Changes in driving distance to specialist physicians in the era of virtual care: a population-based cohort study in Ontario, Canada

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Abstract

Background: Whether virtual health care has changed access to services for patients living far from a specialist physician is unknown. We aimed to determine whether driving distances between patients and their specialists had changed following increased availability of virtual care in Ontario, such that specialists saw patients from farther away.

Methods: We performed a population-based cohort study using linked health and administrative databases. We included all specialist physicians working in Ontario from Jan. 1, 2019, to Nov. 30, 2019 (pre–virtual care period) and from Jan. 1, 2022, to Nov. 30, 2022 (virtual care period), and their patients. Outcomes were measures of proximity between specialists and their patients including differences in 90th-percentile driving distance, mean driving time, and the proportion of patients with driving times longer than 60 minutes between time periods. We used multivariable linear regression models to compare outcomes across physician specialties, adjusting for physician age, sex, practice size, and location.

Results: We included 11 096 specialists (4232 surgical and 6864 medical; 0.8% rural). After adjustment, we found no meaningful changes in the 90th-percentile driving distance between time periods for surgical (difference 6.7 km, 95% confidence interval [CI] –4.1 km to 17.5 km) or medical specialties (difference 1.3 km, 95% CI –6.6 km to 9.2 km). For surgical specialists, the proximity measures of mean driving time increased by 5 minutes (95% CI 1 min to 10 min) and the proportion of patients living more than 60 minutes away increased by 2.1% (95% CI 0.7% to 3.9%), but we saw no significant change for medical specialists.

Interpretation: After expansion of virtual care, the distance between specialists and patients did not meaningfully change. To make virtual care more accessible, especially for those living in rural areas, attention should be paid to other factors such as referral patterns and the role of patients in determining the type of visit they prefer.

Access to specialist services is a major concern across health care systems globally.[1,2] Specialist care tends to be centralized in urban areas, creating rural–urban disparities in specialist access and adverse health outcomes because of delayed treatments, as well as increased costs and reduced patient satisfaction.[2] Various efforts have been made to improve access for people living in underserved areas.[3–8]

Virtual care, which we defined as medical consultations conducted via video or telephone, holds promise for improving access to specialty care, regardless of geographical proximity.[1,9–11] By reducing the transportation burden, virtual care can reduce costs and decrease the geographic impact on access to care.[11–13] Patients with fragility, disability, or mobility difficulties face many barriers to travel and may require specialized or public transportation. For all these reasons, the adoption of virtual care has continued to evolve, with virtual consultations comprising an important proportion (19%) of all physician consultations in Organisation for Economic Cooperation and Development countries in 2021; in March 2022, about half of people in Canada reported that they had been offered a virtual visit.[1,14,15]

Canada, with its vast geography, provides a valuable case study for assessing how technological innovations may increase accessibility in health care. About 18% of people in Canada reside in rural areas, yet only 2.2% of specialists practise in these regions.[16] Before the COVID-19 pandemic (the pre–virtual care period), virtual care accounted for only 1.6% of physician visits and was limited to a small number of platforms, such as the Ontario Telemedicine Network (OTN).[17] Although physicians were

remunerated for clinical care delivered through OTN, use of these services required physicians to register and conduct visits specifically through the OTN system.[18] At the time, both patient and clinician awareness of virtual care options was low, and the necessary infrastructure for broader adoption was not widely available. After the onset of the COVID-19 pandemic in March 2020, virtual care expanded rapidly. New billing codes enabled all physicians to provide virtual care, access to technology became more widespread, and both patients and providers became more familiar with and receptive to virtual care services. Importantly, physicians were reimbursed at rates comparable to in-person visits, further supporting the shift to virtual care delivery.[14,19] Despite positive feedback from both physicians and patients, the rapid expansion of virtual care raised concerns about unequal access to digital technology, the potential weakening of therapeutic relationships, and fragmentation of care.[20,21] In December 2022, remuneration for virtual care in Ontario was reformed to require a specialist to have an existing relationship with the patient, defined as 1 in-person visit in the previous 24 months, before they could comparably bill for a virtual visit. After this change to the billing codes, physicians raised concerns that this would reduce their ability to service patients in rural and remote areas.[22]

We aimed to evaluate whether the changes in use of virtual care facilitated by billing codes and infrastructure available to all physicians expanded the geographic reach of specialist care. Our primary aim was to compare the driving distance and driving time between specialist physicians and their patients in the virtual care period with the pre–virtual care period in Ontario, Canada. We hypothesized that driving distances between patients and their physicians would be longer in the virtual care period, with medical specialties likely showing a greater change than surgical specialties because medical specialties have a larger proportion of health encounters not dependent on physical examination (e.g., counselling, medication review) than surgical specialties, where health encounters more often require physical examination (e.g., surgical planning, wound care). Our secondary aim was to determine whether driving times between patients and their specialists were associated with the modality of care during the virtual care period such that patients with a long driving time to their physician were more likely to receive care virtually.

Methods

Study design

We conducted a population-based cohort study including actively practising specialist physicians registered in Ontario, Canada, who provided care between Jan. 1, 2019, and Nov. 30, 2022. We used health administrative data from ICES, an independent, nonprofit research institute whose legal status under Ontario's health information privacy laws allows it to collect and analyze health care and demographic data, without consent, for health system evaluation and improvement.

Participants

For our primary aim, we included specialist physicians in Ontario (Appendix 1, Supplement Table 1, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.250166/tab-related-content, contains a list of all specialist physician types, definitions, and exclusions) from Jan. 1, 2019, to Nov. 30, 2019 (pre–virtual care period) and from Jan. 1, 2022, to Nov. 30, 2022 (virtual care period). We excluded physicians with missing physician characteristics, those who entered practice or who moved practices during the study period, those who did not see at least 1 patient in either era, and those with visit numbers below the 5th percentile (to improve the precision for those with low volume of patients between eras) or greater than the 95th percentile (to reduce the likelihood of including physicians with group billing, where multiple physicians billed to a single billing number). We excluded community and family medicine practitioners, and specialties generally not amenable to virtual care (i.e., laboratory and pathology medicine, emergency medicine, nuclear medicine). For the secondary aim, we included all patients who had at least 1 encounter with a specialist identified in our primary aim during the virtual care period.

Databases

Using health administrative and demographic data sets linked with unique encoded identifiers and analyzed at ICES, we ascertained specialist physician characteristics using the Corporate Provider Database (Appendix 1, Supplement Table 1). We obtained data on patient visits from the Ontario Health Insurance Plan database, patient demographics from the Registered Persons Database, rurality from the Postal Code Conversion File, and geographic areas to identify the distance between specialist practice location and patient residential location using the Ontario Road Network File.[23]

Exposure

For the primary aim, the exposure was the period of care delivery, defined as either the pre–virtual care period (Jan. 1, 2019, to Nov. 30, 2019), or the virtual care period (Jan. 1, 2022, to Nov. 30, 2022). We defined the virtual care period to allow for almost 2 years of stabilization of uptake of billing codes and virtual care visits.[24] During this period, virtual care could be provided by any provider without predetermined patient–physician relationships (Appendix 1, Supplement Figure 1).[14] Virtual care billing codes included video visits or telephone calls (Appendix 1, Supplement Table 1), as identified using physician billing location code and virtual fee codes.[14,25–27] For the secondary aim, the exposure was the travel time between a physician and patient, during the virtual care period only. We categorized the travel time as less than 30 minutes, 31–60 minutes, and more than 60 minutes.

Outcomes

For each specialist physician, we measured the driving distance for their patient panel, which included all patients who had 1 or more visits with that specialist. We calculated the driving distance as the shortest distance between the patient's residence and the specialist physician's main location of practice by postal code using ArcGIS Network Analysis (version 10.8).[28] We used the Ontario Road Network Road Net Element File from Land Information Ontario, with the listing of Ontario roads and posted speed limits, to calculate travel times by car. We measured travel time based on driving distance and turn delays, and assuming no traffic congestion or other travel impediments. As driving times do not reflect the time

required to travel for those accessing public transportation or transportation accommodating people with disabilities, we also used other measures of distance such as average distance in kilometres.

For the primary aim, we used measures of proximity between specialists' locations and their patients. The primary outcome was the difference across time periods in 90th-percentile driving distance between the location of a specialist physician and the patients in their panel. Secondary outcomes included the difference in mean travel time between specialist physicians and patients in their panel, and the difference in the proportion of a specialist physician's panel with a travel time greater than 60 minutes. For our secondary aim, the outcome was the proportion of virtual visits for patients during the virtual care period, weighted by the number of patient visits to that physician to account for patients with frequent visits.

Covariates

We included provider-level characteristics measured in the pre–virtual care period, namely physician age, physician sex, practice location (urban or rural), practice size, specialty, and specialty type (medical or surgical). In the secondary aim, we included patient-level covariates measured in the virtual care period, namely patient age, sex, and location (urban or rural).

Statistical analysis

For our primary aim, we assessed balance in the baseline characteristics in the pre-virtual and virtual care periods using standardized differences, with a difference of less than 10% considered as balanced.[29]

The unit of analysis for the primary aim was the physician, and the primary dependent variable was the difference between the virtual and pre–virtual care periods in the 90th-percentile driving distance for each specialist physician's patient panel. We measured the association between the difference in the 90th-percentile driving distance in the surgical specialties combined and the medical specialties combined using multivariable linear regression models, adjusting for physician age, sex, and practice location and size. To further understand associations across individual specialties, we used multivariable linear regression including individual surgical specialty indicator variables, with general surgery as the reference group, adjusting for the above covariates; we similarly modelled individual medical specialties, with general internal medicine as the reference group. Linear regression is robust to departures from normality in the residuals when sample sizes are large.

For the secondary aim, the unit of analysis was the individual patient during the virtual care period. We assessed the association between the proportion of virtual visits for a patient with their physician and patient travel time using a multivariable linear regression model among surgical specialties, among medical specialties, and across individual specialties. We used generalized estimating equations with an equicorrelation working correlation matrix to account for patients clustered within physicians. These models adjusted for physician age, sex, practice size and location, and patient age, sex, and location.

We reported the study according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[30] We used SAS version 9.4 for analyses.

Ethics approval

Use of data in this project was authorized under section 45 of Ontario's *Personal Health Information Protection Act* (PHIPA) and did not require review by a research ethics board.

Results

We included 11 096 physicians (4232 surgical specialists, 6864 medical specialists) (Figure 1). A minority (0.8%) practised in rural locations and 61% were male (Table 1 and Appendix 1, Supplement Table 2).

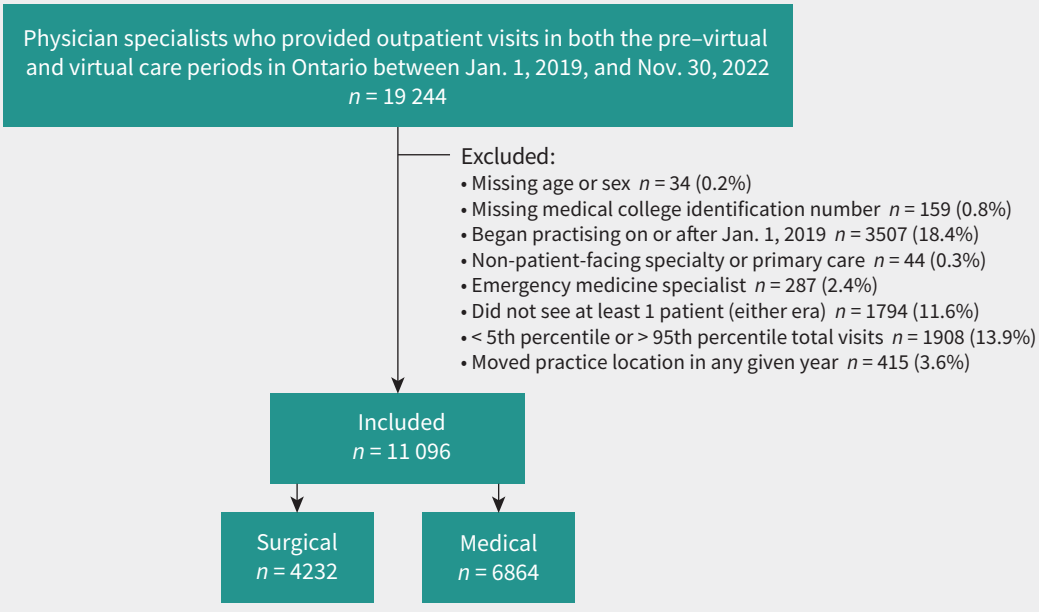

Figure 1: Flowchart of inclusion and exclusion of physician specialists. See Related Content for accessible version.

For surgical and medical specialties combined, the mean difference in 90th-percentile driving distance between the pre–virtual care and virtual care periods did not significantly change (surgical specialty mean difference 6.7 km, 95% confidence interval [CI] –4.1 km to 17.5 km; medical specialty mean difference 1.3 km, 95% CI –6.6 km to 9.2 km) (Table 2). Across surgical specialties, compared with the reference specialty of general surgery, we observed an increase in the difference in 90th-percentile driving distance in the virtual versus pre–virtual care period for cardiothoracic surgery (67.6 km, 95% CI 45.8 km to 89.3 km), and a decrease for ophthalmology (–16.3 km, 95% CI –29.4 km to –3.2 km). Across medical specialties, compared with the reference specialty of general internal medicine, we observed increases in the difference in 90th-percentile driving distance during the virtual versus pre–virtual care period for dermatology (20.4 km, 95% CI 1.6 km to 39.1 km), pediatrics (12.5 km, 95% CI 4.3 km to 20.8 km), and psychiatry (16.0 km, 95% CI 7.6 km to 24.4 km).

For surgical specialties combined, the mean driving time increased in the virtual care period (5 min, 95% CI 1 min to 10 min) compared with the pre–virtual care period, but did not change for medical specialties combined (Table 3). There were no individual surgical specialties with a difference in mean patient driving times between periods.

Across surgical specialties, we found a 2.1% increase (95% CI 0.7% to 3.9%) in the proportion of providers who exceeded the 60-minute threshold in the virtual care period compared with the pre–virtual care period (Table 4). Across medical specialties, we observed no difference in this measure. Across individual surgical and individual medical specialties, we found a significant increase in this proportion for psychiatry (1.2%, 95% CI 0.2% to 2.2%).

For the secondary aim, we included 5 371 190 unique patients who had more than 25 million visits during the virtual care period, of which 23% were virtual (unweighted) (Appendix 1,

Table 1 (part 1 of 2): Characteristics of Ontario specialist physicians in 2019

Characteristic	No. (%) of physicians *n* = 11 096
Age, yr	
< 35	1044 (9.4)
35–44	3510 (31.6)
45–54	3164 (28.5)
55–64	2177 (19.6)
65–74	989 (8.9)
≥ 75	212 (1.9)
Sex	
Female	4307 (38.8)
Male	6789 (61.2)
Years in practice	
≤ 10	1747 (15.7)
11–15	1786 (16.1)
16–20	1575 (14.2)
≥ 21	5988 (54.0)
Census metropolitan area (population size of practice location)	
≥ 1 500 000	5483 (49.4)
1 499 999–500 000	2448 (22.1)
499 000–100 000	2330 (21.0)
99 999–10 000	547 (4.9)
< 10 000 (rural)	91 (0.8)
Missing	197 (1.8)
Surgical specialty	
General surgery	679 (6.1)
Anesthesia	1172 (10.6)
Cardiothoracic surgery	73 (0.7)
Neurosurgery	83 (0.7)
Obstetrics and gynecology	725 (6.5)
Ophthalmology	260 (2.3)
Orthopedics	512 (4.6)
Otolaryngology	224 (2.0)
Plastic surgery	178 (1.6)
Thoracic surgery	42 (0.4)
Urology	228 (2.1)
Vascular surgery	56 (0.5)

Table 1 (part 2 of 2): Characteristics of Ontario specialist physicians in 2019

Characteristic	No. (%) of physicians *n* = 11 096
Medical specialty	
Internal medicine	1254 (11.3)
Cardiology	376 (3.4)
Clinical immunology	37 (0.3)
Dermatology	127 (1.1)
Endocrinology	223 (2.0)
Gastroenterology	263 (2.4)
Genetics	30 (0.3)
Geriatrics	125 (1.1)
Hematology	167 (1.5)
Infectious disease	125 (1.1)
Medical oncology	182 (1.6)
Nephrology	181 (1.6)
Neurology	364 (3.3)
Pediatrics	1204 (10.9)
Physical medicine	168 (1.5)
Psychiatry	1459 (13.1)
Respiratory disease	223 (2.0)
Rheumatology	163 (1.5)
Radiation oncology	193 (1.7)

Supplement Table 3 and Supplement Table 4). The percentage of patients by mean driving time and by the proportion of virtual visits are shown in Appendix 1, Supplement Table 3 and Supplement Table 4. Psychiatry had the highest proportion of virtual care visits (63%). Across surgical specialties, compared with those with travel times less than 30 minutes, those with travel times of 31–60 minutes had a greater proportion of virtual visits (0.9%, 95% CI 0.7% to 1.1%), as did those with travel times greater than 60 minutes (2.5%, 95% CI 2.1% to 2.9%) (Table 5). Across medical specialties, these differences were 2.0% (95% CI 1.7% to 2.3%) for those with travel times of 31–60 minutes and 4.0% (95% CI 3.5% to 4.6%) for those living more than 60 minutes

Table 2: Adjusted difference in 90th percentile driving distance in pre–virtual versus virtual care periods for physicians' patient panels, overall and by individual physician specialty

	90th-percentile driving distance, km, mean ± SD		
Specialty	**Pre–virtual care period**	**Virtual care period**	**Adjusted difference (95% CI)***
Surgical specialties combined	106 ± 133	111 ± 139	6.7 (–4.1 to 17.5)
Medical specialties combined	101 ± 155	107 ± 154	1.3 (–6.6 to 9.2)
Across surgical specialties			
General surgery (ref.)	102 ± 148	103 ± 151	0.0
Anesthesia	119 ± 133	126 ± 134	4.6 (–3.9 to 13.1)
Cardiothoracic surgery	209 ± 267	281 ± 380	67.6 (45.8 to 89.3)
Neurosurgery	153 ± 79	164 ± 90	9.6 (–10.8 to 30.1)
Obstetrics and gynecology	79 ± 110	85 ± 111	2.8 (–7.0 to 12.5)
Ophthalmology	115 ± 176	103 ± 146	–16.3 (–29.4 to –3.2)
Orthopedic surgery	107 ± 116	106 ± 102	–2.0 (–12.4 to 8.3)
Otolaryngology	89 ± 97	99 ± 134	7.2 (–6.5 to 20.9)
Plastic surgery	104 ± 139	107 ± 133	0.7 (–14.1 to 15.4)
Thoracic surgery	128 ± 81	136 ± 87	6.6 (–21.2 to 34.3)
Urology	90 ± 101	98 ± 122	5.7 (–7.9 to 19.3)
Vascular surgery	91 ± 75	100 ± 71	7.4 (–16.9 to 31.7)
Across medical specialties			
General internal medicine (ref.)	105 ± 203	101 ± 187	0.0
Cardiology	116 ± 147	117 ± 138	4.5 (–7.4 to 16.4)
Clinical immunology	87 ± 83	94 ± 82	11.2 (–22.1 to 44.5)
Dermatology	70 ± 51	87 ± 110	20.4 (1.6 to 39.1)
Genetics	75 ± 127	82 ± 107	7.3 (–29.6 to 44.2)
Geriatrics	83 ± 106	88 ± 128	4.9 (–14.0 to 23.8)
Endocrinology	118 ± 49	124 ± 43	9.6 (–4.9 to 24.2)
Gastroenterology	63 ± 128	66 ± 128	8.3 (–5.3 to 21.9)
Hematology	110 ± 112	123 ± 175	14.8 (–1.7 to 31.3)
Infectious disease	118 ± 194	110 ± 154	–5.9 (–24.7 to 12.9)
Medical oncology	96 ± 93	94 ± 83	–0.2 (–16.3 to 15.8)
Nephrology	130 ± 241	128 ± 220	–0.4 (–16.4 to 15.5)
Neurology	119 ± 154	122 ± 149	5.2 (–6.7 to 17.1)
Pediatrics	96 ± 112	107 ± 118	12.5 (4.3 to 20.8)
Physical medicine	90 ± 93	100 ± 99	11.9 (–4.6 to 28.5)
Psychiatry	90 ± 147	106 ± 155	16.0 (7.6 to 24.4)
Respiratory disease	159 ± 248	166 ± 266	9.3 (–5.2 to 23.8)
Rheumatology	110 ± 157	110 ± 148	1.8 (–14.9 to 18.4)
Radiation oncology	107 ± 70	109 ± 70	3.0 (–12.7 to 18.8)

Note: CI = confidence interval, ref. = reference, SD = standard deviation.
*Models adjusted for physician age, physician gender, years of practice, practice location, and practice size.

away. Across most individual specialties, for patients whose travel time was greater than 60 minutes, proportionally more visits were virtual, whereas for those whose travel time was less than 30 minutes, proportionally more visits were in person (Appendix 1, Supplement Table 4).

Interpretation

In this large population-based study, we found that widespread availability of virtual care, accompanied by remuneration changes, was not associated with substantial expansion of specialists'

Table 3: Adjusted difference in mean driving time in pre–virtual versus virtual care periods for physicians' patient panels, overall and by individual physician specialty

	Mean driving time, min, mean ± SD		
Specialty	Pre–virtual care period	Virtual care period	Adjusted difference (95% CI)*
Surgical specialties combined	42 ± 60	44 ± 59	5 (1 to 10)
Medical specialties combined	41 ± 69	43 ± 72	0.7 (–2.8 to 4.3)
Across surgical specialties			
General surgery (ref.)	43 ± 85	46 ± 88	0.0
Anesthesia	49 ± 71	48 ± 60	–3 (–6 to 1)
Cardiothoracic surgery	66 ± 51	74 ± 64	4 (–5 to 13)
Neurosurgery	54 ± 28	57 ± 30	1 (–8 to 9)
Obstetrics and gynecology	34 ± 46	36 ± 48	–1 (–5 to 3)
Ophthalmology	40 ± 46	41 ± 61	–2 (–8 to 3)
Orthopedic surgery	42 ± 45	43 ± 49	0 (–5 to 4)
Otolaryngology	34 ± 35	36 ± 36	0 (–6 to 6)
Plastic surgery	39 ± 44	38 ± 32	–3 (–9 to 3)
Thoracic surgery	45 ± 21	47 ± 22	0 (–11 to 11)
Urology	35 ± 40	39 ± 52	2 (–3 to 8)
Vascular surgery	36 ± 18	41 ± 25	3 (–7 to 13)
Across medical specialties			
General internal medicine (ref.)	45 ± 94	45 ± 94	0.0
Cardiology	48 ± 66	47 ± 58	0 (–6 to 5)
Clinical immunology	37 ± 43	41 ± 44	5 (–10 to 20)
Dermatology	36 ± 35	42 ± 43	5 (–3 to 14)
Genetics	31 ± 64	34 ± 67	4 (–3 to 11)
Geriatrics	36 ± 55	39 ± 84	4 (–2 to 11)
Endocrinology	49 ± 25	53 ± 22	3 (–14 to 19)
Gastroenterology	30 ± 86	32 ± 87	1.0 (–8 to 10)
Hematology	41 ± 35	47 ± 81	5 (–3 to 12)
Infectious disease	49 ± 100	48 ± 97	–2 (–10 to 7)
Medical oncology	39 ± 45	37 ± 38	–2 (–10 to 5)
Nephrology	63 ± 143	56 ± 125	–8 (–15 to 0)
Neurology	44 ± 80	45 ± 80	1 (–4 to 7)
Pediatrics	40 ± 51	43 ± 51	3 (–1 to 6)
Physical medicine	34 ± 28	35 ± 28	0 (–7 to 8)
Psychiatry	34 ± 44	40 ± 61	4 (1 to 8)
Respiratory disease	61 ± 101	63 ± 109	2 (–4 to 9)
Rheumatology	40 ± 37	40 ± 32	0 (–8 to 7)
Radiation oncology	42 ± 27	43 ± 28	–1 (–8 to 7)

Note: CI = confidence interval, ref. = reference, SD = standard deviation.
*Models adjusted for physician age, physician sex, years of practice, practice location, and practice size.

practices to serve patients who lived farther away. Although we did observe statistically significant increases in driving distances in the period of virtual care among surgical specialties, the magnitude of these increases was modest and likely clinically inconsequential, and we did not observe such differences among medical specialties. We did not observe consistent patterns of greater distance between physicians and their patients with the introduction of virtual care, except among psychiatrists, where modest differences were seen across all measures. Between the pre–virtual and virtual care periods, the 90th-percentile distance

Table 4: Adjusted difference in percentage of patients with more than 60 minutes' driving time in pre–virtual versus virtual care periods for physicians' patient panels, overall and by individual physician specialty

	Patients driving > 60 min, %, mean ± SD		
Specialty	Pre–virtual care period	Virtual care period	Adjusted difference (95% CI)*
Surgical specialties combined	15 (20)	16 (21)	2.1 (0.7 to 3.9)
Medical specialties combined	14 (20)	15 (21)	−1.0 (−1.7 to 0.4)
Across surgical specialties			
General surgery (ref.)	15 (22)	16 (24)	0.0
Anesthesia	18 (21)	18 (21)	−0.3 (−1.4 to 0.7)
Cardiothoracic surgery	26 (18)	27 (18)	−0.3 (−3.1 to 2.5)
Neurosurgery	25 (15)	27 (17)	0.5 (−2.1 to 3.2)
Obstetrics and gynecology	11 (20)	12 (20)	−0.1 (−1.3 to 1.2)
Ophthalmology	13 (16)	14 (20)	−0.5 (−2.2 to 1.2)
Orthopedic surgery	16 (21)	18 (23)	0.2 (−1.1to 1.6)
Otolaryngology	12 (17)	14 (18)	−0.0 (−1.8 to 1.8)
Plastic surgery	14 (14)	14 (14)	−0.5 (−2.5 to 1.4)
Thoracic surgery	22 (15)	23 (14)	0.3(−3.3 to 3.9)
Urology	12 (18)	14 (21)	0.7 (−1.0 to 2.5)
Vascular surgery	12 (10)	15 (15)	2.0 (−1.2 to 5.1)
Across medical specialties			
General internal medicine (ref.)	14 (24)	14 (24)	0.0
Cardiology	48 (66)	47 (58)	0.2 (−1.1 to 1.6)
Clinical immunology	12 (18)	15 (19)	2.3 (−1.6 to 6.0)
Dermatology	11 (17)	12 (18)	1.1 (−1.0 to 3.3)
Genetics	9 (13)	10 (14)	1.2 (−0.5 to 2.8)
Geriatrics	11 (18)	11 (17)	−0.6 (−2.2 to 0.9)
Endocrinology	25 (22)	27 (21)	0.5 (−3.7 to 4.8)
Gastroenterology	8 (17)	10 (20)	1.1 (−1.0 to 3.3)
Hematology	16 (19)	17 (18)	−0.3 (−2.2 to 1.5)
Infectious disease	14 (19)	14 (19)	−0.6 (−0.0 to 0.0)
Medical oncology	15 (18)	15 (16)	−1.1 (−0.0 to 0.0)
Nephrology	19 (26)	17 (22)	−2.7 (−4.9 to 0.9)
Neurology	15 (16)	16 (16)	1.4 (−1.2 to 1.5)
Pediatrics	13 (20)	15 (20)	0.8 (−0.1 to 1.8)
Physical medicine	11 (11)	12 (12)	0.5 (−1.4 to 1.4)
Psychiatry	12 (19)	14 (21)	1.2 (0.2 to 2.2)
Respiratory disease	19 (25)	21 (26)	0.8 (−0.9 to 2.4)
Rheumatology	14 (18)	15 (16)	0.2 (−1.7 to 2.2)
Radiation oncology	20 (17)	20 (19)	−0.0 (−1.9 to 1.7)

Note: CI = confidence interval, ref. = reference, SD = standard deviation.
*Models adjusted for physician age, physician gender, years of practice, practice location, and practice size.

between physicians and patients increased among cardiothoracic surgeons, dermatologists, pediatricians, and psychiatrists. We speculate that this may indicate that the convenience of virtual care for those who live far away is an important factor for certain populations (e.g., parents) and that access to certain specific services (e.g., discussions on child behaviour and development, mental health evaluations, pre- or postsurgical evaluations) can be increased using virtual care. Virtual care may be a modality wherein specific portions of a physical examination (e.g., skin examinations) can be adequately evaluated without the need for an in-person visit.

We found that patients living far from care were more likely to use virtual care. Although the increases in the proportion of virtual visits for those who live farther away were small, these increases suggest that distance influences virtual care use, perhaps owing to convenience in terms of the time and cost

Table 5 (part 1 of 2): Association between the percentage of virtual visits to a patient's physician and patient travel time to their physician and physician and patient characteristics (virtual care period only)

Characteristic	Adjusted mean percentage difference of virtual visits (95% CI)*	
	Surgical specialties *n* = 1 540 522 visits (weighted)†	Medical specialties *n* = 4 330 157 visits (weighted)†
Driving time, min		
< 30 (ref.)	0.0	0.0
31–60	0.9 (0.7 to 1.1)	2.0 (1.7 to 2.3)
> 60	2.5 (2.1 to 2.9)	4.0 (3.5 to 4.6)
Physician age, yr		
< 35 (ref.)	0.0	0.0
35–44	2.7 (0.0 to 5.5)	–1.4 (–5.0 to 2.3)
45–54	1.4 (–1.3 to 4.2)	0.9 (–2.8 to 4.6)
55–64	0.8 (–2.1 to 3.6)	1.8 (–2.1 to 5.6)
65–74	4.1 (0.5 to 7.7)	5.3 (0.8 to 9.7)
≥ 75	9.9 (3.3 to 16.4)	10.4 (3.3 to 17.5)
Physician sex		
Female (ref.)	0.0	0.0
Male	–0.9 (–2.6 to 0.9)	–2.1 (–3.6 to –0.5)
Practice size		
Low (ref.)	0.0	0.0
Medium	3.5 (1.9 to 5.1)	3.1 (1.0 to 5.2)
High	6.9 (5.2 to 8.5)	11.8 (9.5 to 14.1)
Physician location		
Urban (ref.)	0.0	0.0
Rural	5.7 (0.8 to 10.5)	4.9 (–5.4 to 15.2)
Patient age, yr		
< 35 (ref.)	0.0	0.0
35–44	2.8 (2.5 to 3)	–0.2 (–0.7 to 0.4)
45–54	5.0 (4.6 to 5.4)	–3.8 (–4.4 to –3.2)
55–64	3.9 (3.5 to 4.2)	–6.3 (–6.9 to –5.6)
65–74	3.3 (3 to 3.6)	–7.8 (–8.5 to –7.2)
≥ 75	2.0 (1.6 to 2.3)	–9.5 (–10.2 to –8.8)
Patient sex		
Female (ref.)	0.0	0.0
Male	–0.7 (–0.9 to –0.5)	–1.6 (–1.7 to –1.4)
Patient location		
Urban (ref.)	0.0	0.0
Rural	0.2 (–0.1 to 0.4)	0.06 (–0.4 to 0.5)

required to travel large distances. Taken together, our results indicate that, although virtual care may have improved access and convenience for some patients living far from care (or who faced other challenges with accessing in-person care), on the whole, the increased availability of virtual care did not meaningfully increase its use for patients living far from specialists.

Virtual care has been widely suggested as a solution to increase access to health care for people living in rural areas. A systematic review of 48 studies of virtual care before and during the peak of the COVID-19 pandemic concluded that telemedicine reduced travel by 6.9–1060 km per surgical consultation, depending on the country and setting.[13] A study in British Columbia

Table 5 (part 2 of 2): Association between the percentage of virtual visits to a patient's physician and patient travel time to their physician and physician and patient characteristics (virtual care period only)

	Adjusted mean percentage difference of virtual visits (95% CI)*	
Characteristic	**Surgical specialties *n* = 1 540 522 visits (weighted)†**	**Medical specialties *n* = 4 330 157 visits (weighted)†**
Surgical specialty		
General surgery (ref.)	0.0	–
Anesthesia	−6.0 (−9.5 to −2.5)	–
Cardiothoracic surgery	−11.3 (−14.3 to −8.3)	–
Neurosurgery	−12.1 (−15.1 to −9.0)	–
Obstetrics and gynecology	−0.1 (−2.4 to 2.2)	–
Ophthalmology	−12.5 (−14.9 to −10.1)	–
Orthopedic surgery	−10.5 (−12.6 to −8.5)	–
Otolaryngology	5.8 (2.7 to 8.9)	–
Plastic surgery	−6.1 (−9 to −3.2)	–
Thoracic surgery	0.0 (−6.3 to 6.3)	–
Urology	10.0 (7.0 to 13.0)	–
Vascular surgery	−1.5 (−7.4 to 4.4)	–
Medical specialty		
General internal medicine (ref.)	–	0.0
Cardiology	–	21.0 (17.2 to 24.7)
Clinical immunology	–	−3.0 (−10.4 to 4.4)
Dermatology	–	22.6 (16.5 to 28.6)
Genetics	–	55.1 (49.2 to 61.0)
Geriatrics	–	32.6 (25.4 to 39.9)
Endocrinology	–	50.8 (38.1 to 63.5)
Gastroenterology	–	5.2 (−0.8 to 11.3)
Hematology	–	−3.3 (−6.3 to −0.4)
Infectious disease	–	23.4 (13.3 to 33.5)
Medical oncology	–	2.1 (−0.1 to 4.3)
Nephrology	–	−15.8 (−18.0 to −13.6)
Neurology	–	25.4 (20.2 to 30.7)
Pediatrics	–	15.79 (13.1 to 18.5)
Physical medicine	–	6.2 (1.8 to 10.7)
Psychiatry	–	71.5 (68.1 to 75.0)
Respiratory disease	–	13.5 (7.7 to 19.3)
Rheumatology	–	9.2 (5.3 to 13.2)
Radiation oncology	–	11.5 (8.1 to 15.0)

Note: CI = confidence interval, ref. = reference category.
*Model adjusted for physician age, sex, practice size, practice location, specialty, and patient age, sex, and location.
†Among surgical specialties, 15% of patient visits were virtual; among medical specialties, 26% of patient visits were virtual.

showed that rural patients saved, on average, 9 hours of travel time when using virtual preoperative surgical consultations instead of in-person visits at a time of limited in-person visits owing to COVID-19 restrictions.[31] Overall, the literature indicates that, during the COVID-19 pandemic or for specific circumstances such as mental health care, virtual care has the potential to reduce travel time, with mixed evidence that this translates into increased access for patients who live far away from the health care provider.[32–34]

Given our results, if virtual care is to increase access to specialty care for rural patients, efforts are required to identify and target other barriers for virtual care, one of which could be that providers refer to specialists within their own self-contained networks. In other words, rural patients may not be referred to specialists who are far away because their provider is not aware of them.[35] Centralized referral systems could pool patient referrals and match patients to specialists.[36] It is also possible that physicians are determining the modality of the visit more than patients. If physicians deem a visit to be amenable to virtual care, allowing the modality of the visit to be routinely decided by patients could increase the use of virtual care by patients for whom access to transportation or time are concerns. This is especially important during seasonal surges of infections and for patients who are immunocompromised.

In December 2022 (after the time period of our study), the billing codes for virtual care in Ontario were changed to require patients to have had an in-person visit with the physician in the previous 24 months, with comparable remuneration. To make specialist care more accessible for rural patients, considerations could be made to change the rule so it does not apply to patients who live more than a certain distance from the specialist. Finally, keeping virtual care codes and the infrastructure and guidelines for virtual care up to date is important to safeguard patients and our health care system delivery during future public health emergencies. Future studies that account for the distance between communities and population size or that examine these associations within different health regions (e.g., northern v. southern regions) would help understand how our findings may be modified by geography.

Limitations

There was likely residual confounding from unmeasured factors such as training for using virtual care, access to technology, or patient–provider language concordance.[37] Satisfaction with care by the physician or patient and clinical outcomes were not available in the databases we used. We conducted our study in a single-payer health system, and the results may not be generalizable to other settings. However, studies in other jurisdictions could use a similar methodology to assess uptake of virtual care. Extrapolation of our findings is limited for regions where there is a different proportion of rural-dwelling patients or where transportation infrastructure is different. We were unable to differentiate between video and telephone visits. Our exclusion of physicians with visit numbers higher than the 95th percentile and lower than the 5th percentile of visits excluded specialists with very high and very low patient volumes from both time periods. For specialists with multiple locations of practice, we could not identify differences in outcomes in the alternative (not main) practice locations; however, we excluded physicians who changed their main location of practice between study periods (3.6%) to ensure our comparison between time periods used the same practice locations. We chose the cut-offs for long distances (90th-percentile distance and driving time > 60 min) to represent distances and travel times for which disparities in health care access are known to start to occur predictably[38] or are used as thresholds for enrolment in health programs meant to address such disparities.[39,40] Although our findings were consistent across all study outcomes, findings may have differed with other thresholds. Findings may differ with a longer period of observation after institution of virtual care.

Conclusion

After the expansion of virtual care in Ontario, specialist physicians did not meaningfully expand their reach to patients who lived farther away. To make virtual care more accessible, especially for patients living in rural areas, attention should be paid to other factors such as referral patterns and the role of patients in determining the type of visit they prefer.

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Data sharing: The data sets from this study are held securely in coded form at ICES. Data-sharing agreements prohibit ICES from making the data sets publicly available, but access may be granted to those who meet prespecified criteria for confidential access, available at www.ices.on.ca/DAS. The complete data set creation plan and underlying analytic code are available from the authors upon request, understanding that the programs may rely upon coding templates or macros unique to ICES.

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