Title: Telemedicine access, care, and outcomes after transient ischemic attack and minor stroke

Short title: Telemedicine in TIA and minor stroke

Amy Y. X. Yu MD MSc[1,2], Jeremy Penn BSc[1], Peter C. Austin PhD[2], Douglas S. Lee MD PhD[2,3], Joan Porter MSc[2], Jiming Fang PhD[2], Donald A. Redelmeier MD MSHSR[4], Moira K. Kapral MD MSc[2,5]

[1]Department of Medicine (Neurology), University of Toronto, Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada, [2]ICES, Toronto, Ontario, Canada, [3]Department of Medicine (Cardiology), University of Toronto-University Health Network, Toronto, Ontario, Canada, [4]Department of Medicine (General Internal Medicine), University of Toronto, Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada, [5]Department of Medicine (General Internal Medicine), University of Toronto-University Health Network, Toronto, Ontario, Canada.

Correspondence to:

Dr. Amy Y. X. Yu, MD, FRCPC, Neurologist, Department of Medicine (Neurology), University of Toronto, Sunnybrook Health Sciences Centre, Office A-455, 2075 Bayview Ave, CANADA

Phone: 1 (416) 480-4866, Fax: 1 (416) 480-5753, amyyx.yu@utoronto.ca, Twitter: @amyyu_md

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Abstract

Background: The COVID-19 pandemic has led to an increase in telemedicine use. We compared care and outcomes in patients with transient ischemic attack (TIA) or minor ischemic stroke before and after the widespread adoption of telemedicine in Ontario, Canada in 2020.

Methods: In a population-based cohort study using linked administrative data, we identified patients with TIA or ischemic stroke discharged from an emergency department (ED) before the widespread use of telemedicine (2015-2020) compared to after (2020-2021). We measured care, including visits with a physician, investigations, and medication renewal. We compared 90-day death before and after 2020 using Cox proportional hazard models and we compared 90-day admission using cause-specific hazard models.

Results: We identified 47,601 patients (49% female, median age 73 years [62-82]) with TIA (n=35,695, 75%) or ischemic stroke (n=11,906, 25%). After 2020, 83.1% of patients had ≥1 telemedicine visit within 90 days of ED discharge compared to 3.8% before. The overall access to outpatient visits within 90 days remained unchanged (92.9% before versus 94.0% after, risk difference [95%CI] 1.1 [-1.3,3.4]). Investigations and medication renewals were unchanged. Clinical outcomes were also similar before and after 2020; the adjusted hazard ratio [95%CI] was 0.97 [0.91,1.04] for 90-day all-cause admission, 1.06 [0.94,1.20] for stroke admission, and 1.07 [0.93,1.24] for death.

Conclusions: Care and outcomes after TIA or minor stroke remained stable after the widespread implementation of telemedicine during the COVID-19 pandemic, suggesting telemedicine is an effective healthcare delivery method that can be complementary to in-person care for minor ischemic cerebrovascular events.

Background

Rapid-access clinics to evaluate patients with minor stroke or transient ischemic attack (TIA) discharged from an emergency department (ED) are the mainstay of secondary stroke prevention strategies.[1,2] Such patients are usually not admitted to hospital, but they are at high risk of experiencing a disabling stroke in the following days or weeks.[3] The Coronavirus disease 2019 (COVID-19) pandemic has disrupted outpatient clinic-based care and has created a need for telemedicine as an alternative to in-person visits.[4]

Prior to the pandemic, telemedicine for stroke in Ontario was largely limited to the Ontario Telestroke Program, which provides support for hyperacute stroke management of patients seen in the EDs of primary stroke centres.[5] Some outpatient telemedicine care was used for patients living in remote regions with the support of an intermediary host site (e.g., nursing station or clinic) with a clinician facilitating the visit. A small number of direct-to-patient telemedicine outpatient visits took place via the pilot Ontario Virtual Care Program, where a limited number of physicians obtained special approval to participate.[6] At the pandemic onset, as in many other jurisdictions internationally, new physician fee codes for outpatient telemedicine care were introduced in Ontario, Canada (population 14.5 million), allowing for widespread direct-to-patient telemedicine care without the need for additional approval.

We used the opportunity created by the COVID-19 pandemic to compare the care and outcomes in patients who were discharged from an ED with TIA or ischemic stroke before and after the widespread implementation of direct-to-patient telemedicine visits. We hypothesized that telemedicine can successfully maintain the quality of stroke prevention care and outcomes.

Methods

In this cohort study using linked administrative data, we identified community-dwelling adult Ontario residents who were discharged alive from an ED without hospital admission with a most responsible diagnosis of TIA (G45.x except G45.4) or ischemic stroke (H34.1, I63.x, I64.x) before and after the implementation of the direct-to-patient telemedicine fee codes.[7] Ontario residents have a universal-access healthcare system funded publicly by the Ontario Ministry of Health and Long-Term Care (MOHLTC).

Between March 14 and April 1, 2020, a series of new physician fee codes for video or telephone visits were announced by the MOHLTC.[8,9] Physician reimbursement remained unchanged for services provided in person or via telemedicine. We used physician billing codes to track in-person versus telemedicine care[10] and defined the pre-telemedicine period as April 1, 2015 to March 31, 2020 and the telemedicine period as April 1, 2020 to March 31, 2021.

The main clinical outcomes of interest were all-cause admission, admission for stroke (ischemic and hemorrhagic), and death within 90 days of the ED discharge date. We described care by comparing the pre-telemedicine and telemedicine periods, including the frequency of in-person or telemedicine visits with a family physician or stroke specialist (neurologist, internist, cardiologist, or geriatrician) within 28 days and 90 days of ED discharge, investigations, including neuroimaging, vascular imaging, and echocardiogram studies, and, for patients aged >65 years, renewal of baseline anti-hypertensive, anti-hyperlipidemia, or anti-hyperglycemic medications within 100 days of the ED visit. We defined baseline medication as any prescription filled between 100 days prior to the ED visit and up to 7 days after the visit. See Supplemental Table 1 for case definitions.

Datasets were linked using unique encoded identifiers and analyzed at ICES (formerly Institute for Clinical Evaluative Sciences). The use of data in this project was authorized under section 45 of Ontario's Personal Health Information Protection Act without the requirement for research ethics board approval.

Statistical methods

We compared patient characteristics in the pre-telemedicine and telemedicine periods using standardized differences because these are insensitive to large sample sizes compared to traditional hypothesis testing with P values. To address the possibility that the pandemic modified health-seeking behavior and may have reduced ED visits for TIA, we computed the annual age-sex standardized rates of ED visits, discharged without admission, for TIA or ischemic stroke, standardized to the Ontario adult population of 2020. We calculated the risk difference (RD) and 95% confidence intervals (CI) to compare care in the two periods. We used Cox proportional hazard models to estimate the adjusted Hazard Ratio (aHR) and 95% CI for 90-day death during the telemedicine compared to the pre-telemedicine period, adjusted for age (continuous), sex, neighborhood income quintile, rurality, most responsible diagnosis (TIA versus stroke), hypertension, diabetes, atrial fibrillation, dyslipidemia, history of stroke, coronary artery disease, and peripheral artery disease (Supplemental Table 1). We used adjusted cause-specific hazard models to evaluate 90-day hospital admission accounting for the competing risk of death.[11]

Results

We identified 47,601 patients discharged from an ED with diagnosis of TIA (n=35,695, 75%) or ischemic stroke (n=11,906, 25%). Median age was 73 years, interquartile range was 62-82, and 49% were female (n=23,468). Patient characteristics in the pre-telemedicine and telemedicine periods were balanced except for a small reduction in the number of patients evaluated in non-designated centres, with a corresponding increase in the number evaluated at comprehensive stroke centers (Table 1). Although the age-sex standardized rate of ED visits for TIA or ischemic stroke was lower in 2020 than previous years, the decrease was consistent with the temporal trends throughout the study period (Figure 1).

Telemedicine visits rapidly increased after April 1, 2020 with 83.1% (n=6,236) of patients having at least one telemedicine visit within 90 days of ED discharge compared to 3.8% (n=1,531) at baseline (Figure 2). When all visit modalities were considered, physician visits remained unchanged between the pre-telemedicine and telemedicine periods (83.2% vs. 85.3% at 28 days; RD 2.2, 95% CI [-0.1, 4.4] and 92.9% vs. 94.0% at 90 days, RD 1.1 [-1.3, 3.5], Figure 3 and Supplemental Table 2).

To explore whether certain patient groups were more vulnerable to a lack of follow-up, we compared the characteristics of the patients who had no follow-up visits within 28 days of ED discharge with patients who had at least one visit. Patients without any visits were more likely to live in the lowest income quintile neighborhoods (compared to other quintiles), rural regions (compared to urban ones), and to have a diagnosis of stroke (compared to TIA), Supplemental Table 3. These patterns were similar before and after the implementation of telemedicine.

We found some differences in the pattern of visits with family physicians versus stroke specialists. Compared to the pre-telemedicine period, there was a greater proportion of patients without any family physician visit within 90 days of the ED discharge during the telemedicine period (21.8% vs. 24.0%; RD 2.2 [1.0, 3.4]), but fewer patients had no specialist visit (23.0% vs. 19.1%; RD -3.9 [-5.0, -2.9]), Supplemental Table 2. However, among patients who were seen by a physician, a higher proportion of patients had three or more visits with a family physician (30.9% vs. 36.8%; RD 5.9 [4.4, 7.3]) or a specialist (12.7% vs. 19.6%; RD 6.9 [5.9, 8.0]) after the implementation of telemedicine compared to baseline.

Use of stroke investigations and early renewal of medications for vascular risk factors remained largely similar in the two time periods (Figure 3). There was an overall increase in vascular imaging use and a shift from using carotid Dopplers in favor of computed tomography angiography, but this was likely due to a change in clinical practice, rather than related to the pandemic or telemedicine, as the use of this test increased throughout the study period (Supplemental Figure 1). Finally, all clinical outcomes including all-cause and stroke-specific admissions and death within 90 days remained unchanged during the two periods (Table 2).

Discussion

In this population-based analysis, we showed a rapid uptake in telemedicine use for the outpatient management of acute minor ischemic cerebrovascular events after April 1, 2020. The number and timeliness of visits with family physicians or specialists and the use of stroke investigations and early medication renewals remained largely stable, and clinical outcomes were unchanged.

TIA and minor stroke account for most of the burden of ischemic cerebrovascular disease and represent an important opportunity for stroke prevention.[12] Our findings suggest that telemedicine is an effective complementary or alternative healthcare delivery method to maintain standard of care when in-person care is disrupted. Given telemedicine has many potential benefits beyond protection against infectious disease exposure during the pandemic, including improved access to stroke experts for patients living in remote regions, reduced time and costs related to travel for the patient, and better engagement of family members and caregivers, our study supports maintaining telemedicine beyond the pandemic.[4,13]

The stability in hospital admissions and deaths outcomes with the widespread adoption of telemedicine was reassuring, particularly because the telemedicine cohort may be vulnerable to selection bias for patients with more severe events. Indeed, prior reports have found that patients with non-disabling strokes were less likely to present to medical attention during the pandemic.[14,15] Nevertheless, about 15% of patients in our cohort did not have any physician follow-up within 28 days of an ED visit for TIA or ischemic stroke, suggesting that the availability of telemedicine as an alternative visit modality may be insufficient to improve access to care for those who are vulnerable to loss to follow-up, including patients who live in neighborhoods with low income quintile, rural areas, or who are diagnosed with stroke as opposed to TIA.

In addition, we found some differences in the patterns of physician visits: a higher proportion of patients had a follow-up with a specialist, but a lower proportion had a follow-up with a family physician during the telemedicine period compared to baseline. Telemedicine fee codes were announced simultaneously for family physicians and specialists, but their uptake may have been slower among family physicians who may be more likely to have a private practice while specialists may be more likely part of a larger group practice or have hospital affiliations, which may have facilitated the initial transition from in-person to telemedicine care. However, we observed that once a patient had connected with a family doctor or specialist, they were more likely to have subsequent visits in the telemedicine period compared to pre-telemedicine. It is not clear if the subsequent visits were driven by the need for additional clinical evaluation (e.g., a comprehensive physical examination after a telephone visit), or if they reflected care via video or telephone that was already occurring before telemedicine (e.g., a phone call to discuss a test result), but this latter type of visit was not previously remunerated and therefore not captured.

Our study has several limitations. Residual confounding from the effects of the pandemic, stroke severity, or other unmeasured confounders is possible. The widespread use of telemedicine coincided with the global pandemic onset, making it impossible to distinguish the effects of one from the other on TIA and stroke care and outcomes. Nevertheless, we adjusted for major vascular comorbidities and all patients in the cohort were discharged from the ED without admission, suggesting that their event was unlikely to be severely disabling. Other limitations include the inability to differentiate video from telephone encounters, a lack of information on patient satisfaction or potential barriers to telemedicine, no pharmacy data for patients aged 65 years and older, and we could not evaluate renewal of acetylsalicylic acid because this medication is available over the counter. Finally, our study population all had an in-person visit with an ED physician and were presumably discharged without hospitalization because there were no disabling deficits identified on physical examination. Our findings may not be generalizable to other clinical scenarios where in-person assessments are required. The external generalizability of our findings to countries without universal healthcare access is also limited.

Conclusion

Understanding care and outcomes after a TIA or minor ischemic stroke in the context of the pandemic and widespread telemedicine use is relevant because this patient population requires urgent outpatient follow-up and may be particularly vulnerable to delays in care. Our findings suggest that telemedicine can be used to replace or complement in-person assessments without negatively affecting care and outcomes. Further work on minimizing loss to follow-up of patients with TIA or minor stroke is needed.

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Table 1 Patient characteristics before and after the implementation of outpatient telemedicine billing codes

	Before telemedicine n = 40,098	**After telemedicine n = 7,503**	**Std diff***
Median age (IQR)**, yrs**	73 (62, 82)	73 (62, 81)	0.024
Female sex n (%)	19,786 (49.3%)	3,682 (49.3%)	0.005
Neighborhood Income Quintile n (%)			
1 (lowest)	8,583 (21.4%)	1,465 (19.5%)	0.047
2	8,479 (21.1%)	1,540 (20.5%)	0.015
3	8,035 (20.0%)	1,506 (20.1%)	0.001
4	7,334 (18.3%)	1,436 (19.1%)	0.022
5 (highest)	7,536 (18.8%)	1,532 (20.4%)	0.041
Missing	131 (0.3%)	24 (0.3%)	0.001
Residence n (%)			
'Large urban 100+k'	29,832 (74.4%)	5,485 (73.1%)	0.029
'Medium urban 10-100k'	4,512 (11.3%)	848 (11.3%)	0.002
'Small town <10k'	5,754 (14.3%)	1,170 (15.6%)	0.035
Most responsible diagnosis n (%)			
Ischemic stroke	10,035 (25.0%)	1,871 (24.9%)	0.002
Transient ischemic attack	30,063 (75.0%)	5,632 (75.1%)	0.002
ED Hospital type			
Comprehensive Stroke Centre	8,041 (20.1%)	1,758 (23.4%)	0.082
Primary Stroke Centre	7,002 (17.5%)	1,458 (19.4%)	0.051
Non-designated Stroke Centre	25,055 (62.5%)	4,287 (57.1%)	0.109
Hypertension n (%)	28,239 (70.4%)	4,995 (66.6%)	0.083
Diabetes n (%)	12,458 (31.1%)	2,367 (31.5%)	0.010
Atrial fibrillation n (%)	7,015 (17.5%)	1,203 (16.0%)	0.039
Dyslipidemia n (%)	16,028 (40.0%)	2,880 (38.4%)	0.033
History of stroke n (%)	4,202 (10.5%)	715 (9.5%)	0.032
Coronary artery disease n (%)	5,915 (14.8%)	984 (13.1%)	0.047
Peripheral artery disease n (%)	1,374 (3.4%)	194 (2.6%)	0.049
Baseline medication use			
Anti-hypertensive	20,652 (51.5%)	3,827 (51.0%)	0.010
Anti-hyperlipidemia	17,320 (43.2%)	3,388 (45.2%)	0.039
Anti-hyperglycemic	5,737 (14.3%)	1,146 (15.3%)	0.027

* Std diff: standardized difference, where value >0.1 indicates a potentially meaningful difference.

Table 2 Admission and death within 90 days of emergency department discharge before and after the implementation of outpatient telemedicine billing codes

	Rate [95% CI] per 100 person-month		**Adjusted HR* [95%CI]**
	Before telemedicine n = 40,098	After telemedicine n = 7,503	
All-cause admission	5.9 [5.7, 6.0]	5.6 [5.3, 5.9]	0.97 [0.91, 1.04]
Stroke admission	1.4 [1.3, 1.4]	1.5 [1.3, 1.6]	1.06 [0.94, 1.20]
Death	1.0 [0.9, 1.0]	1.0 [0.9, 1.1]	1.07 [0.93, 1.24]

CI: confidence interval

* Adjusted for age (continuous), sex, neighborhood income, rurality, most responsible diagnosis (TIA versus stroke), hypertension, diabetes, atrial fibrillation, dyslipidemia, history of stroke, coronary artery disease, and peripheral artery disease.

Figure 1 Age/Sex standardized rates of emergency department visits for transient ischemic attack or ischemic stroke per 100,000 discharged without admission

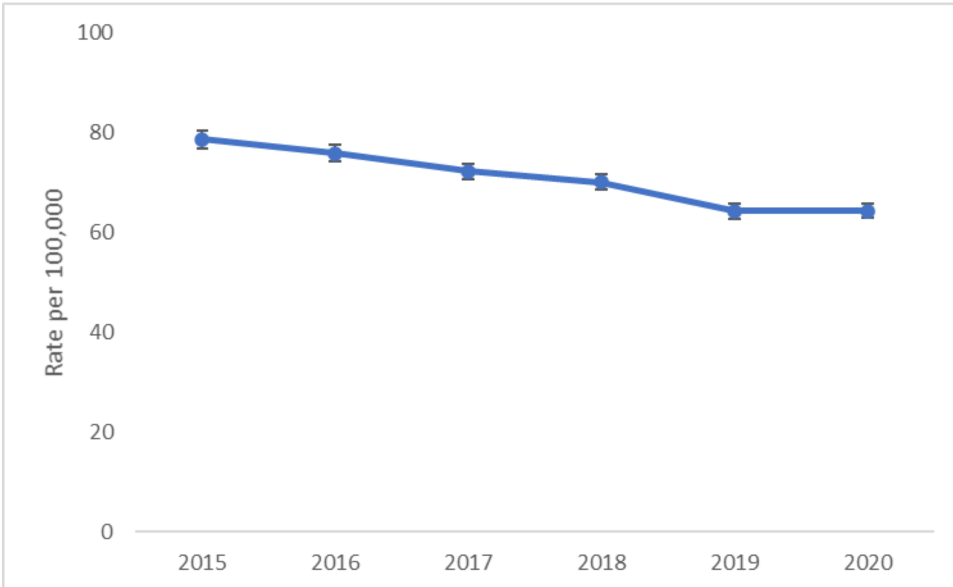


Figure 2 Pattern of clinic visits within 90 days of ED discharge for TIA or minor stroke

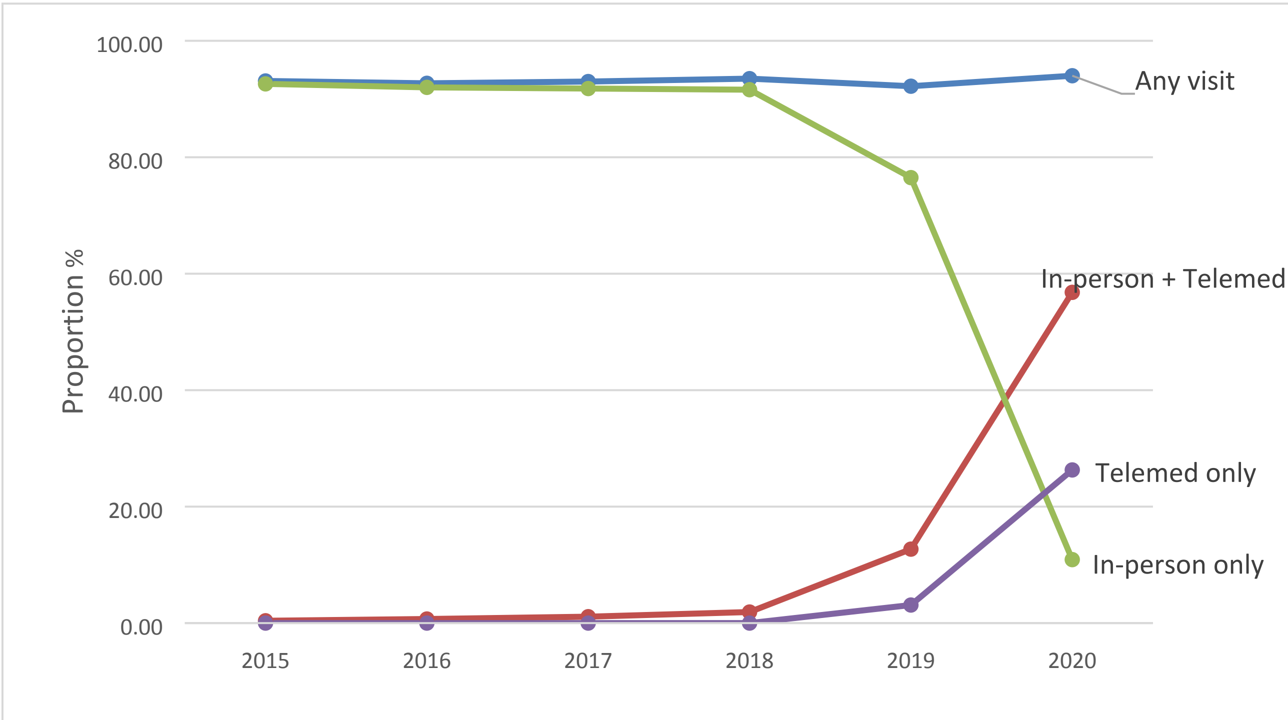
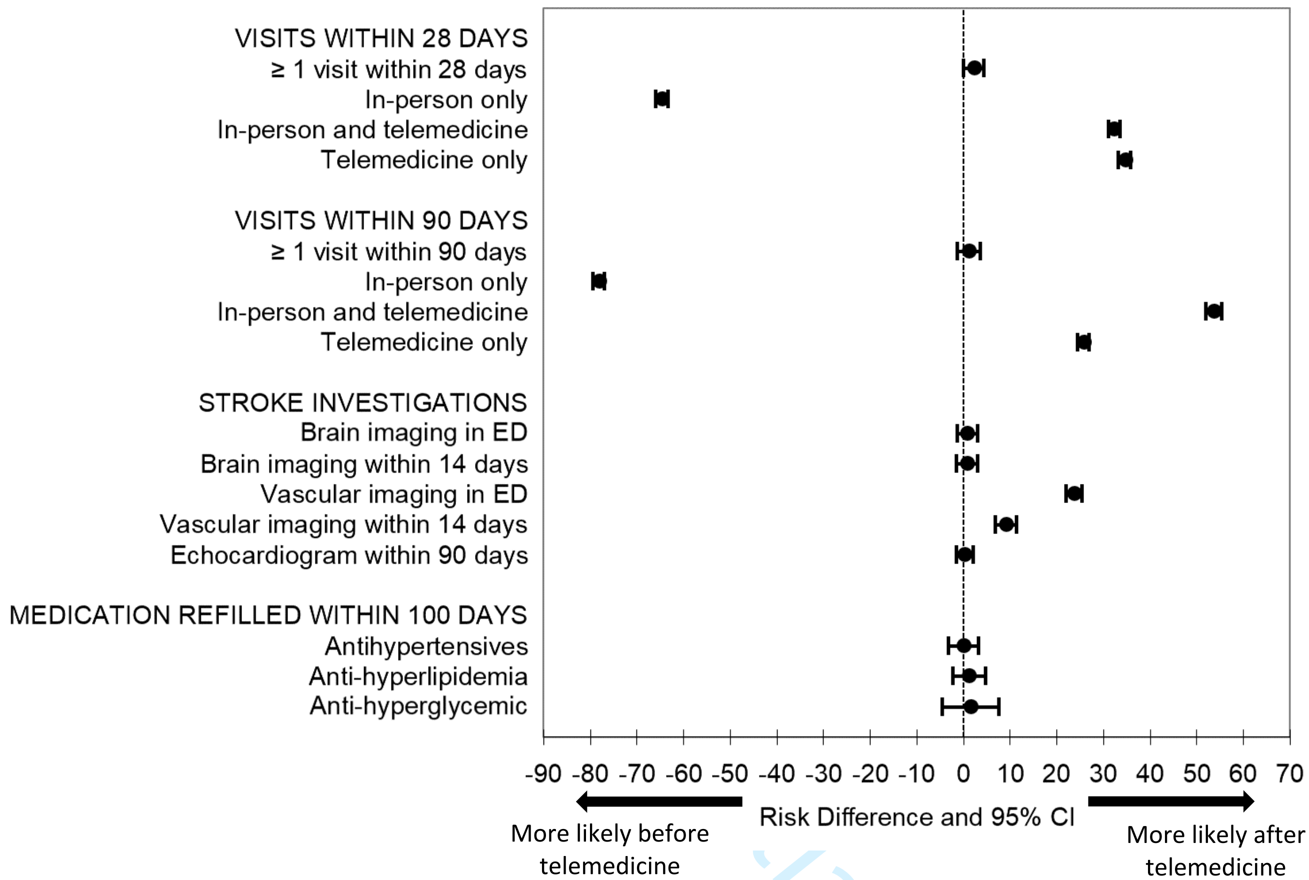


Figure 3 Forest plot of the risk difference and 95% confidence intervals (CI) of clinic visits, stroke investigations, and medication refills after the implementation of telemedicine compared to before



Supplemental Table 1 Case definitions for outcomes and covariates

Outcomes	Database	Definition
All-cause readmission	Discharge Abstract Database National Ambulatory Care Reporting System	A first re-visit to ED or admission to hospital for any reason in the 90 days following index ED visit
Stroke readmission	Discharge Abstract Database	Admission to hospital with a primary diagnosis of ischemic stroke (ICD-10-CA I63.1, I64.x, H34.1) or intracerebral hemorrhagic stroke (I61.x) in the 90 days following index ED visit
Death	Ontario Registered Persons Database	Death within 90 days of index ED visit
Telemedicine visit	Ontario Health Insurance Plan	Physician billing code - K080, K081, K082, K083, B099A, B100A, B103A, B200A, B203A, B209A
Physician visits	Ontario Health Insurance Plan ICES Physician Database Corporate Provider Database	The type of consultation (family doctor or stroke specialist) in the 28 days after index ED visit. The overall number of healthcare visits with family doctors and stroke specialists in the 90 days after index ED visit. A visit includes one or more services billed for by a unique physician ID on a single calendar day. Family doctor specialty = 'Family practice and general practice' Stroke specialty = 'Internal medicine', 'Neurology', 'Cardiology', 'Geriatric medicine'
Neuroimaging	National Ambulatory Care Reporting System Ontario Health Insurance Plan	Canadian classification of health intervention code (CCI) or physician billing code within 14 days of index ED visit including the index event. CT head: CCI code - 3AN20, 3ER20 or Physician billing code - X188, X400, X401, X402, X405

		MRI brain: CCI code - 3AN40, 3ER40 or Physician billing code - X421, X422, X425
Neurovascular imaging	National Ambulatory Care Reporting System Ontario Health Insurance Plan	Canadian classification of health intervention code (CCI) or physician billing code within 14 days of index ED visit including the index event. CT-angiogram: CCI code - 3JE20, 3JX20 or Physician billing code - X404, X417, X408 MR-angiogram: CCI code - 3JE40, 3JX40 or Physician billing code - X431, X435 Carotid Doppler: CCI code - 3JE30 or Physician billing code - J190, J191, J192, J490, J491, J492, J201, J501, J195, J189, J489
Echocardiogram	National Ambulatory Care Reporting System Ontario Health Insurance Plan	Canadian classification of health intervention code (CCI) or physician billing code within 14 days of index ED visit including the index event. CCI code - 3IP30 or Physician billing code - G570, G571, G577, G578, G560, G561, G562, G566, G567, G568, G572, G574, G575, G576, G580, G581, G579
Anti-hypertensive medication	Ontario Drug Benefit	Individual is considered on an anti-hypertensive at baseline if prescription was dispensed in the 100 days before the index ED visit or up to 7 days after the ED visit and where the days supply encompasses the ED visit date. Includes drugs of sub-class: ACE-inhibitors, angiotensin receptor blockers, beta-blockers, calcium channel blockers, calcium blockers, diuretics, and potassium-sparing diuretics or Drug names: clonidine HCL, doxazosin mesylate, guanethidine monosulfate, prazosin HCL, reserpine, reserpine & hydrochorothiazide,

		terazosin HCL, methyldopa, methyldopa HCL, prazosin, hydralazine
Anti-dyslipidemia medication	Ontario Drug Benefit	Individual is considered on an anti-dyslipidemia at baseline if prescription was dispensed in the 100 days before the index ED visit or up to 7 days after the ED visit and where the days supply encompasses the ED visit date. Includes drugs of subclass: statins, calcium blockers and anti-lipemic combination, fibrates, or other antilipemic or Drug names: nicotinic acid, niacin, cholestyramine, cholestyramine resin, cholestyramine resin complex, colestipol HCL
Anti-hyperglycemic medication	Ontario Drug Benefit	Individual is considered on an anti-hyperglycemic at baseline if prescription was dispensed in the 100 days before the index ED visit or up to 7 days after the ED visit and where the days supply encompasses the ED visit date. Includes drugs of subclass: insulins, oral anti-glycemics (including acarbose, acetohexamide, alogliptin, canagliflozin, chlorpropamide, dapagliflozin, gliclazide, glimepiride, glipizide, glyburide, guar gum, linagliptin, metformin, nateglinide, pioglitazone, repaglinide, rosiglitazone, saxagliptin, sitagliptin, tolbutamide, troglitazone)
Predictor variables	**Database**	**Definition**
Age (continuous)	Ontario Registered Persons Database	≥ 18 years of age as of index ED visit
Sex	Ontario Registered Persons Database	Male, Female
Neighborhood income quintile	Statistics Canada Census Postal Code Conversion File	Using the smallest standard geographic area for which census data are disseminated (400-700 persons) to identify a person's

		neighbourhood of residence and the neighbourhood's average income
Rural home location	Postal Code Conversion File	Using the smallest standard geographic area for which census data are disseminated (400-700 persons) to determine the extent of urbanicity of a person's residence Community size = 1 or 2 or 3 'Large urban 100+k' Community size = 4 'Medium urban 10-100k' Community size = 5 or 9 'Small town <10k'
Hypertension	Discharge Abstract Database Same Day Surgery Database Ontario Health Insurance Plan	Lookback to 1991: ≥2 outpatient claims (ICD-9 401.x, 402.x, 403.x, 404.x, or 405.x) in a two-year period, or 1 outpatient + 1 hospitalization or day surgery record (ICD-10-CA I10.x, I11.x, I12.x, I13.x, or I15.x) in a two-year period, or If no outpatient record is found, ≥1 hospitalization or day surgery record
Diabetes	Discharge Abstract Database Ontario Health Insurance Plan Ontario Drug Benefit Program	Lookback to 1991: ≥2 outpatient claims (ICD-9 250) in a one-year period, or ≥1 hospitalization (ICD-10-CA E10, E11, E13, E14), or ≥1 diabetes drug claim in a one-year period
Atrial fibrillation	Discharge Abstract Database National Ambulatory Care Reporting System Ontario Health Insurance Plan	Lookback to 1988: 1 hospitalization or 1 ED visit (ICD-10-CA I48) or 4 outpatient claims (ICD-9 427) in a 1-year period
Dyslipidemia	Discharge Abstract Database Same Day Surgery Database Ontario Health Insurance Plan	Lookback to 1991: 1 hospital admission (ICD-9 272 or ICD-10-CA E78 as any diagnosis), or 2 outpatient claims (ICD-9 272) within 2 years, or 1 outpatient claim followed by 1 hospital admission within 2 years
History of stroke	Discharge Abstract Database	Lookback to 1988: Ischemic stroke: ICD-10-CA I63, I64, H341; ICD-9 434, 436, 362.3 or

		Hemorrhagic stroke: ICD-10-CA I60, I61; ICD-9 430, 431
Coronary artery disease	Discharge Abstract Database Same Day Surgery Database	Lookback to 1988: ICD-10-CA I21, I22, or CCI 1IJ50, 1IJ57GQ, 1IJ54, 1IJ76 ICD-9 410 or CCP 4802, 4803, 481
Peripheral artery disease	Discharge Abstract Database Same Day Surgery Database	Lookback to 1988: ICD-10-CA I702, I713, I714, I739, I743, I744 or CCI 1JE57, 1JE50, 1JE87 ICD-9 4402, 4413, 4414, 4439, 4442 or CCP 5012

ED: emergency department, CCI: Canadian classification of health interventions, CCP: Canadian classification of procedures

Supplemental Table 2 Clinic visits and care before and after the implementation of outpatient telemedicine billing codes

	Before telemedicine n = 40,098	After telemedicine n = 7,503	Risk Difference [95% confidence intervals]
At least 1 visit within 28 days n (%)	33,353 (83.2%)	6,403 (85.3%)	2.2 [-0.1 , 4.4]
Visit type within 28 days n (%)			
In-person and telemedicine	373 (0.9%)	2,496 (33.3%)	32.3 [31.0 , 33.6]
In-person only	32,817 (81.8%)	1,284 (17.1%)	-64.7 [-66.0 , -63.4]
Telemedicine only	163 (0.4%)	2,623 (35.0%)	34.6 [33.2 , 35.9]
No visits	6,745 (16.8%)	1,100 (14.7%)	-2.2 [-3.1 , -1.2]
At least 1 visit within 90 days n (%)	37,254 (92.9%)	7,053 (94.0%)	1.1 [-1.3 , 3.5]
Visit type within 90 days n (%)			
In-person and telemedicine	1,298 (3.2%)	4,264 (56.8%)	53.6 [51.9 , 55.3]
In-person only	35,723 (89.1%)	817 (10.9%)	-78.2 [-79.4 , -77.0]
Telemedicine only	233 (0.6%)	1,972 (26.3%)	25.7 [24.5 , 26.9]
No visits	2,844 (7.1%)	450 (6.0%)	-1.1 [-1.7 , -0.5]
Family doctor visits within 90 days n (%)			
0	8,753 (21.8%)	1,802 (24.0%)	2.2 [1.0 , 3.4]
1	10,218 (25.5%)	1,572 (21.0%)	-4.5 [-5.7 , -3.4]
2	8,728 (21.8%)	1,369 (18.2%)	-3.5 [-4.6 , -2.5]
3+	12,400 (30.9%)	2,760 (36.8%)	5.9 [4.4 , 7.3]
Stroke specialist visits within 90 days n (%)			
0	9,235 (23.0%)	1,432 (19.1%)	-3.9 [-5.0 , -2.9]
1	16,564 (41.3%)	2,740 (36.5%)	-4.8 [-6.3 , -3.3]
2	9,211 (23.0%)	1,860 (24.8%)	1.8 [0.6 , 3.0]
3+	5,088 (12.7%)	1,471 (19.6%)	6.9 [5.9 , 8.0]
Brain imaging in ED n (%)	32,597 (81.3%)	6,161 (82.1%)	0.8 [-1.4 , 3.1]
Brain imaging within 14 days n (%)	36,728 (91.6%)	6,930 (92.4%)	0.8 [-1.6 , 3.1]
Vascular imaging in ED n (%)	10,246 (25.6%)	3,691 (49.2%)	23.6 [22.0 , 25.3]
Vascular imaging within 14 days n (%)	30,006 (74.8%)	6,300 (84.0%)	9.1 [6.9 , 11.4]
Echocardiogram within 90 days n (%)	21,054 (52.5%)	3,952 (52.7%)	0.2 [-1.6 , 2.0]
Medications refilled within 100 days[a]			
Anti-hypertensives n/N (%)	19,042/20,652 (92.2%)	3,529/3,827 (92.2%)	0.0 [-3.3 , 3.3]
Anti-hyperlipidemia agent n/N (%)	15,510/17,320 (89.5%)	3,076/3,388 (90.8%)	1.2 [-2.3 , 4.7]
Anti-hyperglycemic n/N (%)	5,237/5,737 (91.3%)	1,068/1,146 (92.8%)	1.5 [-4.6 , 7.6]

ED: emergency department

[a] Denominators reflect number of patients aged >65 years on the medication at baseline

Supplemental Table 3 Patient characteristics comparing patients who had at least one ambulatory clinic visit within 28 days of emergency department discharge to those without visits before and after the implementation of outpatient telemedicine billing codes

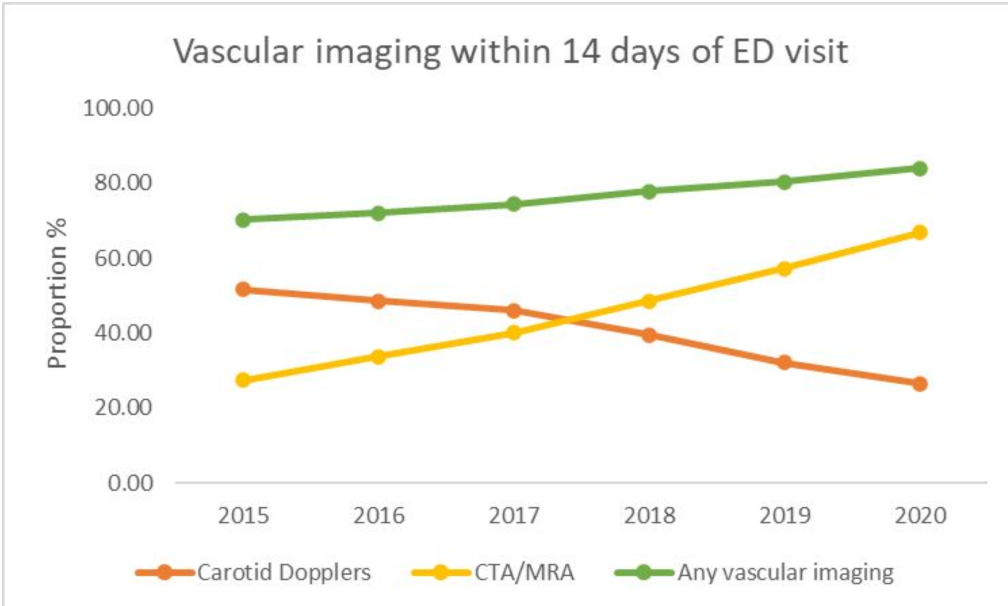
	Before telemedicine* n = 39,562			**After telemedicine n = 7,503**			
	In-person only n = 32,817	**No visits n = 6,745**	**p-value**	**In-person only n = 1,284**	**No visits n = 1,100**	**≥ 1 Telemed n = 5,119**	**p-value**
Median age (IQR), yrs	72 (62, 81)	75 (63, 85)	<0.001	73 (63, 81)	73 (62, 83)	73 (63, 81)	0.007
Age group n (%)							
18-45 years	1,350 (4.1%)	344 (5.1%)	<0.001	50 (3.9%)	52 (4.7%)	220 (4.3%)	<0.001
46-65 years	9,315 (28.4%)	1,663 (24.7%)		334 (26.0%)	298 (27.1%)	1,440 (28.1%)	
66-75 years	8,527 (26.0%)	1,448 (21.5%)		344 (26.8%)	263 (23.9%)	1,410 (27.5%)	
76-85 years	8,911 (27.2%)	1,685 (25.0%)		388 (30.2%)	279 (25.4%)	1,387 (27.1%)	
>85 years	4,714 (14.4%)	1,605 (23.8%)		168 (13.1%)	208 (18.9%)	662 (12.9%)	
Female sex n (%)	16,118 (49.1%)	3,404 (50.5%)	0.043	603 (47.0%)	541 (49.2%)	2,538 (49.6%)	0.244
Neighborhood Income Quintile n (%)							
1 (lowest)	6,779 (20.7%)	1,704 (25.3%)	<0.001	258 (20.1%)	273 (24.8%)	934 (18.2%)	<0.001
2	6,911 (21.1%)	1,454 (21.6%)		290 (22.6%)	211 (19.2%)	1,039 (20.3%)	
3	6,603 (20.1%)	1,315 (19.5%)		249 (19.4%)	226 (20.5%)	1,031 (20.1%)	
4	6,084 (18.5%)	1,141 (16.9%)		256 (19.9%)	184 (16.7%)	996 (19.5%)	
5 (highest)	6,356 (19.4%)	1,087 (16.1%)		227-232	201-206	1,104 (21.6%)	
Missing	84 (0.3%)	44 (0.7%)		†	†	15 (0.3%)	
Residence n (%)							
'Large urban 100+k'	25,288 (77.1%)	4,174 (61.9%)	<0.001	827 (64.4%)	657 (59.7%)	4,001 (78.2%)	<0.001
'Medium urban 10-100k'	3,364 (10.3%)	1,079 (16.0%)		212 (16.5%)	182 (16.5%)	454 (8.9%)	
'Small town <10k'	4,165 (12.7%)	1,492 (22.1%)		245 (19.1%)	261 (23.7%)	664 (13.0%)	
Most responsible diagnosis n (%)			<0.001				
Ischemic stroke	7,804 (23.8%)	2,072 (30.7%)		312 (24.3%)	366 (33.3%)	1,193 (23.3%)	<0.001
Transient ischemic attack	25,013 (76.2%)	4,673 (69.3%)		972 (75.7%)	734 (66.7%)	3,926 (76.7%)	
ED Hospital type							
Comprehensive stroke centre	6,885 (21.0%)	1,144 (17.0%)	<0.001	352 (27.4%)	239 (21.7%)	1,167 (22.8%)	<0.001
Primary stroke centre	5,805 (17.7%)	1,150 (17.0%)		223 (17.4%)	263 (23.9%)	972 (19.0%)	
Non-designated stroke centre	20,127 (61.3%)	4,451 (66.0%)		709 (55.2%)	598 (54.4%)	2,980 (58.2%)	
Hypertension n (%)	23,142 (70.5%)	4,737 (70.2%)	0.6351	839 (65.3%)	730 (66.4%)	3,426 (66.9%)	0.553

Diabetes n (%)	10,152 (30.9%)	2,140 (31.7%)	0.2	395 (30.8%)	348 (31.6%)	1,624 (31.7%)	0.801
Atrial fibrillation n (%)	5,588 (17.0%)	1,332 (19.7%)	<0.001	181 (14.1%)	179 (16.3%)	843 (16.5%)	0.114
Dyslipidemia n (%)	13,360 (40.7%)	2,440 (36.2%)	<0.001	454 (35.4%)	368 (33.5%)	2,058 (40.2%)	<0.001
History of stroke n (%)	3,115 (9.5%)	1,034 (15.3%)	<0.001	104 (8.1%)	155 (14.1%)	456 (8.9%)	<0.001
Coronary artery disease n (%)	4,820 (14.7%)	1,023 (15.2%)	0.312	162 (12.6%)	160 (14.5%)	662 (12.9%)	0.300
Peripheral artery disease n (%)	1,056 (3.2%)	300 (4.4%)	<0.001	36 (2.8%)	32 (2.9%)	126 (2.5%)	0.249

*Patients with telemedicine visits in the 2015-2020 “before telemedicine” period are censored due to small numbers.

† Censored due to small numbers.

Supplemental Figure 1 Vascular imaging within 14 days of the emergency department visit (including imaging done in the emergency department) by fiscal years



CTA: computed tomography angiography, MRA: magnetic resonance angiography