Title: Association between continuity and access: A retrospective multilevel cohort study in primary care

Subtitle: If continuity is king, access is queen

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Abstract

Background: Continuity is a tenet of family medicine. We explored whether a change in access (improving or worsening) to a primary care provider (PCP) is associated with a change in provider (PC) or clinic continuity (CC), discontinuity, or emergency department (ED) utilization.

Methods: We used the time to third next available (TNA) appointment as a measure of access of 190 PCPs from 2009 to 2016 in the province of Alberta and calculated the provider and clinic continuity, discontinuity, and ED utilization based on the PCPs' historical panels. We identified those PCPs who had improved, worsened or had observed no change in appointment delay each year. These groups were then assessed in multi-level models to determine the association with continuity at the physician and clinic levels, and ED.

Results When compared to PCPs who had no change in access, PCPs with improved access had improved PC by 6.8% per year, reduced discontinuity by 2.1% per year, and decreased ED encounters by 104 visits per 1000 patients per year. When compared to the PCPs with no change in their TNA, those PCPs with worsening access had a 6.2% decrease in PC, and an increase number of ED encounters (52 visits per 1000 paneled patients per year). Changes in appointment delay to PCPs had no impact on clinic continuity when compared to those PCPs with no change in their appointment delay.

Interpretation Improving access by reducing the appointment delay to a PCP may be one mechanism to improve continuity of care.

Key Words: primary care, family medicine, continuity, access, delay, attachment, physician panels

Introduction

Alberta is transforming its provincial healthcare system to enhance care in the community, moving from a focus on acute care services to one that meets the health and social needs of its population (1). An important aspect of community-based care is the patient's medical home (PMH), where the majority of care is led by a consistent primary care provider (PCP). This concept, known as continuity of care (COC), was highlighted decades ago (2), and mechanisms to support information exchange and disease management within an interpersonal relationship make COC a tenet of primary care (3). Studies have demonstrated that patients with high COC to a single provider are associated with better outcomes, such as fewer hospitalizations (4-11) and lower emergency department (ED) encounters (12-16), improved delivery of preventative-care services (17-20), increased adherence to medications (21-23), enhanced satisfaction (24, 25), and lower costs (9, 26, 27).

Access to primary care is about a patient's opportunity to receive timely, appropriate and quality health services (28). It is widely agreed that the opportunity for a patient to receive care when needed is associated with better patient and system outcomes (29). Timely access to primary care is operationally defined in this study as the length of time a patient waits for an appointment with their PCP. The question of precisely how delaying primary care intersects with COC has not been examined empirically. Bennet postulated COC and access to primary care were not independent concepts (30). Intuitively, if the delay in access to one's own PCP is too great from the patient's perspective, it follows that they may seek care from another PCP and place COC in peril.

We designed this study to explore the relationship between primary care access and COC.

Methods

Study Cohort

This was a retrospective observational cohort study of 205 PCPs participating in the Chinook Primary Care Network (CPCN) in Alberta, Canada from 2009 to 2016, who were actively measuring third next available (TNA) appointment for their short appointments throughout the year (more than thirteen weekly measures of delay between January and December) and had an annual panel. Primary Care Networks (PCN)s in Alberta are the common delivery model of primary care consisting of PCPs and allied health professionals delivering care in their communities (31). The CPCN serves an urban centre of 100,000 and 14 small rural communities. The CPCN was an early adopter of office practice redesign concepts (32), learning to measure delay for physician appointments, and balancing patient demand with physician supply; data were regularly collected for improvement purposes.

Access (Short Appointment Delay)

Primary care access was measured using the TNA appointment (33) metric, which is the delay patients experience accessing providers for a scheduled appointment. Short appointments are typically 10-15 minutes in duration and are for routine primary care encounters. TNA was recorded in an online database at the same time on Tuesdays by clinic staff; therefore, a week was defined as starting on Tuesday and extending to the following Monday. The TNA measures for each PCP were recorded between January 5, 2009 to January 2, 2017.

Historical Panels

Each CPCN PCP had a panel -- a list of patients for whom the PCP was the most responsible provider of continuous and longitudinal primary healthcare. PCPs reviewed their panels and reconfirmed the attachment with their patients annually. Panels from 2009 to 2016 were extracted from the PCP's electronic medical record.

Outcome Measures: Continuity (Provider, Clinic), Discontinuity, and Emergency Department Encounters

The historical panels for each PCP were matched to the Alberta Health Practitioner Claims database to determine the visits of patient to a PMH observed each week. To ensure patient activity was linked to one encounter rather than multiple claims, we defined one visit as the same patient seeing the same PCP in the same clinic on the same day. The weekly number of visits was tabulated, using the same definition of 'week' as used for the TNA metric.

We calculated a weekly provider continuity (PC) outcome using the Known Provider Continuity Index (34) which summarizes the number of weekly visits the paneled patients made to their attached PCP. This step ensured we could link the activity of the PCP's panel directly to the TNA measure on a weekly basis. We also calculated a weekly clinic continuity (CC) outcome by determining the number of visits the paneled patients made to other PCPs within the PMH, as well as a weekly discontinuity outcome that we defined as the number of visits the paneled patient made to a PCP in another PMH. Furthermore, we matched the PMHs to the Alberta Health Services Distance and Drive-Time Look-Up map, and included only those visits to a PMH that was within a 50km driving radius of where the paneled physician was located (35).

Historical panels for each PCP were also linked to the National Ambulatory Care Reporting System, which is used in Canada for collecting and reporting on all levels of ambulatory care, including ED. Only non-scheduled visits to the ED and urgent care centers were included. We defined one ED encounter as a paneled patient visiting an ED within a 50 km driving radius of the paneled PCP location. A weekly ED encounter outcome was then calculated, using the same definition of week described above.

Confounding Variables

We selected a number of PCP practice and panel variables that have been shown to influence appointment delay and continuity (6, 36-45) (Table 1). We also calculated the starting TNA value as a confounding variable to assess whether having a higher starting value influenced the outcome of interest by taking the average of the first three TNA measures.

Table 1: Practice and panel level confounding variables

Confounding Variables	
Practice Characteristics	**Panel Characteristics**
Number of PCPs in the PMH(6, 36)	PCP panel size (37, 38)
Gender of PCPs(39, 40)	Age of panel (37)
Location PMH PCPs(41)	Number of patients on multiple panels (42)
Number of days worked per week (43)	Panel complexity[1](37, 44)
	Number of female patients (37, 45)

PCP=Primary Care Provider; PMH=Patient's Medical Home

[1]The Canadian Institute of Health Information's Population Grouper, was used to infer patient complexity (46).

Statistical Analysis

Each year, the PCPs whose appointment delay either improved (statistically significant negative trajectory), worsened (statistically significant positive trajectory), or remained stable (not statistically significant) were identified through linear regressions. Grouping the PCPs in this manner created three annual TNA trajectory categories. Scatter plots for each TNA trajectory category were created, and a linear regression was added to visualize the relationship between the outcome variables over a one year period.

In this analysis, PCPs' weekly appointment delay and continuity metrics were assessed in one-year segments, with the majority of PCPs measuring for more than one year during the eight year study period. Our multi-level mixed-effects linear regression models accounted for three levels of effects: Level-1 units were the weekly continuity measurements for one year; Level-2 units were the measuring PCPs for that year, and Level-3 units were all measurement years for a PCP at the same clinic. The association between TNA trajectory categories and the weekly continuity trajectory was examined using a group by time interaction. The model included a random intercept for each PCP within a given year. Confounding variables were added at the PCP and clinic levels as fixed effects without interactions with time. In this way, our study design estimated how continuity changed when PCPs improved or worsened their appointment delays after adjusting for relevant confounders and accounting for the association among observations within PCPs in a given year.

All analysis was performed using Stata 13.1.

Ethics approval

This study was approved by Health Research Ethics Board-3 at the University of Alberta.

Results

Of the 205 PCPs, only 190 met our inclusion criteria (greater than thirteen weekly measures of TNA between January and December) within the calendar year (Table 2). The number of physicians increased annually from 2009 to 2016 (from 81 to 133), which led to a corresponding increase in the number of paneled patients each year (from 110,868 to 169,653). The number of clinics and the number of PCPs per clinic increased over the first three years of the study, whereas the percentage of female PCPs remained stable and the percentage of rural PCPs decreased over time. The panel size, mean age, complexity, female composition and elderly representation all remained consistent over the study period. There was a decrease in the overall number of patients present on multiple PCP panels (from 13.9% to 11.4%). (Table 3).

Table 2: Number of physicians who met the inclusion criteria each calendar year

	2009	2010	2011	2012	2013	2014	2015	2016
Number of PCPs with a panel	86	93	119	119	130	152	154	153
Number of PCPs excluded (<13 TNA measures within the year).	5	2	22	3	16	38	28	20
Number of PCPs included in analysis	81	91	97	116	114	114	126	133

TNA=third next available appointment

Table 3: Descriptive statistics for confounding variables for each study year.

Confounding Variables	2009	2010	2011	2012	2013	2014	2015	2016
Practice Characteristics								
Number of PCPs	81	91	97	116	114	114	126	133
Number of clinics	17	18	19	24	23	21	22	23
Percent of female PCPs	25.9	29.7	30.9	28.9	32.5	28.1	31.2	30.5
Percent of rural PCPs	58.0	56.0	54.6	46.6	46.5	50.0	46.0	48.9
Mean (SD) number of days worked per week	4.0 (1.5)	4.0 (1.5)	3.9 (1.5)	4.0 (1.5)	4.0 (1.4)	4.1 (1.3)	4.0 (1.4)	3.9 (1.4)
Mean (SD) number of PCPs per clinic	7.1 (3.4)	7.3 (3.6)	8.2 (4.5)	8.7 (4.1)	7.9 (3.9)	9.5 (5.0)	8.4 (3.5)	7.9 (3.4)
Panel Characteristics								
Number of paneled patients	110868	114531	108244	151866	157631	158974	164965	169563
Mean (SD) values:								
PCP panel size	1458.8 (779)	1286.9 (742)	1127.5 (674)	1368.2 (928)	1382.7 (832)	1406.8 (845)	1330.4 (829)	1367.4 (806)
Age of panel (years)	39.6 (6.8)	40.1 (7.2)	40.4 (7.3)	40.3 (6.8)	40.1 (6.5)	40.0 (6.1)	39.1 (5.8)	39.2 (6.0)
Percent of panel on multiple panels	13.9 (6.9)	13.4 (7.7)	14.1 (10.9)	12.5 (7.1)	14.0 (7.5)	11.5 (5.9)	12.0 (8.9)	11.4 (8.3)
Percent of panel complex	5.2 (1.8)	5.0 (1.7)	5.6 (1.8)	5.3 (1.7)	4.8 (1.9)	5.1 (1.7)	5.3 (1.8)	6.0 (2.0)
Percent of panel female	55.2 (13.5)	55.5 (13.8)	55.2 (14.4)	55.3 (13.4)	54.2 (13.2)	53.5 (12.6)	53.6 (12.4)	53.1 (11.9)
Percent of panel over 60 years of age	21.3 (9.7)	22.4 (10.5)	22.4 (10.8)	23.5 (10.3)	23.1 (10.0)	22.7 (9.4)	22.3 (8.8)	22.9 (9.4)

SD=standard deviation

Overall, the four outcomes variables appeared relatively stable year upon year when viewed at the aggregate level (Table 4).

Table 4: Means (SD) of the outcome variables for each year of the study period.

Outcome Variables	2009	2010	2011	2012	2013	2014	2015	2016
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Provider Continuity	58.7 (21.9)	60.6 (23.7)	60.9 (24.2)	62.3 (23.8)	62.3 (22.6)	64.2 (22.1)	64.1 (22.3)	63.6 (22.5)
Clinic Continuity	76.7 (11.8)	79.5 (12.3)	80.2 (11.5)	80.1 (12.7)	79.1 (12.4)	81.0 (10.4)	81.1 (10.5)	79.6 (11.5)
Discontinuity within 50km of the clinic	14.6 (10.0)	12.7 (9.2)	11.6 (9.0)	11.4 (9.3)	11.1 (9.1)	9.6 (7.6)	10.2 (8.0)	10.6 (8.5)
All Cause Emergency Department Visits (per 1000) within 50 km of the clinic	1.14 (0.6)	1.06 (0.6)	1.04 (0.6)	1.06 (0.6)	0.95 (0.5)	0.98 (0.6)	1.01 (0.7)	1.03 (0.6)

We analyzed individual PCP TNA trajectories over the 8 year time period, and found 96 (11%) annual TNA trajectories that improved, 669 (77%) remained stable, and 107 (12%) that worsened. Weeks for each year of the study period were combined to depict each of the average weekly outcome measures (provider and clinic continuity, discontinuity, and ED utilization) segmenting by the TNA exposure groups. (Figure 1). A linear regression line was applied to each scatterplot.

For PCPs with an improved annual TNA trajectory, PC (= 0.21, p <0.001, R^2 = 34.0%) and CC (= 0.06, p <0.001, R^2 = 35.1%) increased, whereas the discontinuity (= -0.07, p <0.001, R^2 = 51.0%) and ED visit rates (=-0.0024, p <0.001, R^2 = 29.3%) decreased. When the annual TNA trajectories worsened, PC (= -0.22, p <0.001, R^2 = 41.8%) and CC (= -0.05, p <0.001, R^2 = 37.5%) decreased, whereas the discontinuity (=0.01, p <0.001, R^2 = 10.6%) and the ED visit rates (= 0.0023, p <0.001, R^2 = 30.5%) increased. When the TNA trajectories remained stable, PC (= 0.02, p=0.41, R^2 =1.4%) did not change; CC (= 0.01, p < 0.05, R^2 =10.4%) and discontinuity (= 13.4, p<0.001, R^2 = 45.6%) increased, and the ED visit rate decreased (= -0.0024, p<0.001, R^2 = 35.7%).

With the exception of the starting TNA variable, the confounding variables were balanced across the three TNA exposure groups (Table 5). We stratified the starting TNA values into three groups (< 5 days, 5-10 days, and > 10 days) to explore the impact on the outcome variables (PC, CC, discontinuity, and ED utilization), and found it affects the degree of change in continuity over time, but not the direction of effect.

Table 5: Confounding variables within the Third Next Available Exposure Groups

	TNA Exposure Group		
	Improving	**Stable**	**Worsening**
Practice Characteristics			
Percent of female PCPs	39.6	27.8	34.3
Percent of rural PCPs	51.0	50.5	47.7
Mean (SD) number of days worked per week	4.1 (1.4)	4.0 (1.4)	4.0 (1.4)
Mean (SD) number of PCPs per clinic	8.8 (4.3)	8.0 (4.0)	8.0 (3.9)
Panel Characteristics			
Mean (SD) values:			
PCP panel size	1412.8 (934.4)	1388.1 (791.7)	1363.3 (938.2)
Age of panel (years)	39.2 (5.3)	40.0 (6.6)	39.2 (6.9)
Percent of panel on multiple panels	13.3 (7.8)	13.1 (8.4)	12.4 (8.4)
Percent of panel complex	5.6 (2.4)	5.3 (2.0)	5.4 (1.8)
Percent of panel female	57.4 (12.8)	54.2 (13.5)	55.7 (13.7)
Starting TNA	11.7 (10.7)	4.4 (5.0)	4.1 (4.1)

TNA=third next available; SD=standard deviation

All confounding variables were included in each of the four separate multi-level regression models, one for each outcome of interest (Table 6). The key output within each is the difference in adjusted outcome trajectories during one year when TNA was improving or worsening compared to when TNA was stable. Coefficients representing this relationship were extracted from each of the four full model outputs and summarized in Supplemental Table 7.

Table 6: Multi-level model of the Effect on Third Next Available Exposure Groups.

Outcome Variable	B (95% CI), P value
Provider Continuity	
When TNA is Improving	0.15 (0.10 to 0.19), <0.001
When TNA is Worsening	-0.10 (-0.15 to -0.05), <0.001
Stable TNA Trajectory (ref)	0.02 (0.00 to 0.04), 0.071
When TNA is improving vs Stable	*0.13 (0.08 to 0.18), <0.001*
When TNA is worsening vs Stable	*-0.12 (-0.17 to -0.07), <0.001*
Clinic Continuity	
When TNA is Improving	0.03 (0.002 to 0.07), 0.035
When TNA is Worsening	-0.02 (-0.05 to 0.02), 0.361
Stable TNA Trajectory (ref)	0.01 (-0.003 to 0.02), 0.122
When TNA is improving vs Stable	*0.02 (-0.01 to 0.06), 0.154*
When TNA is worsening vs Stable	*-0.03 (-0.06 to 0.01), 0.163*
Discontinuity <50km	
When TNA is Improving	-0.06 (-0.08 to -0.03), <0.001
When TNA is Worsening	-0.01 (-0.03 to 0.02), 0.652
Stable TNA Trajectory (ref)	-0.02 (-0.03 to -0.01), <0.001
When TNA is improving vs Stable	*-0.04 (-0.06 to -0.01), 0.009*
When TNA is worsening vs Stable	*0.01 (-0.02 to 0.04), 0.353*
ED Visit Rate / 1000 patients <50km	
When TNA is Improving	-0.0032 (-0.0044 to -0.0020), <0.001
When TNA is Worsening	-0.0005 (-0.0017 to 0.0008), 0.461
Stable TNA Trajectory (ref)	-0.0017 (-0.0021 to -0.0012), <0.001
When TNA is improving vs Stable	*-0.0015 (-0.0028 to -0.0003), 0.018*
When TNA is worsening vs Stable	*0.0012 (-0.001 to 0.0025), 0.064*

TNA=third next available appointment; B=Beta Coefficient, CI=confidence interval

PCPs who improved their TNA over a one-year period saw improvements in PC, discontinuity and in ED utilization by their paneled patients as compared to PCPs with stable TNA. They saw an improvement in PC of 6.8% (0.13*52 weeks) per year (p<0.001), reduced discontinuity of 2.1% (0.04*52 weeks) per year, and few ED visits by 78 visits per 1000 paneled patients per year (1.5*52 weeks) (p<0.05). There was no change in CC (p=0.154).

In the group of PCPs where the TNA worsened over the year, PC decreased by 5.2% (-0.10*52 weeks) per year ($p<0.001$) and 6.2% (-0.12*52 weeks) per year when compared to PCPs whose TNA was stable ($p<0.001$). There was no change in CC ($p=0.163$) or discontinuity ($p=0.353$). ED visits further increased by 64 visits per 1000 paneled patient per year (1.2*52 weeks) ($p<0.1$) compared to PCPs with stable TNA.

Interpretation

When PCPs improved their appointment delay, PC also improved, patients' attendance with external providers was lower, and patients' utilization of the ED decreased. The opposite result was found when PCPs worsened their availability to their patients (decreased PC, and increased ED utilization).

Our findings support the following observations on the impact of appointment delay on continuity. When faced with delay for an appointment, patients chose to break their COC with their attached PCP and seek care at another PMH or in the ED. Although we are unable to claim a causal link between appointment delay and reduced COC, future work from our team will explore this linkage. Merely focusing on COC as the key to good patient outcomes without understanding how access influences COC is shortsighted. High provider continuity may be the desired intended outcome; it cannot be achieved without addressing access issues. Availability of the PCP ensures the patient can seek care when they need it, and with their own provider.

Our data shows that changes in appointment delay of a PCP was not associated with a change in CC. The Office Practice Redesign philosophy operant in the CPCN encourages each PCP to 'take care of your own' (47), so the option to see another PCP in the same PMH was typically not available. Contingency plans when the attached PCP is away for more than a few days (e.g. on vacation) may include offering appointments with another PCP practicing in the PMH, but those situations reflect an exception rather than common practice.

Other studies have explored the relationships between access and COC (16, 25, 36, 37, 43, 48-58), access and ED utilization (16, 59-70), between COC and ED utilization (4, 12-15, 61, 71, 72), and have used various algorithms to develop virtual panels to associate patient to activity to specific PCPs (12, 14, 32, 34, 73). In the majority of these studies, access (25, 36, 48-51, 54, 57, 58, 60, 62, 65-70, 74), COC and ED utilization (25, 36, 48-51, 54, 57, 58, 60, 62, 65-70, 74) were inferred through self-report in patient surveys. Our study appears to be a unique analytical exploration of the relationship between PCP access and COC by using each PCP's actual panel over time to calculate the continuity indices and patient activity to the local ED.

To the best of our knowledge, this is the first study to confirm a long-held assumption: COC and access are not independent concepts. PCPs cannot be available at all times, so it is reasonable to posit that PCP led team-based care in the PMH is a plausible strategy to increase access to a consistent team and subsequently, COC. Metrics that can assess 'team continuity' should be developed. The culture and funding of primary care needs to shift in ways that support COC at the team level, and manage patient expectations around who on the team is best to meet the presenting need.

Limitations of this Study

One limitation of this study was its restriction to one PCN, which does not serve a large metropolitan centre where more service options may be available (e.g. "walk-in" clinics). The observed relationship

between TNA and PC will undoubtedly be more complex in the presence of other care alternatives. The increased ED use when the PCP's delay worsened may not necessarily equate to a deteriorating condition, but reflect a convenient source of primary care. Regardless of the reason for the visit, in our province, the increased utilization of the ED when the PCP's delay worsens results in nearly a three-fold increase in cost for the visit, as compared to a PMH visit.

Conclusions

Our analysis suggests that changing appointment delay in primary care can influence how patients choose to use the healthcare system, and impact PC, discontinuity, and ED utilization. This, in turn, can impact health and system outcomes. As our province repositions the healthcare system to ensure patients receive appropriate care in the community, a focus on improving appointment delay to PCPs practicing in the community, as this PCN did, should be a focal point of primary care reform.

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References

1. Alberta Health Services. The 2017-2020 Health Plan and Business Plan. A Healthier Future. Together. Edmonton, Canada: Alberta Health Services; 2018/2019. p. 1-35.
2. Starfield B. Continuous Confusion? Am J Public Health. 1980;70(2):117-9.
3. Wall EM. Continuity of care and family medicine: defintion, determinants, and relationship to outcome. J Fam Pract. 1981;13(5):655-64.
4. Tammes P, Purdy S, Salisbury C, MacKichan F, Lasserson D, Morris RW. Continuity of primary care and emergency hospital admissions among older patients in England. Ann Fam Med. 2017;15(6):515-22.
5. Jung B, Cho KH, Lee DH, Kim S. The effects of continuity of care on hospital utilization in patients with knee osteoarthritis: analysis of Nationwide insurance data. BMC Health Serv Res. 2018;18(1):1-12.
6. Barker I, Steventon A, Deeny SR. Association between continuity of care in general practice and hospital admissions for ambulatory care sensitive conditions: cross sectional study of routinely collected, person level data. British Medical Journal. 2017;356(j84):1-9.
7. Cho KH, Lee SG, Jun B, Jung B, Kim J, Park E. Effects of continuity of care on hospital admission in patients with type 2 diabetes: analysis of nationwide insurance data. BMC Health Serv Res. 2015;15(107):1-10.
8. Bayliss EA, Ellis JL, Shoup JA, Zeng C, McQuillan DB, Steiner JF. Effect of continuity of care on hospital utilization for seniors with multiple medical conditions in an integrated health care system. Ann Fam Med. 2015;13(2):123-29.
9. Bazemore A, Petterson S, Peterson LE, Bruno R, Chung Y, Phillips Jr. RL. Higher primary care physician continuity is associated with lower costs and hospitalizations. Ann Fam Med. 2018;16(6):492-7.
10. Kao Y, Wu S. Is continuity of care associated with avoidable hospitalization among older asthmatic patients? Medicine. 2016;95(38):1-7.
11. Nyweide DJ, Anthony DL, Bynum JPW, Strawderman RL, Weeks WB, Casalino LP, et al. Continuity of care and the risk of preventable hospitalization in older adults. JAMA Intern Med. 2014;173(20):1879-85.
12. Ionescu-Ittu R, McCusker J, Ciampi A, Vadeboncoeur A, Roberge D, Larouche D, et al. Continuity of primary care and emergency department utilization among elderly people. CMAJ. 2007;177(11):1362-8.
13. Bentler SE, Morgan RO, Virnig BA, Wolinsky FD. The association of longitudinal and interpersonal continuity of care with emergency department use, hospitalization, and mortality among Medicare beneficiaries. PLoS ONE. 2014;9(12):1-18.
14. Gill JM, Mainous III AG, Nsereko M. The effect of continuity of care on emergency department use. Arch Fam Med. 2000;9(4):333-8.
15. Katz DA, McCoy KD, Vaughan-Sarrazin MS. Does greater continuity of veterans administration primary care reduce emergency department visits and hospitalization in older veterans ? J Am Geriatr Soc. 2015;63(12):2510-8.
16. Yoon J, Cordasco KM, Chow A, Rubenstein LV. The relationship between same-day access and continuity in primary care and emergency department visits. PLoS ONE. 2015;10(9):1-12.
17. Fenton JJ, Franks P, Reid RJ, Elmore JG, Baldwin L. Continuity of care and cancer screening among health plan enrollees. Med Care. 2007;46:58-62.
18. Arnold LD, McGilvray MMO, Cooper JK, James AS. Inadequate cancer screening: lack of provider continuity is a greater obstacle than medical mistrust. J Health Care Poor Underserved. 2017;28(1):362-77.

19. Blewett LA, Johnson PJ, Lee B, Scal PB. When a usual source of care and usual provider matter : adult prevention and screening services. Journal of General Internal Medicine. 2008;23(9):1354-60.
20. Poole B, Gelmon K, Kan L. Is Canadian women's breast cancer screening behaviour associated with having a family doctor ? Can Fam Physician. 2010;56:e150-7.
21. Dossa AR, Moisan J, Guenette L, Lauzier S, Gregoire J. Association between interpersonal continuity of care and medication adherence in type 2 diabetes: an observational cohort study. CMAJ OPEN. 2017;5(2):359-64.
22. Hansen RA, Voils CI, Farley JF, Powers BJ, Sanders LL, Sleath B, et al. Prescriber continuity and medication adherence for complex patients. Ann Pharmacother. 2015;49(3):293-302.
23. Warren JR, Falster MO, Tran B, Jorm L. Association of Continuity of Primary Care and Statin Adherence. PLoS ONE. 2015;10(10):1-13.
24. Fan VS, Burman M, McDonell MB, Fihn SD. Continuity of care and other determinants of patient satisfaction with primary care. J Gen Intern Med. 2004;20(3):226-33.
25. Wetmore S, Boisvert L, Graham E, Hall S, Hartley T, Wright L, et al. Patient satisfaction with access and continuity of care in a multidisciplinary academic family medicine clinic. Canadian Family Physcian. 2014;60(April):230-6.
26. De Maeseneer JM, De Prins L, Gosset C, Heyerick J. Provider continuity in family medicine: does it make a difference for total health care costs? Ann Fam Med. 2003;1(3):144-8.
27. Hollander MJ, Kadlec H. Financial implications of the continuity of primary care. The Permanente Journal. 2015;19(1):4-10.
28. Gulliford M, Figueroa-Munoz J, Morgan M, Hughes D, Gibson B, Beech R, et al. What does 'access to health care' mean? Journal of Health Services Research Policy. 2002;7(3):186-8.
29. College of Family Physicians of Canada. A Vision for Canada. Family Practice. The Patient's Medical Home. Ottawa (Ca); 2011 September 2011.
30. Benett IJ. Access, continuity, or both. Br J Gen Pract. 2014;64(August):2013-4.
31. Alberta Health. Primary health care Edmonton, Canada: Government of Alberta; 2019 [Available from: https://www.alberta.ca/primary-health-care.aspx#toc-3.
32. Murray M. Patient care: access. BMJ. 2000;320(7249):1594-6.
33. Murray M, Berwick DM. Advanced access: reducing waiting and delays in primary care. JAMA. 2003;289(8):1035-40.
34. Ejlertsson G, Berg S. Continuity of care in health care teams. A comparison of continuity measures and organisational solutions. Scand J Prim Health Care. 1985;3(2):79-85.
35. Alberta Health and Wellness. Calculating Distances in Alberta: Geographic Methodology Series No. 4. In: Branch HS, editor. Edmonton, Alberta: Alberta Health and Wellness; 2004.
36. Haggerty J, Pineault R, Beaulieu M-D, Brunelle Y, Goulet F, Rodrique J, et al. Accessibility and Continuity of Primary Care in Quebec. Canadian Health Services Research Foundation; 2004.
37. Balasubramanian H, Banerjee R, Denton B, Naessens J, Stahl J. Improving clinical access and continuity through physician panel redesign. J Gen Intern Med. 2010;25(10):1109-15.
38. Murray M, Davies M, Boushon B. Panel size: how many patients can one doctor manage? Fam Prac Manag. 2007;14(4):44-51.
39. Keane D, Woodward CA, Ferrier BM, Cohen M, Goldsmith CH. Female and Male Physicians: Different Practice Profiles: Will increasing numbers of female GPs affect practice patterns of the future? Can Fam Physician. 1991;37:72-81.
40. Bertakis KD, Franks P, Azari R. Effects of physician gender on patient satisfaction. J Am Med Womens Assoc (1972). 2003;58(2):69-75.
41. Weeks WB, Wallace AE. Rural-urban differences in primary care physicians' practice patterns, characteristics, and incomes. J Rural Health. 2008;24(2):161-70.

42. Kasteler J, Kane RL, Olsen DM, Thetford C. Issues underlying prevalence of "doctor-shopping" behavior. J Health Soc Behav. 1976;17(4):329-39.
43. Panattoni L, Stone A, Chung S, Tai-Seale M. Patients report better satisfaction with part-time primary care physicians, despite less continuity of care and access. J Gen Intern Med. 2015;30(3):327-33.
44. Salisbury C, Johnson L, Purdy S, Valderas JM, Montgomery A. Epidemiology and impact of multimorbidity in primary care: a retrospective cohort study. Brit J Gen Pract. 2011;61(January):e12-21.
45. Wang Y, Hunt K, Nazareth I, Freemantle N, Petersen I. Do men consult less than women? An analysis of routinely collected UK general practice data. BMJ Open. 2013;3(8):e003320.
46. (CIHI) CIfHI. CIHI's Population Grouping Methodology 1.0. Canadian Institute for Health Information (CIHI); 2016.
47. Salisbury C, Sampson F, Ridd M, Montgomery A. How should continuity of care in primary health care be assessed? Brit J Gen Pract. 2009;59(April):e134-41.
48. Bower P, Roland M, Campbell J, Mead N. Setting standards based on patients' views on access and continuity: secondary analysis of data from the general practice assessment survey. BMJ. 2003;326(7383):258-63.
49. Ehman KM, Deyo-Svendsen M, Merten Z, Kramlinger AM, Garrison GM. How preferences for continuity and access differ between multimorbidity and healthy patients in a team care setting. J Prim Care Community Health. 2017;8(4):319-23.
50. Forrest CB, Starfield B. Entry into primary care and continuity: the effects of access. Am J Public Health. 1998;88(9):1330-6.
51. Haggerty JL, Pineault R, Beaulieu MD, Brunelle Y, Gauthier J, Goulet F, et al. Practice features associated with patient-reported accessibility, continuity, and coordination of primary health care. Ann Fam Med. 2008;6(2):116-23.
52. Hung D, Chung S, Martinez M, Tai-seale M. Effect of organizational culture on patient access, care continuity, and experience of primary care. J Ambul Care Manage. 2016;39(3):242-52.
53. Nelson K, Sun H, Dolan E, Maynard C, Beste L, Bryson C, et al. Elements of the patient-centred medical home associated with health outcomes among veterans: the role of primary care continuity, expanded access, and care coordination. J Ambul Care Manage. 2014;37(4):331-8.
54. Raivio R, Jääskeläinen J, Holmberg-Marttila D, Mattila KJ. Decreasing trends in patient satisfaction, accessibility and continuity of care in Finnish primary health care – a 14-year follow-up questionnaire study. BMC Fam Pract. 2014;15(98):1-7.
55. Stange KC. Tension between access and continuity. ANN FAM MED. 2011;9(1):85-5.
56. Guthrie B, Wyke S. Personal continuity and access in UK general practice: a qualitative study of general practitioners' and patients' perceptions of when and how they matter. BMC Fam Pract. 2006;7(1):1-9.
57. Regan S, Wong ST. Patient perspectives on primary health care in rural communities: effects of geography on access, continuity and efficiency. Rural Remote Health. 2009;9:1-12.
58. Rosland AM, Krein SL, Kim HM, Greenstone CL, Tremblay A, Ratz D, et al. Measuring patient-centered medical home access and continuity in clinics with part-time clinicians. Am J Manag Care. 2015;21(5):e320-8.
59. Basu S, Phillips RS. Reduced emergency department utilization after increased access to primary care. PLoS Med. 2016;13(9):2014-16.
60. Cowling TE, Harris M, Watt H, Soljak M, Richards E, Gunning E, et al. Access to primary care and the route of emergency admission to hospital: retrospective analysis of national hospital administrative data. BMJ Qual Saf. 2016;25(6):432-40.
61. Tammes P, Purdy S, Salisbury C, Ridd MJ, Mackichan F, Lasserson D, et al., editors. Can continuity of primary care decrease emergency care use? A nested case-control study2016 Nov 25, 2016: Elsevier Ltd.

62. van den Berg MJ, van Loenen T, Westert GP. Accessible and continuous primary care may help reduce rates of emergency department use. An international survey in 34 countries. Fam Pract. 2016;33(1):42-50.
63. Whittaker W, Anselmi L, Kristensen R, Lau Y-s, Bailey S, Bower P, et al. Associations between Extending Access to Primary Care and Emergency Department Visits: A Difference-In-Differences Analysis. PLoS Med. 2016;13(9):1-19.
64. Blank FS, Li H, Henneman PL, Smithline HA, Santoro JS, Provost D, et al. A descriptive study of heavy emergency department users at an academic emergency department reveals heavy ED users have better access to care than average users. J Emerg Nurs. 2005;31(2):139-44.
65. Cowling TE, Cecil EV, Soljak MA, Lee JT, Millett C, Majeed A, et al. Access to primary care and visits to emergency departments in England: a cross-sectional, population- based study. PLoS One. 2013;8(6):1-6.
66. Harris MJ, Patel B, Bowen S. Primary care access and its relationship with emergency department utilisation: an observational, cross-sectional, ecological study. Br J Gen Pract. 2011;61(593):e787-93.
67. Howard M, Goertzen J, Kaczorowski J, Hutchison B, Morris K, Thabane L, et al. Emergency department and walk-in clinic use in models of primary care practice with different after-hours accessibility in Ontario. Healthc Policy. 2008;4(1):73-88.
68. MacKichan F, Brangan E, Wye L, Checkland K, Lasserson D, Huntley A, et al. Why do patients seek primary medical care in emergency departments? An ethnographic exploration of access to general practice. BMJ Open. 2017;7(4):1-12.
69. Mian O, Pong R. Does better access to FPs decrease the likelihood of emergency department use? Results from the Primary Care Access Survey. Can Fam Physician. 2012;58(November):e658-66.
70. Weisz D, Gusmano MK, Wong G, Trombley J. Emergency department use: a reflection of poor primary care access? Am J Manag Care. 2015;21(2):e152-60.
71. Chaiyachati KH, Gordon K, Long T, Levin W, Khan AM, Meyer E, et al. Continuity in a VA patient-centered medical home reduces emergency department visits. PLoS One. 2014;9(5):1-13.
72. Nyweide DJ, Bynum JP. Relationship between continuity of ambulatory care and risk of emergency department episodes among older adults. Ann Emerg Med. 2013;69(4):407-15.
73. Atlas SJ, Grant RW, Ferris TG, Chang Y, Barry MJ. Patient-physician correctedness and quality of primary care. Ann Intern Med. 2010;150(5):325-35.
74. Cecil E, Bottle A, Cowling TE, Majeed A, Wolfe I, Saxena S. Primary care access, emergency department visits, and unplanned short hospitalizations in the UK. Pediatr. 2016;137(2):2-11.

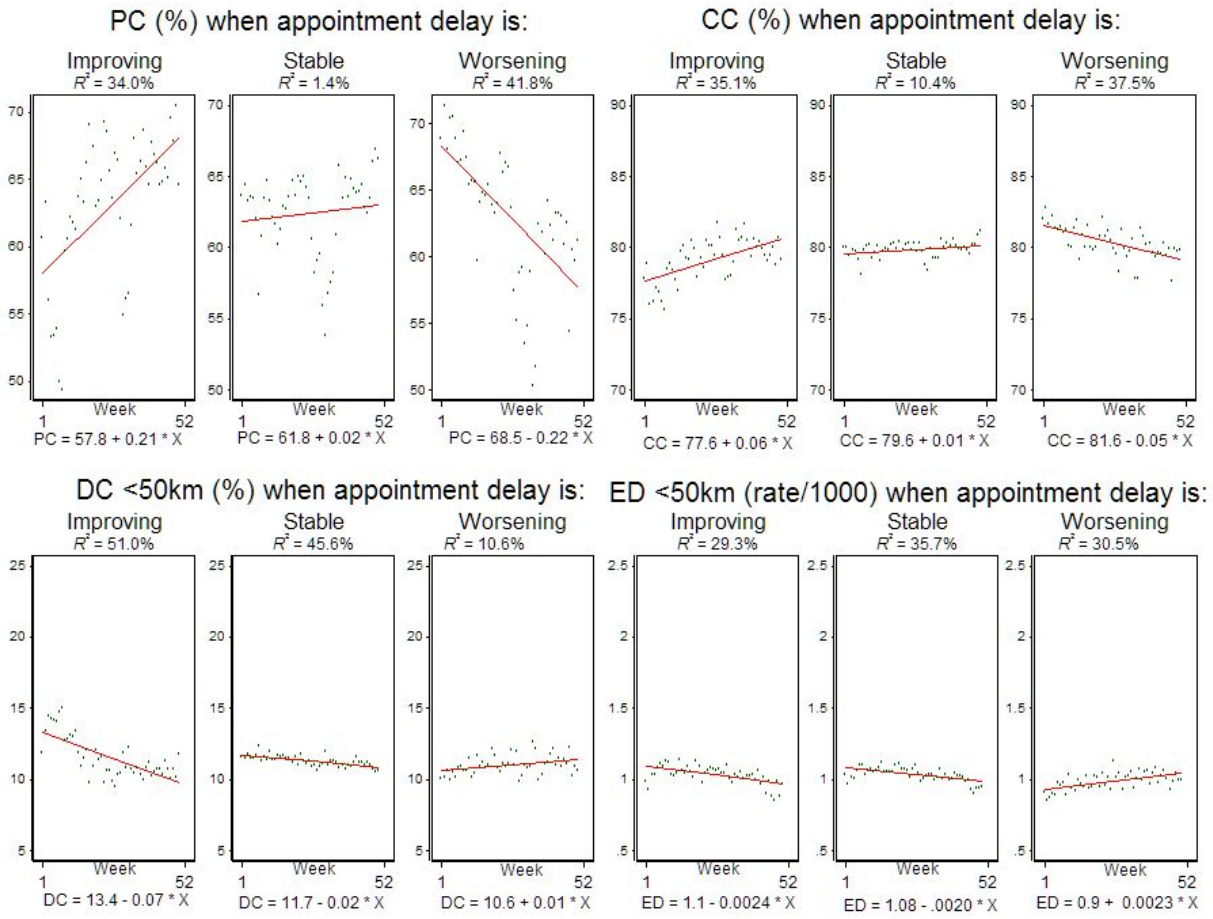

Fig 1: Scatterplot and linear regression of average weekly outcome measures (provider continuity, clinic continuity, discontinuity, and ED utilization) within each TNA exposure group.

PC=Provider Continuity; CC=Clinic Continuity; DC=Discontinuity; ED=Emergency Department; TNA=Third Next Available appointment

Supplemental Table 1: Full Outputs of Multi-Level Models of Outcome Variables (Provider Continuity, Clinic Continuity, Discontinuity, and Emergency Department Visits).

	B (95% CI), P value			
	Provider Continuity	Clinic Continuity	Discontinuity	Emergency Department Visits
Fixed Effects				
Intercept	68.90 (52.16 to 8.64), <0.001ǂǂǂ	83.13 (73.51 to 92.74), <0.001ǂǂǂ	13.21 (5.61 to 20.82), 0.001ǂǂǂ	0.55 (0.19 to 0.92), 0.003ǂǂǂ
Week	0.02 (0.00 to 0.03), 0.071ǂ	0.01 (0.00 to 0.02), 0.122	-0.02 (-0.03 to -0.01), <0.001ǂǂǂ	-0.002 (0.00 to 0.00), <0.001ǂǂǂ
Percent of Panel on Multiple Panels	-0.38 (-0.50 to -0.27), <0.001ǂǂǂ	-0.56 (-0.62 to -0.50), <0.001ǂǂǂ	0.45 (0.40 to 0.50), <0.001ǂǂǂ	0.013 (0.01 to 0.02), <0.001ǂǂǂ
Percent panel complex	0.76 (0.22 to 1.29), 0.006ǂǂǂ	0.40 (0.09 to 0.70), 0.011ǂǂ	-0.35 (-0.59 to -0.11), 0.005ǂǂǂ	0.015 (0.00 to 0.03), 0.007ǂǂǂ
Physician Panel Size (x100)	-0.06 (-0.23 to 0.10), 0.457	-0.25 (-0.34 to -0.15), <0.001ǂǂǂ	0.08 (0.00 to 0.16), 0.043ǂǂ	-0.010 (-0.010 to -0.010), <0.001ǂǂǂ
Physician is Female	-2.14 (-6.77 to 2.49), 0.365	1.48 (-1.30 to 4.27), 0.296	-3.58 (-5.87 to -1.28), 0.002ǂǂǂ	-0.15 (-0.29 to -0.01), 0.037ǂǂ
Mean Age of Panel (years)	0.01 (-0.36 to 0.38), 0.954	0.05 (-0.16 to 0.27), 0.632	-0.02 (-0.18 to 0.15), 0.832	0.006 (0.00 to 0.01), 0.169
Rural Physician	-6.53 (-9.90 to -3.16), <0.001ǂǂǂ	-0.24 (-2.32 to 1.84), 0.821	-2.86 (-4.62 to -1.09), 0.002ǂǂǂ	0.52 (0.41 to 0.63), <0.001ǂǂǂ
Number of physicians per clinic	-0.15 (-0.52 to 0.22), 0.426	-0.06 (-0.27 to 0.16), 0.615	-0.10 (-0.28 to 0.08), 0.264	-0.01 (-0.02 to 0.00), 0.005ǂǂǂ
Percent of panel female	-0.01 (-0.13 to 0.10), 0.820	-0.01 (-0.08 to 0.06), 0.826	0.03 (-0.02 to 0.09), 0.211	0.00 (0.00 to 0.00), 0.967
Percent of panel over 60 years of age	0.22 (-0.01 to 0.44), 0.064ǂ	0.20 (0.07 to 0.33), 0.003ǂǂǂ	-0.19 (-0.30 to -0.09), <0.001ǂǂǂ	0.004 (0.00 to 0.01), 0.124
# Days Worked Less than Normal	-11.09 (-11.22 to -10.97), <0.001ǂǂǂ	-2.92 (-2.99 to -2.86), <0.001ǂǂǂ	1.65 (1.60 to 1.70), <0.001ǂǂǂ	0.006 (0.00 to 0.01), 0.001ǂǂǂ
Starting TNA	-0.13 (-0.29 to 0.03), 0.121	-0.06 (-0.14 to 0.03), 0.217	-0.02 (-0.09 to 0.05), 0.543	0.000 (0.00 to 0.00), 0.969

Stable TNA Trajectory (ref)	--	--	--	--
Improving TNA Trajectory	-2.30 (-5.14 to 0.54), 0.113	-0.40 (-2.02 to 1.22), 0.630	1.66 (0.28 to 3.04), 0.019‡‡	0.042 (-0.01 to 0.09), 0.114
Worsening TNA Trajectory	-0.70 (-3.50 to 2.09), 0.622	-0.93 (-2.53 to 0.68), 0.256	0.57 (-0.78 to 1.93), 0.409	0.013 (-0.04 to 0.07), 0.614
Stable TNA Trajectory*week (ref)	--	--	--	--
Improving TNA Trajectory*week	0.13 (0.08 to 0.18), <0.001‡‡‡	0.02 (-0.01 to 0.06), 0.154	-0.04 (-0.06 to -0.01), 0.009‡‡‡	-0.002 (0.00 to 0.00), 0.001‡‡‡
Worsening TNA Trajectory*week	-0.12 (-0.17 to -0.07), <0.001‡‡‡	-0.02 (-0.06 to 0.01), 0.163	0.01 (-0.01 to 0.04), 0.353	0.001 (0.00 to 0.00), 0.001‡‡‡
Random Effects				
Inter-physician variance	91.50 (79.19 to 105.72)	31.49 (27.08 to 36.61)	31.43 (23.22 to 42.56)	0.12 (0.09 to 0.15)
Within-Physician variance	184.67 (181.86 to 187.52)	49.85 (49.09 to 50.62)	49.85 (49.09 to 50.62)	0.135 (0.13 to 0.14)
Variance – Week	0.03 (0.02 to 0.03)	0.02 (0.01 to 0.02)	0.01 (0.01 to 0.02)	0.00 (0.00 to 0.00)
Covariance – Intercept, Week	-0.58 (-0.78 to -0.37)	-0.38 (-0.47 to -0.29)	-0.38 (-0.47 to -0.29)	0.00 (0.00 to 0.00)
Inter-clinic variance	74.47 (54.12 to 102.48)	31.43 (23.22 to 42.56)	31.43 (23.22 to 42.56)	0.12 (0.09 to 0.15)
Inter-class correlation	33.1%	38.7%	38.7%	46.3%

TNA=third next available appointment

‡Denotes significance at p<0.1, ‡‡Denotes significance at p<0.05, ‡‡‡Denotes significance at p<0.01

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	3,4
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4
Bias	9	Describe any efforts to address potential sources of bias	3
Study size	10	Explain how the study size was arrived at	2
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4,5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5
		(*b*) Describe any methods used to examine subgroups and interactions	5
		(*c*) Explain how missing data were addressed	5
		(*d*) If applicable, explain how loss to follow-up was addressed	n/a
		(*e*) Describe any sensitivity analyses	n/a
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	5
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5
		(b) Indicate number of participants with missing data for each variable of interest	5,6
		(c) Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	Report numbers of outcome events or summary measures over time	6

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	7,8 n/a n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9
Generalisability	21	Discuss the generalisability (external validity) of the study results	9,10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.