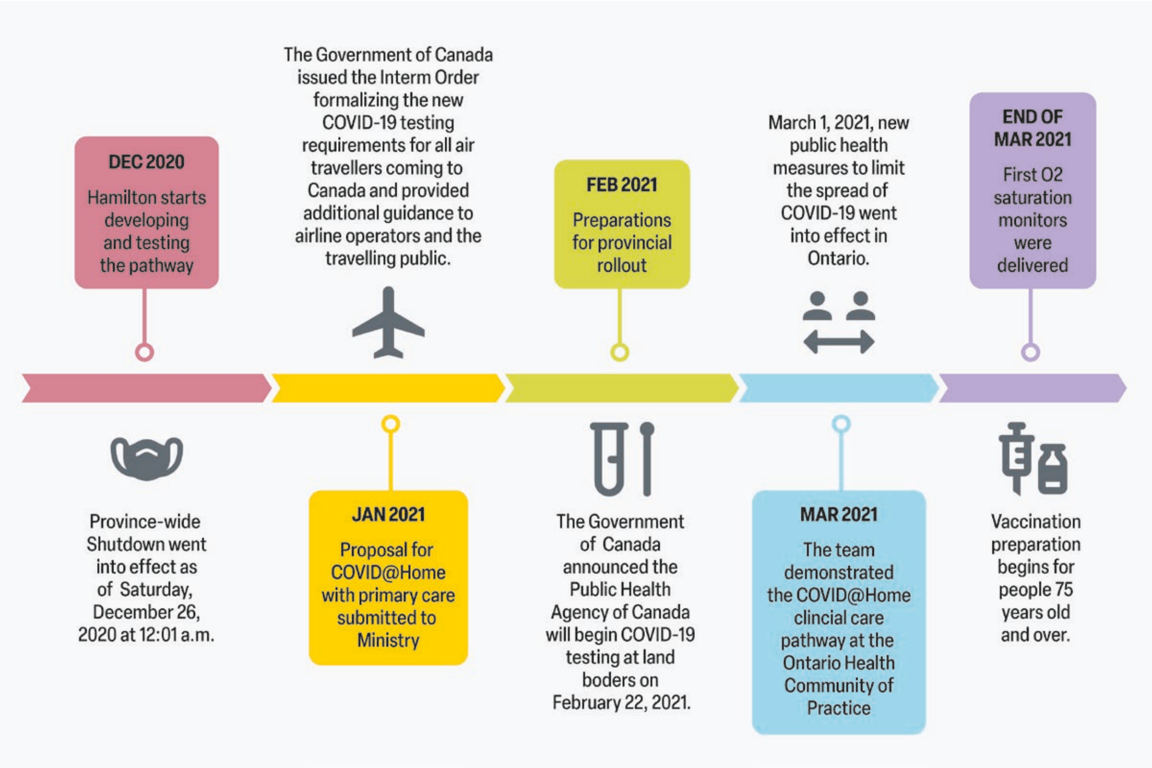

Figure 1. Local implementation and provincial scale up of the pathway.

Pathway description

The six components of the Pathway are outlined in Table 1. The components include an evidence-based clinical care pathway (https://hfam.ca/clinical-pathways-and-evidence/) (see screenshots in Supplementary Appendix 1) published online with open access; remote assessment and monitoring of COVID-19, care of other comorbid conditions, mental health, and psychosocial needs; oxygen saturation monitors distributed to practices across the province by Ontario Health to lend to selected patients during their illness; and patient resources, which were also hyperlinked into a downloadable EMR monitoring template. Implementation involved four main activities for primary care providers: training, initiation, patient risk stratification, and monitoring and management of COVID-19 and relevant comorbid conditions and psychosocial needs. Additional activities of the Pathway and its implementation are described in Supplementary Appendix 2.

Data collection

As shown in Table 2, we developed a multipronged data collection approach to evaluate the Pathway in which study variables and groups (patients, providers, and practices) were mapped onto the RE-AIM framework. Web analytics provided data on unique users of the Pathway website and its resources. All primary care providers from the province of Ontario who undertook to use the Pathway for their patient group could request pulse oximeters from Ontario Health. They all provided data as part of the request on a standard form. A subset of this group of Ontario providers also volunteered to regularly provide patient outcome data, and to later complete a survey. Patients across Ontario were invited to complete a satisfaction survey. Survey data were collected anonymously in REDCap v11.0.3 [33, 34].

We used data from Statistics Canada to create choropleth maps describing the characteristics of patients reached by the Pathway across Ontario. Data sources included the 2016 Census Forward Sortation Area (FSA) boundary shapefile, the 2016 Census Profile including population density and median household income reported at the FSA level, the Ontario Medical Association's Rurality Index of Ontario (RIO) calculator to identify the rurality status of the FSAs, and data from Ontario Health on the number of pulse oximeters distributed and the patient population at primary care practices at the FSA level. FSAs are a geographical boundary defined by the Canada Post Corporation for groups of postal code areas.

A subset of Ontario patients where complete clinical data could be extracted from the EMR formed a complete cohort to examine demographics, comorbidities, clinical outcomes, and psychological needs. The cohort was defined as all (consecutive) COVID-19-positive patients within a practice-based research network (PBRN) of more than 50 000 patients of whom around 37 000 had been seen within the last 2 years (McMaster University Sentinel and Information Collaboration 'MUSIC') between 1 December 2020 and 31 October 2021 [35]. This cohort comprised 659 COVID-19-positive patients and is referred to as the 'PBRN cohort'. The Pathway's EMR form allowed evaluation of detailed clinical care and pathway utilization (Supplementary Appendix 3).

Evaluation outcomes

Each RE-AIM dimension was represented by one or more outcomes which were mapped to a specific evaluative study variable at the patient, provider, and practice level [29, 30] (Table 3, Supplementary Appendix 4). *Reach* was evaluated

Table 1. Six key components of the COVID@Home Clinical Care Pathway.

Pathway feature	Details
1. Information Overview	•An open access, easily accessible web- and evidence-based clinical care pathway (Available from website: https://hfam.ca/clinical-pathways-and-evidence/) that included step-by-step guidance, resources and links.
2. Resources for the assessment and remote monitoring of COVID-19 and related resources	•Guides to conducting remote assessments of COVID-19 including: history, examination, assessing COVID-19 severity, referrals, monitoring and follow up, management, isolation guidelines, management of COVID-19 in the post-acute phases, and paediatric assessment and referral. Related resources in the areas of mental health, sexual assault, social support, long-term care, and palliative care, among others.
3. Patient resources on COVID-19, vaccinations, and related topics	•Information on vaccinations and related topics including mobility and fitness, pain, nutrition, maternal newborn care, and mental wellness and stress management that can be emailed to the patient, or accessed by patients from a patient resources tab on the https://hfam.ca/clinical-pathways-and-evidence/ website.
4. Information updates on the latest evidence	•Updated evidence, resources and links in real-time.
5. Remote patient monitoring form	•A simple, digital monitoring form (EMR monitoring form) for providers to collect information on patient's symptoms, vitals, psychosocial needs, and health advice provided.
6. Remote monitoring equipment	•Equipment required for remote clinical monitoring for reassurance/rapid detection of deterioration, as needed e.g. oxygen monitoring pulse oximeters.

Abbreviation: EMR, electronic medical record.

at the individual level among patients in the PBRN cohort (e.g. patient clinical characteristics), provincially using sociodemographic data (e.g. rural/urban, income), and for individual users of the Pathway using web analytics data. *Effectiveness* was evaluated at the individual level using patient mortality data reported from participating provincial practices and surveys on patient satisfaction and providers' experiences. Detailed information on patients' clinical care (e.g. vitals, medication management), psychosocial needs, and healthcare utilization were examined among patients who comprised the PBRN cohort. *Adoption* was evaluated at the setting and staff level and included the number of providers who used the Pathway and their practice type, and the region of the province where the Pathway was delivered to patients. *Implementation* was evaluated at the staff level and included providers' engagement with the Pathway's implementation strategies (e.g. community of practice webinars, website: https://hfam.ca/clinical-pathways-and-evidence/, ordering and receiving pulse oximeters), objective measures of providers' fidelity to key components of the Pathway, and providers' survey responses on acceptability/feasibility of delivering the Pathway. *Maintenance* was evaluated at the individual level by examining the web use of the Pathway in the 12 months after the evaluation period.

Table 2. Evaluation activities.

Data source	Timeframe
Cohort of consecutive patients using EMR monitoring form data and patient characteristics	1 December 2020 to 31 October 2021 (after Pathway development and piloting in Fall of 2020)
Patients and providers across Ontario and Hamilton city sites using patient outcome report and survey data	1 June 2021 to 31 October 2021 (after the start of provincial scale up of the Pathway)
Pulse oximeter ordering and distribution using Ontario Health data	31 March 2021 to 31 March 2022 (after the start of provincial scale up of the Pathway)
Community of Practice webinars from Ontario Health data	1 March 2021 to 30 September 2021 (throughout provincial scale up of the Pathway)
Web usage with web analytics data	1 March 2021 to present (parallel to the provincial scale up of the Pathway)
Provincial coverage of pulse oximeter distribution using Ontario Health data, Statistics Canada data, and the Ontario Medical Association's Rurality Index of Ontario calculator	31 March 2021 to 31 March 2022 for pulse oximeters, or as indicated by data source (parallel to the provincial scale up of the Pathway)

Data analysis

We performed a descriptive analysis and examined the range of values, extent of missing data, and normality of data. For continuous variables, means with standard deviations (SD) for normally distributed data were calculated, otherwise medians with ranges. For categorical variables, counts and percentages were calculated. Patient mortality was calculated from reports by participating Ontario practices to the evaluation team (# patient deaths/size of practice). Patient mortality as reported in this study was compared to patient mortality as reported in a published study which represented individuals who had a severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) test report for a variant of concern (VOC) (VOC: Alpha, Beta, Gamma, and Delta including VOC not detected) between 7 February and 27 June 2021 and who did not have a record of long-term care residency [36]. We report on percent difference with corresponding 95% confidence intervals (CI) and *P*-value from the Mantel-Haenszel chi-square statistic for a difference in proportions. Spatial analysis was used to report the empirical quartiles of the ratio of distributed pulse oximeters to available primary care population patients at the FSA level, the quintiles of population density (person/km^2) from 2016, and the quintiles of the median household income in Canadian Dollars in 2016 at the FSA level. Rural FSAs were indicated as RIO scores ≥ 40. ArcMap 10.8.1 was used for all spatial analyses and SAS (v 9.4) for descriptive analysis. Definitions, data quality checking, and cleaning processes are described in Supplementary Appendix 5.

Ethical considerations

This study received an ethics waiver from McMaster University's Integrated Research Ethics Board (Hamilton) (5 November 2020) as a quality improvement project.

Results

We report the results below, grouped by each RE-AIM dimension.

Reach

There were 19 474 unique users to the website after the provincial rollout on 1 March 2021 with 90% accessing the clinical care pathway. Figure 2a–c shows Pathway reach across Ontario using pulse oximeter distribution data that included 378/513 FSAs (73.7%), of which 10.9% were in rural Ontario regions (RIO score ≥ 40). Within the identified 41 rural regions of Ontario, 20 (48.8%) were in Northern Ontario, 10 (24.4%) in Western Ontario, 6 (14.6%) in Eastern Ontario, and 5 (12.2%) in Central Ontario. These data also show good reach to patients across the range of urban area types as indicated by population density and income quintiles. In the PBRN cohort, the average age of patients was 37 years (SD: 20.7 years, range 1–101 years), the majority were women (57.1%), 50% of patients had one or more chronic conditions, and 10% of patients had five or more chronic conditions. Risk stratification of patients recorded 22% as high risk and 20% as average risk at the start of monitoring.

Effectiveness

We compared total mortality to a population-based cohort from the Ontario Public Health Case and Contact Management Database, used to study relative mortalities of different variants over a parallel time period in Ontario. Patient mortality reported from 147 primary care practices that implemented the Pathway including 4556 patients across Ontario was 0.44% (20/4556) compared to a mortality of 0.86% (1820/212 326) in the population-based data [36] (P = .0023). This represented a difference of 0.42% (95% CI: 0.22%–0.61%). It should be noted that the population-based cohort excluded long-term care residents and so was well matched to the Ontario primary care patient population which also excluded long-term care.

The PBRN cohort provided some detailed clinical data as shown in Table 4. Of the 119 patients (18.1%) who required and received a pulse oximeter, 19 patients (16.0%) had a record of clinically important abnormal oxygen saturation (O_2 Sat ≤ 93%). Among patients able to record it, 23% of patients had a heart rate > 90 bpm at some point (mean heart rate 82 bpm, SD: 13 bpm). Patient visits mostly comprised consultations on psychological needs including mental health (15.6%), advice on accessing needed supports (14.5%), and financial concerns (12.4%). Provider advice and education focussed on having the illness course explained and education on limiting exertion and breathing positions. Advice given on managing comorbidities and about regular medications were also frequently provided (e.g. medications to pause during dehydrating illness to avoid kidney injury, and management of diabetes, Table 4). Patients spent a median of 4 days (Range: 1–57 days, Fig. 3a) in care from their first visit (healthcare utilization pathway) representing 8.8 days (SD: 5.4) (Range: 0–58 days, Fig. 3b) from their first symptoms (or positive test).

Patient (n = 201) and provider (n = 233) survey results are shown in Table 5. An overall patient satisfaction of 91.8% was achieved which indicated patients were very satisfied or satisfied with their care. All specific metrics of patient satisfaction were also high (Range: 80%–90%): patients strongly agreed or agreed with the evaluative components addressing the functions of primary care (e.g. comprehensive, person-centred, continuity). Providers felt very satisfied with the Pathway and resources and felt implementing the Pathway model of care increased their confidence, enabled them to provide excellent care, and had a positive impact on their relationship with their patients as well as relationships and collaborations across the health system.

Adoption

There were 2200 primary care practices invited to attend an information webinar about the Pathway resulting in 4220 Most Responsible Provider (MRP) clinicians (Family Physicians or Nurse Practitioners) from 1296 unique primary care practices who requested oxygen saturation monitors for their practice and participated in the Pathway across Ontario. Provider survey data (n = 233) from sentinel clinics showed that 83% of providers implemented using team-based care teams (these were not necessarily pre-existing—they involved new and informal teams) while 17% of providers implemented the model in their solo practice.

Implementation

The key implementation strategies of the Pathway included its development as an evidence-based online resource (https://hfam.ca/clinical-pathways-and-evidence/), an open-access format that allowed for widespread uptake and dissemination as an online tool, and training webinars provided (> 14 webinars). Fidelity to the Pathway's key components included 2059 Pathway EMR monitoring visits by providers, and 28 816 oxygen saturation monitors distributed with a median delivery time of 4 days, and high provider satisfaction with procurement processes (> 80%). Local implementation sites (e.g. PBRN) had also acquired and distributed oxygen saturation monitors to their patients, not accounted for in the requests to Ontario Health. Providers agreed that the process of ordering pulse oximeters was straightforward (184/222, 82.9%), the shipment of pulse oximeters was timely and efficient (181/219, 82.6%), and enough pulse oximeters were received (179/220, 81.4%).

Three questions in the survey completed by sentinel providers examined the extent of acceptability/feasibility of the Pathway. The percentage of providers that reported it was very important or important when asked about the importance for patients to be cared for by a primary care team who knows them well was 86.4% (185/214). On a scale of 1 to 10, with higher scores representing more familiarity, 141 providers felt the Pathway was familiar with a median score of 7 (92 missing responses; Range: 1–10). On a scale of 1 to 10, with higher scores representing increased likelihood, 139 providers reported that it was somewhat likely (median score of 5) that the Pathway will become part of routine practice (n = 94 missing responses, Range: 1–10).

Maintenance

Web analytic data for the 12-month use of the hfam website after active implementation and scale up (1 November 2021—31 October 2022) showed 25 395 unique users of the clinical pathway across Ontario during this time. We observed that the web traffic volumes mirrored the shape of pandemic waves.

Table 3. RE-AIM framework mapped to pathway evaluation.

Dimension	Outcomes	Study variable (and scoring)	Data source
Reach	• Patient characteristics • Pathway (hfam.ca) users	• Age, sex/gender, chronic conditions, risk level, socioeconomic factors (rural/urban, income). • # unique users, # resources accessed	• PBRN cohort • Government data • Web analytics
Effectiveness	Patients: • Clinical care/patient outcomes • Monitoring pathway utilization • Satisfaction Providers: • Experiences	• Hypoxia (≤ 93%), heart rate (beats/min), blood pressure (mmHg), respiration rate (breaths/min), # COVID-19 symptoms (e.g. dyspnoea), # consultations for psychosocial needs, # counselling visits on hydration, illness education, and use of medications, patient mortality. • Visit type[1]: # single visits, # remote monitoring visits, utilization duration (days)[1]: a. healthcare: time from first clinical visit to discharge date b. illness duration: time from first sign of illness (symptoms or positive test date) to discharge date. • 8 questions asking about patients experiences of receiving care at home including questions on feeling comfortable, clearly explained care plan, clear instructions on areas of concern, accessible healthcare team, contact from care team, good teamwork between members of care team, connection to services, and overall satisfaction (strongly agree to strongly disagree, and not applicable). • a. 4 questions asking about implementing the Pathway on collaborations between health partners, awareness and understanding of services provided by health partners, relationships with other healthcare providers in the community, and relationships with patients (strongly disagree to strongly agree); b. 5 questions asking about the resources of the Pathway including questions on confidence with managing patients in their homes, ability to provide excellent care, application of evidence-based practices, ability to understand the information, resources were easy to access (strongly disagree to strongly agree).	• EMR form for PBRN cohort • Provincial reporting • EMR form for PBRN cohort • Patient survey • Provider survey
Adoption	• Provider and practice characteristics	• # providers, # practices, practice type.	• Provincial reporting • Provider survey
Implementation	Providers: • Implementation strategies • Fidelity to key Pathway components • Acceptability/feasibility	• a. # community of practice training webinars; b. 3 questions asking about ordering pulse oximeters including questions on process, timing and efficiency of shipment, and whether enough pulse oximeters were received (strongly disagree to strongly agree, and not applicable); c. time to receipt pulse oximeters. • a. EMR form: # times used/patient monitoring visits; b. pulse oximeters use: # pulse oximeters distributed. • 3 questions: a. familiarity of the Pathway (feels very new to feels completely familiar) b. whether it will become part of routine practice (not at all to completely) c. importance of caring for patients by a primary care team that knows them well (not at all important to very important, and not applicable).	• Ontario Health data • EMR form for PBRN cohort • Ontario Health data • Provider survey
Maintenance	• 12-month use of hfam.ca	• # unique users.	• Web analytics

[1]Calculated measure.

Conclusions

We evaluated the implementation and effectiveness of a clinical care pathway for COVID-19 which was embedded in and delivered by primary care across the province. Our results showed that a PC-developed and provincially coordinated model for primary care's engagement in mitigating the COVID-19 crisis was successfully implemented with substantial uptake, wide and ongoing use, and demonstrated clinical and population health benefits in terms of clinical care, patient mortality, and health equity across the province. Implementation of a clinical care pathway integrated within primary care during an emergency was efficient and feasible and supported the widespread delivery of evidence-based, equity-enhancing, comprehensive primary care during COVID-19. These data reinforce evidence supporting the foundations and functions of primary care to address population health endured in a novel disease outbreak.

The innovative Pathway components that were the intended drivers of improved benefits to patients, providers, and the health system through the core functions of primary care including access, continuity, comprehensive, coordinated, and person-focussed care are suggested when compared to other research. Another Canadian primary care group described a smaller family medicine-led remote monitoring program that monitored patients initially seen at an Assessment Centre and involved 616 patients with COVID-19 [14, 37]. There were similarities in terms of patient age, sex, and presence of comorbidities as well as satisfaction and use of oxygen monitors. There were notable differences in patients' length of stay in each program; our Pathway discharged patients 3 days earlier when measured from the first appointment and approximately 9 days after symptoms developed, perhaps owing to slight differences in definition but more importantly, to differences in the remote monitoring model of care. In contrast to the previous study which relied more on video visits [38], the COVID@Home Pathway visits were predominately conducted by phone thereby improving access and continuity of care by lessening patients' need for technology

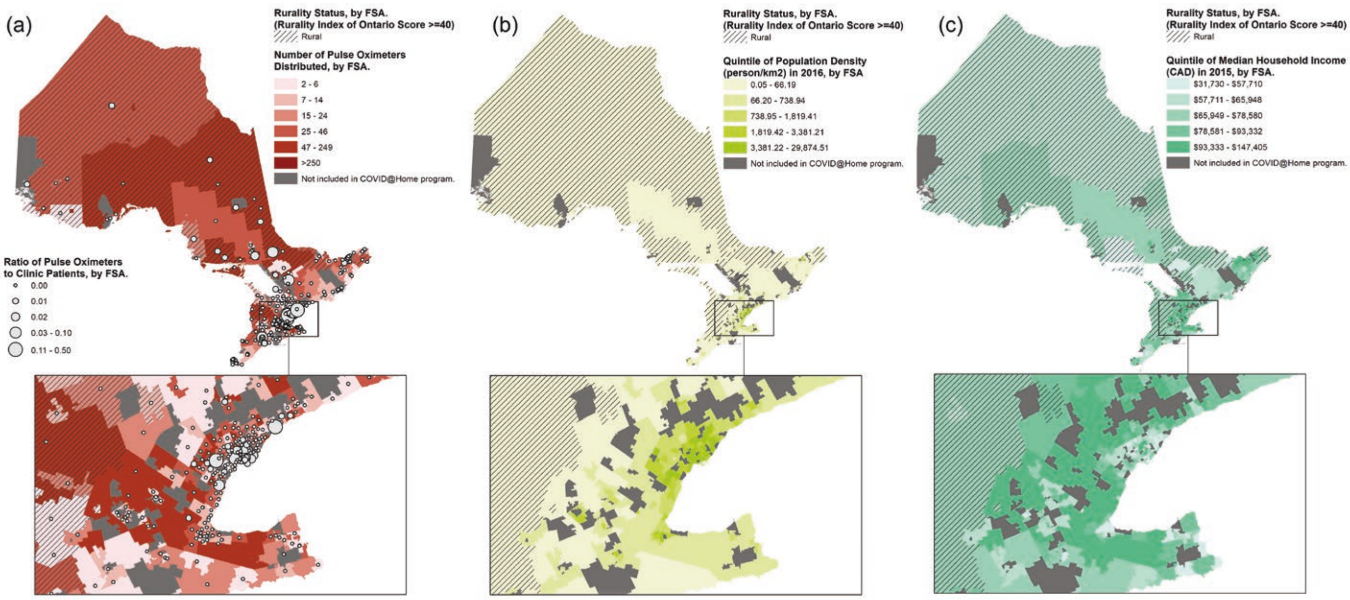

Figure 2. Patient reach of oxygen saturation monitors in Ontario by socioeconomic factors: rurality status, population density, income.

[39]. Additionally, patients who received the COVID@Home Pathway benefited from person-centred, comprehensive care (e.g. COVID-19 and comorbidities) provided within the context of an existing, longitudinal patient-provider relationship as noted in the Effectiveness section and Table 4, whereas in the previous study, approximately 30% of patients were not connected to a primary care provider [37]. In comparison to a provincial cohort study carried out at the same time and excluding long-term care, thereby providing a well-matched comparator [36], our evaluation suggested reduced mortality. While both estimates were less than 1%, if extrapolated to the Ontario population, the primary care Pathway represents thousands more deaths potentially avoided. While there may be biases unaccounted for in this two-group comparison such as age, comorbidities, and vaccination status, the large numbers in each sample allow precise estimates and, the following two factors taken together suggest that the 2-fold difference in mortality is likely an underestimate: firstly, the exclusion of long-term care patients from the mortality estimate in Fisman et al. (2021) [36] would have reduced their patient mortality estimate (e.g. maps onto the primary population eligible), and secondly, the mortality estimate in this work is based on higher risk patients (42% at high or average risk level) with comorbidities (50% vs. 5.1% with one or more comorbidities) which would have likely increased the Pathway's patient mortality estimate. This finding of reduced mortality exemplifies 'continuity' as one of the core functions of the Pathway (e.g. known provider) and postulated mechanism of patient/population benefit, and is consistent with a large population-based study that found a reduced risk of hospital admissions and mortality even with a short patient-provider relationship duration (2–3 years) that was more marked with a > 15-year duration compared to 1 year (e.g. 25% reduced risk of mortality) [40].

Strengths and weaknesses

The impetus for the development of the Pathway was rooted in responding to the emergence of the COVID-19 crisis, the recognition of the foundational role of primary care in the health system to optimize patient clinical care and population health, and the need to engage this early rather than later in any health system challenge of this scale. The Pathway was developed to enable broad reach to patients and providers within the primary care setting during the COVID-19 pandemic and as such, required minimal new infrastructure as it leveraged existing primary care practices and structures. Key strengths of the Pathway's development and implementation include: (i) local practices were supported to tailor and adapt implementation formats to meet their context which included using local practice knowledge and community linkages, (ii) the Pathway itself was implemented as an online, open access, evidence-based clinical care pathway (https://hfam.ca/clinical-pathways-and-evidence/) format and providers were appropriately trained on its use, (iii) the Pathway was developed to be strategically integrated into primary care without the need for referral or additional specialists/consultations for patient management of COVID-19, (iv) development involved early feedback and iterations with local sites, and (v) the provincial authority used their resources to co-ordinate a remarkably rapid widespread implementation and scale up.

The planning of data collection and evaluation of the Pathway was guided by the RE-AIM framework. Given the need for rapid implementation of the Pathway and the immense pandemic-induced clinical load that the health care system and its providers were experiencing at the time, as well as the similarly short time to put evaluation methods in place, we used a pragmatic approach to minimize the burden of data collection methods. As such, our findings are susceptible to individual-level selection biases in regard to providers who volunteered to complete our surveys and patients' motivations to seek care during the pandemic. Our evaluation is mainly based on descriptive analysis, therefore we did not model statistical associations or present adjusted analysis to control for patient-, provider-, or pandemic-related factors. In addition, given the pragmatic nature of the study, we did not set targets for sample size. Using web analytics data to evaluate the Pathway is efficient however these data are unable to discern who was using the Pathway and how the information was being used. Although we implemented the Pathway

Table 4. Patient and clinical care characteristics of the PBRN cohort ($n = 659$)[1].

Characteristics	Mean (SD), %, or n (%)
Reach: patient characteristics	
Ave. age (years)	37.0 (20.7)
% females	57.1
% with 1 + chronic conditions	50.0
% with 5 + chronic conditions	10.0
Risk level	
% low	58.9
% average	19.3
% high	21.9
Effectiveness: patients clinical care	
% hypoxia[2] (≤ 93%)	16.0
% abnormal heart rate[3] (> 90 bpm)	23.1
Ave. heart rate (bpm)[3]	82.0 (13.0)
Ave. diastolic bp (mmHg)[4]	126.1 (17.2)
Ave. systolic bp (mmHg) [4]	79.3 (10.9)
Ave. respiration rate (breaths/min)[5]	16.0 (2.3)
Top COVID-19 symptoms at first visit (per patient)[6]	
Cough	281/554 (50.7%)
Loss of taste/smell	132/529 (25.0%)
GI upset	97/539 (18.0%)
Fever	91/558 (16.3%)
Dyspnea	58/546 (10.6%)
Headache	59/659 (9.0%)
Fatigue	56/659 (8.5%)
Consultations for psychosocial needs (per monitoring visit)[7]	
Mental health	
No	1378 (84.4)
Yes	255 (15.6)
Accessing needed supports	
No	1391 (85.5)
Yes	236 (14.5)
Financial concerns	
No	1402 (87.6)
Yes	199 (12.4)
Access to food	
No	1476 (88.8)
Yes	186 (11.2)
Housing concerns	
No	1442 (89.1)
Yes	177 (10.9)
Access to caregivers	
No	1482 (90.2)
Yes	161 (9.8)
Counselling (# times)[8]	
Illness course	1652
Hydration and comfort medications	72
Education on exertion and breathing	1380
Managing comorbidities	621
Advice given about regular medications	840
Summary of goals documented	556

Abbreviations: GI, gastrointestinal.
[1]$n = 659$ unless specified otherwise.
[2]$n = 119$ patients with pulse oximeter use.
[3]$n = 381$ monitoring visits.
[4]$n = 169$ monitoring visits.
[5]$n = 55$ monitoring visits.
[6]Denominators varies from 529 to 659 (per patient).
[7]Denominators varies from 1601 to 1662 (per monitoring visit).
[8]Based on the EMR form, checkbox only.

widely and it was delivered widely by many practices across the province, our findings may not apply to time periods outside of the pandemic or other contexts. We examined whether the Pathway maximized health equity by assessing its reach across income levels and rural/urban communities for a Canadian province of over 14 million. The evaluation of the Pathway did not include all equity factors (e.g. race, ethnicity, education, occupation) however social and contextual factors related to differential health outcomes and access to care were evaluated including psychosocial needs and chronic conditions. A secondary aim of the Pathway was to reduce unnecessary use of hospital services. While the uptake of this model (presumably) reduced the strain on Ontario hospitals, we did not perform a cost analysis as we did not have and could not reasonably collect adequate data to support this given the contextual pressures described, and because much of the work was completed without funding.

Primary care is an evidence-based mechanism for optimizing clinical care and population health. The nature of and evidence for the particular mechanisms is well documented (access, continuity, comprehensiveness, and person-focus)—the Sandvik paper referenced is just one example and there are many [4, 17, 18]. The model was deliberately developed to leverage these evidence-based mechanisms. It is impossible to tell from the data available which of these was more or less important in the implementation and effects seen, but it seems logical to suppose that these are again the key underlying mechanisms here. Co-design with rapidly responsive iterations to clinician feedback was an important mechanism for engagement as were the multiple knowledge translation activities through known channels (hfam, organizational webinars, and provincial health organizations) [25]. Many jurisdictions around the world argued for a greater involvement of primary care at the outset of the pandemic than occurred, but there has been little, if any, evidence on its role and effectiveness to improve the public's health for a novel infectious disease outbreak such as COVID-19. Our evaluation of the patients and providers who implemented the Pathway in the early more serious wave of the pandemic prior to population vaccination highlights the fundamental value of primary care. There are implications beyond addressing patients' immediate care needs and helping to lessen the adverse individual and health system impacts of the COVID-19 pandemic waves. Our evaluation suggests embedding the model within existing primary care fostered other sustainable health system benefits through strategic design, implementation, and broad integration within primary care, and reported benefits across socioeconomic settings, prevention and management of health problems, and minimizing unnecessary acute or specialist care (e.g. ability for clear and efficient triage and rapidly referring to acute care for patients requiring hospital assessment and treatment). These data show it is fundamental that any holistic treatment, care management, and system-wide quality improvement efforts engage at the outset with primary care, no matter how novel the health challenge. The Pathway model was developed into a similar pathway for chronic obstructive pulmonary disease care on the hfam website, and a contract for a formal organizational model for widespread Health Pathways has been funded. Further research can focus on the key process, context, and content dimensions critical to the sustainability of the model.

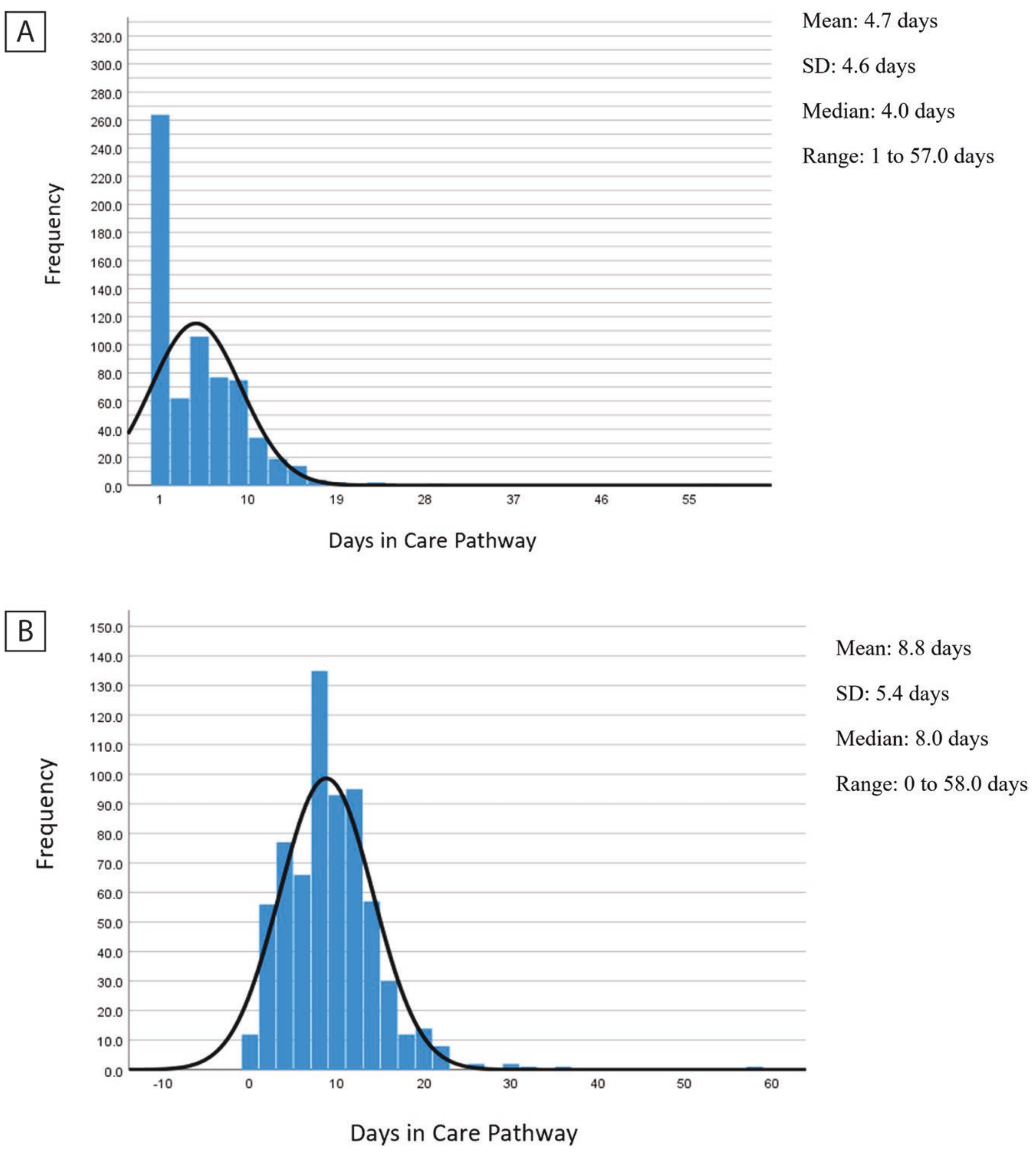

Figure 3. Pathway utilization (n = 662) a. Healthcare utilization b. Illness care pathway.

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Table 5. Evaluation of the pathway by patient (N = 201)[1] and provider surveys (N = 233)[2].

Survey questions[3]	No. responding strongly agree or agree/total no. responses (%)
Patients	
I was comfortable being treated at home	186/200 (93.0)
The plan for my care was clearly explained to me	169/197 (85.8)
I was given clear instructions about what to do if I had concerns	185/200 (92.5)
I was able to get in touch with a member of my health care team when needed	163/200 (81.5)
I received enough contact from my health care team	180/200 (90.0)
There was good teamwork between members of my healthcare team	162/199 (81.4)
I was connected to all the services I needed to recover safely at home	165/199 (82.9)
Overall, how satisfied were you with the care you received at home[4]	180/196 (91.8)
Providers	
The resources increased my confidence with managing COVID patients in their homes	130/146 (89.0)
The resources enabled me to provide excellent primary care to COVID patients in their homes	114/144 (79.2)
The resources allowed me to apply the best available evidence to my practice	121/145 (83.4)
I was able to understand the information contained with the resources	132/145 (91.0)
The resources were easy to access (Ontario providers only)	109/135 (80.7)
Implementing the Pathway improved collaboration between health partners	120/230 (52.2)
Implementing the Pathway increased my awareness and understanding about services provided by health partners	134/229 (58.5)
Implementing the Pathway strengthened my relationships with other healthcare providers in my community	106/228 (46.5)
Caring for patients in their home has helped strengthen the provider-patient relationship	192/224 (85.7)

[1]Number of incomplete survey questions for patients ranged from 1 to 4.
[2]Number of incomplete surveys for providers ranged from 87 to 89 for questions on resources and ranged from 3 to 9 for questions on sustainability of relationships.
[3]Responses to the survey questions were recorded on 5-point Likert scale.
[4]Proportion indicates survey respondents who were 'very satisfied' or 'satisfied'.

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Supplementary data

Supplementary data is available at *Family Practice* online.

Conflict of interest

None declared.

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Data availability

All data are incorporated into the article and its online supplementary material. The data underlying this article are available in the article and in its online supplementary material.

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