

Cardiovascular Disease Risk Management During COVID-19: In-Person vs Virtual Visits

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Management of cardiovascular disease (CVD) risk (ie, risk of having an event such as heart attack or stroke) is a common focus of primary care. In response to the COVID-19 pandemic's onset, many primary care practices began offering telephone and video visits, a care delivery mode called synchronous virtual care (VC).¹⁻⁵ This spike in primary care visits delivered virtually⁶⁻⁸ provided an opportunity to examine whether CVD risk management delivered in this manner yields different outcomes than care delivered in person. This is important because although VC rates have declined since their peak, VC continues to be a common care delivery mode.⁹

Results of prior studies indicated that VC may be associated with management of CVD risk factors (eg, blood pressure [BP], hemoglobin A_{1c} [HbA_{1c}]) similar to in-person care.¹⁰⁻¹⁵ However, we know of no prior evidence on overall CVD risk management associated with VC in primary care settings serving socioeconomically vulnerable populations, such as community-based safety net clinics.¹⁶ Understanding the relationship between VC and CVD risk management is important in these settings, as community clinics' low-income, medically/socially complex patients have high rates of unmanaged CVD risk^{17,18} and transportation-related barriers to accessing care.¹⁹ We examined change over time in CVD risk management when patients received care in person vs through VC in the 2 years post pandemic onset (March 2020 to February 2022) and compared with the year before the pandemic (March 2019 to February 2020).

METHODS

OCHIN, the study setting, is a national network of primary care safety net clinics; its members (96 community clinic organizations running 493 clinic sites in 14 states as of September 2018) share a centrally managed instance of the Epic electronic health record (EHR). Shortly after the pandemic's onset, OCHIN members' VC capabilities were expanded to include embedded/facilitated VC functionality within the EHR, including video and telephone options; a rapidly increased number of patients received care via these modalities.²⁰

ABSTRACT

OBJECTIVES: Limited research has assessed how virtual care (VC) affects cardiovascular disease (CVD) risk management, especially in community clinic settings. This study assessed change in community clinic patients' CVD risk management during the COVID-19 pandemic and CVD risk factor control among patients who had primarily in-person or primarily VC visits.

STUDY DESIGN: Retrospective interrupted time-series analysis.

METHODS: Data came from an electronic health record shared by 52 community clinics for index (March 1, 2019, to February 29, 2020) and follow-up (July 1, 2020, to February 28, 2022) periods. Analyses compared follow-up period changes in slope and level of population monthly means of 10-year reversible CVD risk score, blood pressure (BP), and hemoglobin A_{1c} (HbA_{1c}) among patients whose completed follow-up period visits were primarily in person vs primarily VC. Propensity score weighting minimized confounding.

RESULTS: There were 10,028 in-person and 6593 VC patients in CVD risk analyses, 9874 in-person and 5390 VC patients in BP analyses, and 8221 in-person and 4937 VC patients in HbA_{1c} analyses. The VC group was more commonly younger, female, White, and urban. Mean reversible CVD risk, mean systolic BP, and percentage of BP measurements that were 140/90 mm Hg or higher increased significantly from index to follow-up periods in both groups. Rate of change between these periods was the same for all outcomes in both groups, regardless of care modality.

CONCLUSIONS: Among community clinic patients with CVD risk, receiving a majority of care in person vs a majority of care via VC was not significantly associated with longitudinal trends in reversible CVD risk score or key CVD risk factors.

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TAKEAWAY POINTS

Among primary care community clinic patients with high cardiovascular disease (CVD) risk, in the period following the onset of the COVID-19 pandemic, receipt of mostly in-person vs mostly virtual care was not associated with rate of change in CVD risk or CVD risk factor management. No significant difference in these measures over time was associated with mode of care. Furthermore, mean CVD risk was lower at the end of the study period than projected based on prepandemic trends, regardless of care mode. This indicates that virtual and in-person care can yield similar outcomes when managing CVD risk among low-income patients.

- ▶ Results add knowledge by focusing on virtual care for community clinic patients, whose rates of CVD and uncontrolled risk factors are high and for whom a virtual care option might mitigate common access barriers (eg, transportation insecurity).
- ▶ Results indicate the importance of reimbursing safety net clinics for providing virtual care and of policies that expand equitable access to virtual care.
- ▶ More research is needed on the optimal ratio of in-person to virtual visits for CVD risk management and other health elements managed in primary care settings and on the circumstances in which CVD risk management via virtual care is most and least effective.

In 2018, the CV Wizard clinical decision support system was activated in 70 OCHIN clinics for a trial of its effectiveness; the analyses presented here used data from these clinics.²¹⁻²³ CV Wizard's algorithms process EHR data to generate a 10-year reversible CVD risk estimate (hereafter called CVD risk) and evidence-based care recommendations for patients meeting specific risk criteria (ie, aged 40-75 years with [1] a > 10% risk of a CV event in the next 10 years attributable to uncontrolled CVD risk factors, [2] diabetes and ≥ 1 uncontrolled CVD risk factor, or [3] CVD and ≥ 1 uncontrolled CVD risk factor).²³ Study data on CVD risk score came from CV Wizard. All other data were extracted from the parent trial clinics' EHR and made research ready by the Accelerating Data Value Across a National Community Health Center clinical research network of PCORnet.²⁴

Clinical outcomes related to CVD risk were examined: CVD risk, systolic BP (SBP), diastolic BP (DBP), and HbA_{1c}. Analyses compared change in these outcomes during a prepandemic index period (March 2019 to February 2020) and a follow-up period (July 2020 to February 2022). March 2020 through June 2020 was considered a washout period during which the study's clinics established VC capacity and CV Wizard was set up for use in VC.

The analysis population included patients with at least 1 index period primary care visit at 1 of the 70 study clinics at which they met CV Wizard's risk criteria and at least 1 primary care visit in the follow-up period. For BP and HbA_{1c} analyses, at least 1 relevant measurement in the index and follow-up periods was also required. BP data could be self-reported during VC or collected during in-person visits. HbA_{1c} data came from a laboratory test for which results were received in the patient's EHR from a clinic or external laboratory. Blood draws for HbA_{1c} (unassociated with an ambulatory visit) were not counted as in-person visits. Clinics with less than 10% of visits coded as VC in the follow-up period were excluded, as was another clinic at which key outcomes of interest were rarely recorded during the follow-up period. Patients who died during the study period were excluded. For each outcome, population-level monthly means were calculated for the index (12 time points) and follow-up (20 time points) periods.

The independent variable was created by categorizing patients based on how many primary care visits in the follow-up period were in person vs VC: (1) the majority of visits (> 50%) were in person or evenly split between in person and VC (in-person group) or (2) the majority were VC (VC group). Analyses compared these groups regarding how index period trends in the monthly mean outcome measures changed in the follow-up period.

Interrupted time-series analysis was used to account for index period trends when assessing VC impacts on follow-up period outcomes. To evaluate the presence of immediate or long-term impacts, models included both a level term and a slope-change term. Models used multilevel segmented regression. A random effect for

clinic was included to account for clinic-level clustering. Monthly mean data over time were plotted to assess trends visually and to assess nonstationarity and seasonality. Although some seasonality was apparent in the CVD risk and BP outcomes, these effects were minimal, and Durbin-Watson statistics^{25,26} were nonsignificant at 6- and 12-month lags. These statistics and autocorrelation and partial autocorrelation function plots determined the nature of autocorrelation; because strong serial autocorrelation was indicated, a first-order autoregressive structure was added to the model. A log transformation was applied to eliminate skew in outcome variables. Both improved model fit.

Inverse propensity score weighting was used to minimize potential confounding caused by index period differences between comparison groups. Weighting was based on patient age, race/ethnicity, gender, language, number of index period clinic visits, federal poverty level, most common payer across visits, and level of rurality of patient residence (determined using zip codes linked to US Department of Agriculture Economic Research Service Rural-Urban Commuting Area codes and assigned using University of Washington Rural Research Health Center–recommended categories). To create the propensity score, these variables were put into a logistic regression model with the VC/in-person category as the dependent variable. Stabilized inverse propensity score weights were used to reduce type I errors. After applying the weights, there was less than 10% absolute standardized difference between the groups in all covariates, indicating good balance.²⁷

We also assessed COVID-19 status during the follow-up period in the comparison groups. **eAppendix Table 1** (eAppendix available at ajmc.com) lists the diagnostic codes used for this purpose.

RESULTS

Patients from 52 clinics were included; 957 patients (0.5% of initial population) died during the study period and were excluded. CVD risk analyses included 10,028 (60.3%) in-person and 6593 (39.7%)

VC patients, BP analyses included 9874 (64.7%) in-person and 5390 (35.3%) VC patients, and HbA_{1c} analyses included 8221 (62.5%) in-person and 4937 (37.5%) VC patients. Characteristics of the CVD risk analysis population are in **Table 1**, including distribution of visits that were VC vs in person; those of the BP and HbA_{1c} subsets are in **Appendix Tables 2** and **3**. A higher percentage of the VC group patients were female and White compared with the in-person group. A higher percentage of the VC group visits were by urban residents and were paid by Medicaid. As noted, methods were used to minimize confounding that this might cause.

Table 2 displays unadjusted outcome measures for both comparison groups. In the index period, mean CVD risk and BP were higher in the in-person group than the VC group, mean HbA_{1c} level was higher in the VC group, the proportion of measurements at which CVD risk was elevated was not different between the groups, rate of uncontrolled BP was higher in the in-person group, and rate of measurements with uncontrolled HbA_{1c} was higher in the VC group. In most cases, these differences were significant but small. Table 2 also shows the unadjusted changes in outcomes between the index and follow-up periods. After propensity score weighting, the parameter in the regression model representing the difference in index period intercept between groups was not significant.

These results also show the unadjusted overall changes in CVD risk between the index and follow-up periods. Mean CVD risk score increased in both groups (in person: 9.2 to 10.6; VC: 9.0 to 10.1) as did proportion of measurements with more than 10% risk (from 34.9% to 37.8% and from 34.5% to 38.4%, respectively). Mean SBP increased in both groups (from 131.2 to 133.2 mm Hg and from 129.6 to 131.0 mm Hg, respectively), mean DBP was static in both groups, and the proportion of BP measurements 140/90 mm Hg or higher increased in both groups (from 30.9% to 34.0% and from 28.0% to 30.3%, respectively; these differences were significant at $P < .0001$). In both groups, mean HbA_{1c} level was static.

The in-person group had a significant upward index period trend in CVD risk ($P = .004$) with no significant change for other outcome measures ($P = .51$ for SBP, $P = .46$ for DBP, and $P = .91$ for HbA_{1c}). Between the end of the index period

TABLE 1. Patient Characteristics of the CVD Risk Change Analysis Population

Characteristics	In-person group ^a		VC group ^b		Difference <i>P</i> (χ^2 or <i>t</i> test)
Patient characteristics: index period					
Total, n (%)	10,028	60.3	6593	39.7	
Age in years at study start, mean (SD)	57.62	8.86	56.41	8.73	< .0001
Sex, n (%)					
Female	5066	50.5	3640	55.2	< .0001
Male	4962	49.5	2953	44.8	
Race, n (%)					
Asian	379	3.8	235	3.6	< .0001
Black	1981	19.8	653	9.9	
White	6615	66.0	4901	74.3	
Other	263	2.6	217	3.3	
Unknown	790	7.9	587	8.9	
Ethnicity, n (%)					
Hispanic	3269	32.6	2307	35.0	< .0001
Non-Hispanic	6759	67.4	4286	65.0	
Primary language, n (%)					
English	6501	64.8	4378	66.4	.0004
Spanish	2798	27.9	1837	27.9	
Other	729	7.3	378	5.7	
FPL, n (%)					
Majority of visits < 138% FPL	6456	64.4	4252	64.5	.7478
Majority of visits ≥ 138% FPL	2339	23.3	1555	23.6	
All visits missing FPL	1233	12.3	786	11.9	
Had COVID-19 diagnosis in follow-up period	1020	10.2	818	12.4	< .0001
Visit characteristics					
Visits in index period, mean (SD)					
Number of total visits	5.40	4.84	6.03	5.21	< .0001
In-person primary care	4.38	3.42	4.78	3.62	< .0001
VC primary care	1.33	0.78	1.60	1.17	.0002
Visits in follow-up period, mean (SD)					
Total visits	7.71	6.91	10.47	8.82	< .0001
In-person primary care	4.57	3.98	2.97	2.28	< .0001
VC primary care	2.51	2.05	6.20	5.00	< .0001
Distribution of encounter modality, n (%)					
0% (no VC encounters)	2596	25.9	0	0.0	N/A
0.01% to < 25% VC encounters	1419	14.2	0	0.0	
25% to < 35% VC encounters	2114	21.1	0	0.0	
35% to < 50% VC encounters	1601	16.0	0	0.0	
50% to < 65% VC encounters	2298	22.9	1738	26.4	
65% to < 75% VC encounters	0	0.0	1514	23.0	
75% to < 85% VC encounters	0	0.0	1403	21.3	
85% to < 95% VC encounters	0	0.0	485	7.4	
95%-100% VC encounters	0	0.0	1453	22.0	

(continued)

TABLE 1. (Continued) Patient Characteristics of the CVD Risk Change Analysis Population

Characteristics	In-person group ^a		VC group ^b		Difference P (χ^2 or t test)
Both time periods					
Total visits, n (%)	146,818	54.3	123,626	45.7	
Payer, n (%)					< .0001
Medicaid	43,867	29.9	49,684	40.2	
Medicare	57,835	39.4	43,595	35.3	
Private	19,426	13.2	10,080	8.2	
Uninsured	21,482	14.6	15,733	12.7	
Other	4208	2.9	4534	3.7	
Rurality (patient's residence), n (%)					< .0001
Urban	85,411	58.2	97,418	78.8	
Large rural	39,082	26.6	23,046	18.6	
Small rural	22,325	15.2	3162	2.6	

CVD, cardiovascular disease; FPL, federal poverty level; N/A, not applicable; VC, virtual care.

^aMajority or equally in-person visits.

^bMajority VC visits.

and the start of the follow-up period (ie, the washout period), there was a 2.2% ($P = .006$) increase in this group's mean SBP and a 3.4% ($P = .04$) decrease in mean HbA_{1c}. Neither mean CVD risk nor mean DBP changed.

Differences in change in the outcomes of interest between the comparison groups during the washout period are relevant to understanding follow-up period results (Figures 1, 2, and 3). During the washout period, change in CVD risk, SBP, and DBP was not significantly different between comparison groups. HbA_{1c} level increased 5.2% more in the VC group than the in-person group ($P = .04$).

The difference in slope of change over time between the prepandemic onset index period and the post-pandemic onset follow-up period was the same between groups for all outcomes, with no significant difference in longer-term impact.

Mean CVD risk increased for both groups in the index period but leveled off for the in-person group during follow-up, whereas the VC group mean decreased slightly but not significantly (Figure 1). The counterfactual dashed lines show that both groups had lower mean CVD risk at the end of the study period than that projected based on index period trends. Mean HbA_{1c} was stable for both groups in the index period, with no significant change in the follow-up period (Figure 2). For BP (Figure 3), little change was seen in the index period; during follow-up, the mean SBP of the in-person group increased initially but then flattened, whereas the VC group's mean SBP dropped slightly and continued a modest upward trajectory, ultimately ending below the predicted counterfactual. For DBP, both groups trended downward in the follow-up period.

DISCUSSION

Among community clinic patients, mean CVD risk and SBP increased slightly following the pandemic's onset, which aligns with findings

of prior research.²⁸⁻³² Pandemic-related drivers of risk include patients having difficulty maintaining CVD risk reduction behaviors.¹ The fact that SBP naturally increases with age³³ likely explains some of the higher SBP over time observed here and some of the CVD risk increase.

The increased CVD risk and SBP in the first few months post pandemic onset gradually corrected after some time; DBP and HbA_{1c} followed similar patterns. Because DBP increases into one's 50s and declines thereafter, given the age distribution of this population, we would expect DBP to be flat or slightly decrease over time.³⁴ That these measures improved more than expected based on prepandemic trends might reflect a post-pandemic onset correction to care over time in the study clinics.³⁵

The rates of increase of mean CVD risk and SBP were not significantly different between comparison groups, suggesting that in these circumstances, CVD risk management was of similar quality regardless of care delivery mode. It is possible that VC visits were used selectively to tailor care to patients' needs and/or used more often for quick assessment/follow-up and to increase care accessibility and that in-person visits were used more often when in-depth physical assessment and more specialized treatment were needed.

These findings align with prior research showing that CVD risk management through VC yields outcomes similar to those associated with in-person visits,³⁶ although little prior research involved community clinic populations.^{10,12,14,37-40} Results from one study found that VC was associated with worse BP control but not among patients with 1 or more recorded BP measurements, perhaps reflecting poor documentation rather than inferior BP control.¹⁵ Synchronous VC has also been associated with outcomes similar to those from in-person care for hospitalizations and emergency department visits among patients with heart failure, but this evidence is limited⁴¹ and results vary.⁴² Research is needed to better understand the circumstances in which CVD risk management via VC is most effective. For example, VC visits may be more effective when patients have an established relationship with a provider and less ideal for new patient visits.

These results add knowledge by focusing on community clinic patients, whose rates of CVD and uncontrolled risk factors are higher than those of the general population.⁴³ The finding that CVD risk management was as effective when delivered mostly via VC vs mostly in person holds particular promise for community clinic patients, as a VC option for care receipt might mitigate some access barriers for these patients (eg, transportation insecurity) without affecting care quality.⁴⁴ Transportation insecurity negatively affects health care access and outcomes, especially among individuals with lower income and those with chronic conditions.⁴⁵ However, VC also has the potential to increase disparities in access and health outcomes because individuals without the resources needed to engage in VC

(eg, broadband internet) may not benefit from VC equitably.⁴⁶⁻⁵⁴ Policies related to VC should ensure that its potential benefits are distributed equitably; this may involve expanding access to high-speed internet and other resources needed to use such technologies.

Limitations

Analysis results can be generalized only to community clinic patients who accessed care during the periods prior to and after the pandemic's onset. The differences between comparison groups at the start of the follow-up period warrant consideration because the groups were defined by the visits they had during that period, which could have been influenced by their CVD risk management status or practice decisions about when to use in-person or VC visits. Propensity score weighting addressed these differences, but contextual reasons why patients received VC vs in-person care may still have influenced mode of care.

In sum, the in-person group had somewhat higher mean CVD risk and SBP levels at the start of follow-up than the VC group and somewhat lower HbA_{1c} levels. This might have influenced care received in the follow-up period if clinics emphasized seeing patients in person based on their most recent BP. Yet the mean number of total visits in the follow-up period was higher in the VC group, indicating more points of engagement with the clinic. The interrupted time-series analysis with inverse propensity score weighting is intended to mitigate such potential bias because the in-person group was well balanced with the VC group on outcome variables, as seen through the model output and patient characteristics, through weighting. Furthermore, it was not feasible to assess whether CVD risk management was a focus of these visits. This is a minor limitation, as all included patients had high risk of CVD, and CVD risk management is often discussed in community clinics regardless of the main purpose of the visit.

Analyses were limited to clinics that had previously volunteered for a study on CVD risk management, with the potential that this received particular emphasis in these clinics. However, CVD risk management is of importance to all primary care community clinics because of its health impacts and because management of specific CVD risk factors is a reported quality metric. These analyses also excluded clinics with low VC provision rates, which may differ from those willing and able to implement this change. Analyses

also excluded patients who died during follow-up. Results may not be generalizable to the sickest patients.

Comparison group categories reflect whether the majority of a given patient's visits were in person or VC; results do not reflect the impact of receiving all care virtually. However, these categories reflect real-world practice, where a combination of care modes is likely. Research is needed to assess whether specific proportions of in-person to VC visits optimize outcomes and whether there is a threshold of proportion of VC visits below which care outcomes are less optimized. Furthermore, we were unable to distinguish between different virtual care modalities (eg, video or telephone)

TABLE 2. Analysis Outcomes by Study Period in Each Analysis Population

Outcomes	In-person group ^a		VC group ^b		Difference P (χ ² or t test)
CVD risk change					
n	109,027		91,988		
CVD 10-year risk score as %, mean (SD)					
Index period	9.19	10.14	8.99	10.08	.0130
Follow-up period	10.57	12.36	10.12	11.09	< .0001
CVD risk score > 10%, n (%)					
Proportion > 10% in index period	13,318	34.9	9682	34.5	.3320
Proportion > 10% in follow-up period	24,800	37.8	23,142	38.4	.0247
BP change					
n	97,302		50,480		
Systolic BP, mean (SD)					
Index period	131.20	18.70	129.60	18.65	< .0001
Follow-up period	133.20	19.33	131.00	19.28	< .0001
Diastolic BP, mean (SD)					
Index period	76.42	10.71	75.87	10.83	< .0001
Follow-up period	76.46	10.88	75.76	10.90	< .0001
Uncontrolled BP, n (%)					
Measured BP ≥ 140/90 mm Hg in index period	13,987	30.9	8071	28.0	< .0001
Measured BP ≥ 140/90 mm Hg in follow-up period	15,909	34.0	5757	30.3	< .0001
HbA_{1c} change					
n	43,885		25,699		
HbA _{1c} ^c mean (SD)					
Index period	8.00	2.01	8.21	2.07	< .0001
Follow-up period	8.01	1.99	8.23	2.00	< .0001
Uncontrolled HbA _{1c} , n (%)					
Measurements with HbA _{1c} ≥ 8% in index period	6607	37.9	4648	43.9	< .0001
Measurements with HbA _{1c} ≥ 8% in follow-up period	9158	38.9	6094	45.5	< .0001

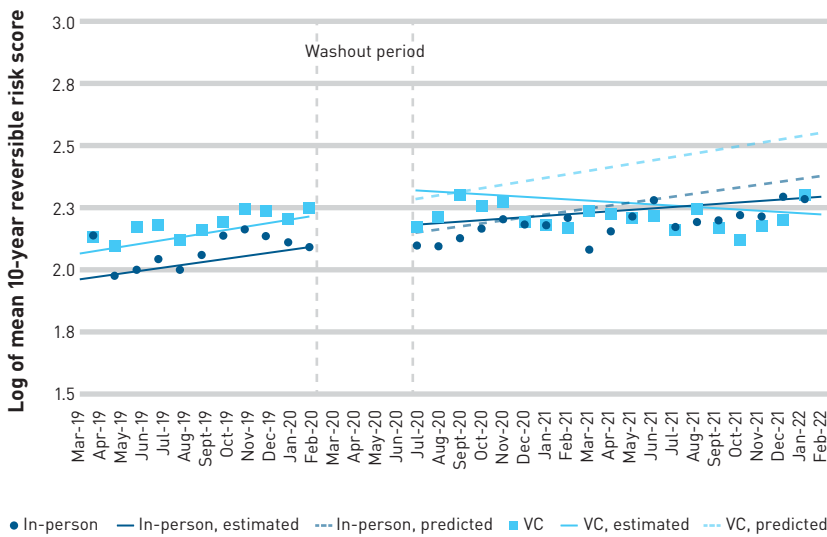
BP, blood pressure; CVD, cardiovascular disease; HbA_{1c}, hemoglobin A_{1c}; VC, virtual care.

^aMajority or equally in-person visits.

^bMajority VC visits.

^cMeans for HbA_{1c} are calculated after excluding 584 additional measurements for which the value was only given as above or below a certain number; these were retained for use in categorical analyses but excluded from continuous analyses.

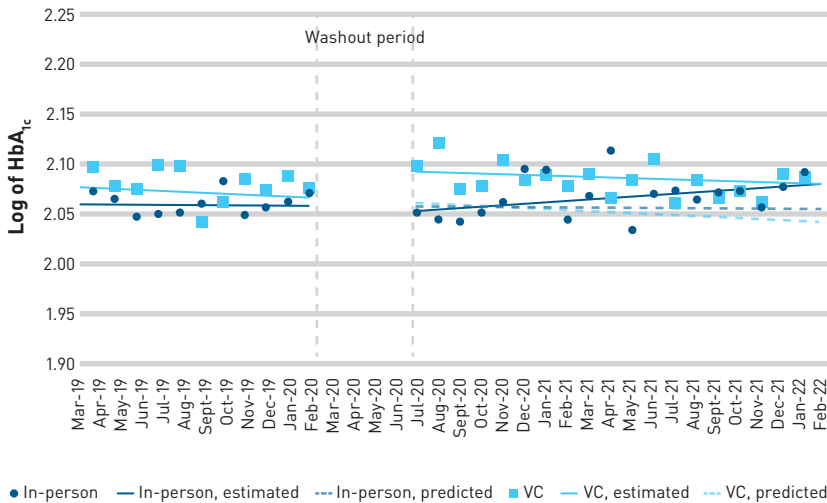
FIGURE 1. CVD Risk^a



CVD, cardiovascular disease; VC, virtual care.

^aMonthly means of 10-year CVD reversible risk score by VC usage, March 2019 to February 2022, with modeled output from interrupted time series segmented regression overlaid.

FIGURE 2. HbA_{1c}^a



HbA_{1c}, hemoglobin A_{1c}; VC, virtual care.

^aMonthly means of HbA_{1c} by VC usage, March 2019 to February 2022, with modeled output from interrupted time series segmented regression overlaid.

because modality is not well documented or easily determined using EHR data.

Results relating to BP were likely affected by practices beginning to document BP from patient-reported measures in the postpandemic period. Home-based measures are known to trend lower than those taken at in-person visits.⁵⁵ Postpandemic BP trends in both groups should be interpreted noting that they differed categorically from the pre-pandemic onset trends. It is also possible that BP measures in VC visits are lower than those taken in the office setting due to preferential patient reporting of lower BP measures.

Although just 10% to 14% of the analysis populations had a COVID-19 diagnosis in the follow-up period, it was statistically more likely in the VC group. In sensitivity analyses excluding persons who received a diagnosis of COVID-19 during follow-up, results were not meaningfully different than those in the original models; details are available upon request.

All follow-up period data came from the first 2 years post pandemic onset, a period in which primary care provision was substantially disrupted. Therefore, results do not indicate the comparability of in-person care vs VC in a more typical period. Nevertheless, this period of rapid change in care delivery provides an opportunity for initial assessments of CVD risk management outcomes in VC. Our team's companion article published in this issue assesses the quality of CVD preventive care at in-person vs VC visits in the same population analyzed here, which will illuminate this potential; further research is needed to understand these patterns.

CONCLUSIONS

In the 2 years post pandemic onset among community clinic patients with high risk of CVD, having a majority of visits via VC was associated with CVD risk management outcomes that did not differ from having a majority of visits in person. This supports reimbursing safety net clinics for providing VC as part of increasing care accessibility and policies designed to expand equitable access to VC. Research is needed on the optimal ratio of in-person to VC visits in terms of CVD risk management and other health elements in primary care settings. ■

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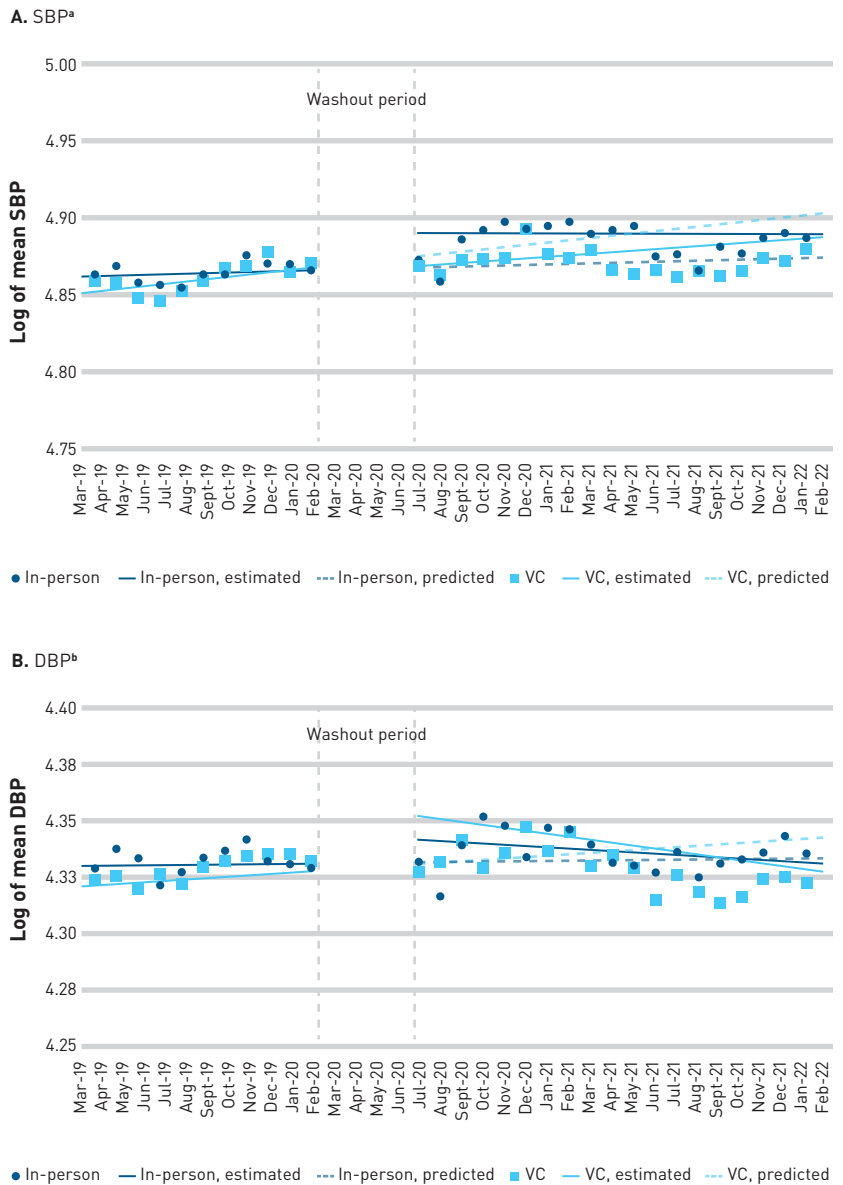
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FIGURE 3. BP



BP, blood pressure; DBP, diastolic BP; SBP, systolic BP; VC, virtual care.

*Monthly means of SBP by VC usage, March 2019 to February 2022, with modeled output from interrupted time series segmented regression overlaid.

*Monthly means of DBP by VC usage, March 2019 to February 2022, with modeled output from interrupted time series segmented regression overlaid.

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eAppendix Table 1. Diagnostic Codes Used to Identify COVID Occurrence in the Follow-Up Period

Code	Code description
J12.82	Pneumonia due to coronavirus disease 2019
U00	COVID-19
U07.1	COVID-19
U09	Post COVID-19 condition
U09.9	Post COVID-19 condition, unspecified
U49	COVID-19
U50	COVID-19
U85	COVID-19
Z86.16	Personal history of COVID-19
Z86.19	Personal history of other infectious and parasitic diseases
U07.2	COVID-19, virus not identified (clinically diagnosed)

eAppendix Table 2. BP Change Analysis Population

	Majority or equally in-person visits (in-person group)		Majority VC visits (VC group)		Difference p-value (chi-sq / t-test)
	N	%	N	%	
Patient characteristics					
Total	9,874	64.7	5,390	35.3	
Age at study start (mean, sd)	57.64	8.85	56.40	8.73	<.0001
Sex					<.0001
Female	5,003	50.7	3,051	56.6	
Male	4,871	49.3	2,339	43.4	
Race					<.0001
Asian	372	3.8	198	3.7	
Black	1,969	19.9	549	10.2	
White	6,494	65.8	3,964	73.5	
Other	257	2.6	167	3.1	
Unknown	782	7.9	512	9.5	
Ethnicity					<.0001
Hispanic	3,223	32.6	1,957	36.3	
Non-Hispanic	6,651	67.4	3,433	63.7	
Primary Language					0.0029
English	6,388	64.7	3,506	65.0	
Spanish	2,764	28.0	1,566	29.1	
Other	722	7.3	318	5.9	
Income					0.0039
Missing	1,205	12.2	564	10.5	
Majority <138	6,361	64.4	3,507	65.1	
Majority >138	2,308	23.4	1,319	24.5	
Had COVID diagnosis in follow-up period	1,014	10.3	729	13.5	<.0001
Visit characteristics					
Visits in index period (mean, sd)					
Total visits	5.41	4.85	6.41	5.38	<.0001
AV - primary care	4.39	3.42	5.05	3.70	<.0001
TH - primary care	1.33	0.79	1.60	1.20	0.0005
Visits in follow-up period (mean, sd)					
Total visits	7.78	6.92	12.01	8.87	<.0001
AV - primary care	4.58	3.98	3.00	2.29	<.0001
TH - primary care	2.52	2.06	6.93	5.08	<.0001
Distribution of encounter modality (N, %)					
0% (no VC encounters)	2,571	26.0	0	0.0	

.01 to <25% VC encounters	1,419	14.4	0	0.0	
25% to <35% VC encounters	2,108	21.3	0	0.0	
35% to <50% VC encounters	1,601	16.2	0	0.0	
50% to <65% VC encounters	2,175	22.0	1,732	32.1	
65% to <75% VC encounters	0	0.0	1,491	27.7	
75% to <85% VC encounters	0	0.0	1,364	25.3	
85% to <95% VC encounters	0	0.0	462	8.6	
95%-100% VC encounters	0	0.0	341	6.3	
Both time periods					
Total visits	145,385	56.4	112,333	43.6	
Payor					<.0001
Medicaid	43,231	29.7	45,603	40.6	
Medicare	57,415	39.5	39,473	35.1	
Private	19,230	13.2	8,755	7.8	
Uninsured	21,306	14.7	14,191	12.6	
Other	4,203	2.9	4,311	3.8	
Rurality (patient's residence)					<.0001
Urban	84,642	58.2	88,833	79.1	
Large rural	38,504	26.5	20,646	18.4	
Small rural	22,239	15.3	2,854	2.5	

eAppendix Table 3. HbA_{1c} Change Analysis Population

	Majority or equally in-person visits (in-person group)		Majority VC visits (VC group)		Difference p-value (chi-sq / t-test)
	N	%	N	%	
Patient characteristics					
Total	8,221	62.5	4,937	37.5	
Age at study start (mean, sd)	57.40	8.92	55.87	8.71	<.0001
Sex					<.0001
Female	4,303	52.3	2,857	57.9	
Male	3,918	47.7	2,080	42.1	
Race					<.0001
Asian	341	4.1	206	4.2	
Black	1,587	19.3	468	9.5	
White	5,364	65.2	3,585	72.6	
Other	210	2.6	157	3.2	
Unknown	719	8.7	521	10.6	
Ethnicity					<.0001
Hispanic	3,023	36.8	2,019	40.9	
Non-Hispanic	5,198	63.2	2,918	59.1	
Primary Language					0.0029
English	4,949	60.2	2,983	60.4	
Spanish	2,619	31.9	1,638	33.2	
Other	653	7.9	316	6.4	
Income					0.0043
Missing	944	11.5	480	9.7	
Majority <138	5,357	65.2	3,244	65.7	
Majority >138	1,920	23.4	1,213	24.6	
Had COVID diagnosis in follow-up period	900	10.9	696	14.1	<.0001
Visit characteristics					
Visits in index period (mean, sd)					
Total visits	5.50	4.66	6.31	5.23	<.0001
AV - primary care	4.46	3.28	4.96	3.64	<.0001
TH - primary care	1.32	0.80	1.64	1.23	0.0002
Visits in follow-up period (mean, sd)					
Total visits	7.96	6.92	11.52	8.92	<.0001
AV - primary care	4.67	3.96	3.08	2.34	<.0001
TH - primary care	2.54	2.06	6.68	5.14	<.0001
Distribution of encounter modality (N, %)					
0% (no VC encounters)	2,045	24.9	0	0.0	

.01 to <25% VC encounters	1,227	14.9	0	0.0	
25% to <35% VC encounters	1,765	21.5	0	0.0	
35% to <50% VC encounters	1,368	16.6	0	0.0	
50% to <65% VC encounters	1,816	22.1	1,481	30.0	
65% to <75% VC encounters	0	0.0	1,224	24.8	
75% to <85% VC encounters	0	0.0	1,114	22.6	
85% to <95% VC encounters	0	0.0	382	7.7	
95%-100% VC encounters	0	0.0	736	14.9	
Both time periods					
Total visits	123,420	55.3	99,573	44.7	
Payor					<.0001
Medicaid	35,923	29.1	40,432	40.6	
Medicare	47,303	38.3	32,384	32.5	
Private	16,805	13.6	8,315	8.4	
Uninsured	19,515	15.8	14,235	14.3	
Other	3,874	3.1	4,207	4.2	
Rurality (patient's residence)					<.0001
Urban	74,147	60.1	81,056	81.4	
Large rural	31,307	25.4	16,257	16.3	
Small rural	17,966	14.6	2,260	2.3	