ARIC Manuscript Proposal #4205

PC Reviewed: 02/14/23 **Status: _____** **Priority: 2**
SC Reviewed: _____ **Status: _____** **Priority: ____**

1.a. Full Title: Association of continuity of care with post-acute care among stroke patients discharged to home

b. Abbreviated Title (Length 26 characters): Continuity of care and stroke

2. Writing Group [please provide a middle name if available; EX: Adam Lee Williams]:
Writing group members: Ning Li, Anna Kucharska-Newton, Silvia Koton, Lena Mathews, Kunihiro Matsushita; others welcome

I, the first author, confirm that all the coauthors have given their approval for this manuscript proposal. __NL___ **[please confirm with your initials electronically or in writing]**

First author [please provide a middle name if available; EX: Adam Lee Williams]:
Address:

Ning Li
Department of Biostatistics, College of Public Health
University of Kentucky
Lexington, Kentucky, 40503

Phone: (859)2859654 Fax:
E-mail: Ning. Li@uky.edu

ARIC author to be contacted if there are questions about the manuscript and the first author does not respond or cannot be located (this must be an ARIC investigator).

Name: **Anna Kucharska-Newton**
Address:

The Gillings School of Global Public Health; UNC-CH
123 West Franklin St, Suite 410.
Chapel Hill, NC 27514

Phone: 9196040782 Fax:
E-mail: anna_newton@unc.edu

3. Timeline: This proposal is part of a doctoral dissertation, with completion planned for Spring 2024.

4. Rationale:

Stroke remains a leading cause of death and disability worldwide. [1] A recent report from the American Heart Association indicated that in the United States, more than 795,000 people have a stroke annually and 13,700 deaths are annually attributed to stroke. [2] Various factors have been associated with elevated risk stroke risk, including non-modifiable factors, such as age, sex, race, and family history, and modifiable cardiometabolic factors, such as hypertension, diabetes, smoking, alcohol intake, drug abuse, and atrial fibrillation. [3]

Extent studies suggest that these non-modifiable and modifiable risk factors along with socioeconomic factors are associated with continuity of care and post-acute care for stroke survivors. [4-6] Continuity of care is a coordinated and uninterrupted healthcare service that is provided consistently for patients[7] and manifests as long-term cooperation between a patient and a care provider to prevent and control risk factors, identify symptoms, manage care transitions, and provide medical treatment after discharge. [6] Several studies have shown an inverse association of continuity of care with mortality, [8-10] preventable hospitalization among fee-for-service Medicare beneficiaries, [6,11] and hospital length of stay. [12] As an essential part of stroke care, continuity of care has the potential to be associated with stroke survivors' quality of care after discharge. [13] A thorough investigation of post acute hospitalization care following discharge to home has not been done in conjunction with primary care and specialist care prior to the stroke. However, lack of coordination either by virtual consultation or face-to-face between healthcare professionals and stroke survivors from different disciplines may increase the rate of complications and decrease the survival of stroke survivors. [14]

This proposal will leverage CMS Medicare data linked with ARIC participant data to provide estimates of continuity of care in the year prior to incident ischemic or hemorrhagic stroke and to examine post-acute use of ambulatory care within 30 days post-discharge, risk of 30-day readmission, and one-year all-cause mortality in association with pre-stroke continuity of care.

Since medical claims data are, for the most part, not available for beneficiaries enrolled in the Medicare Advantage plan, analyses of healthcare utilization patterns and continuity of care will be limited to fee-for-service (FFS) beneficiaries.

5. Main Hypothesis/Study Questions:

1. Describe continuity of care prior to stroke hospitalization, overall and by sex, age, race/ethnicity, study center, and measures of SES.

2. Describe healthcare utilization among stroke survivors discharged to home after acute in-hospital treatment (time to first ambulatory care visit, presence of a visit within 14 days post-discharge, risk of 30-day readmission) overall and by sex, age, race, study center, and measures of SES.

3. Examine the association of pre-stroke continuity of care with post acute care and post-stroke healthcare utilization among stroke survivors discharged to home.

6. Design and analysis (study design, inclusion/exclusion, outcome and other variables of interest with specific reference to the time of their collection, summary of data analysis, and any anticipated methodologic limitations or challenges if present).

Study population

We will include ARIC cohort participants who survived an incident stroke hospitalization during the years 1992-2018 and who have had continuous enrollment in FFS Medicare within 1 year prior to and at least three months after the incident stroke hospitalization. Participants will need to be at least 66 years old at the time of the incident stroke to allow for a one year look-back period, given the Medicare enrollment age of 65 years. Participants with at least two primary care or specialist care visits within 1 year prior to the incident of stroke will be included in the second study question. Continuity of care, a continuous variable, can only be measured among individuals who have had at least two outpatient care visits. From prior analyses in other cohorts, we anticipate that the proportion of participants with no outpatient visits or those with just one outpatient visit prior to the stroke events will be minimal (<5%). In initial analyses, we will apply the standard ARIC demographic exclusions (i.e., exclusion form analysis of Black participants from the MD and MN centers and exclusion of participants of self-reported race other than Black or White). In a sensitivity analysis, we will include all study participants eligible on the basis of their Medicare FFS enrollment status, with participants of race other than Black and White included in analyses together with White participants. Participants with missing information on educational attainment, Area Deprivation Index, comorbidities (hypertension, diabetes), and cardiometabolic factors (systolic blood pressure, fasting glucose, and lipid profile) will be excluded.

Outcomes

ARIC cohort surveillance data (1992-2018) will be used to identify probable or definite incident stroke hospitalizations. Information on ambulatory care visits will be obtained from the Evaluation and Management HCPCS (Healthcare Common Procedure Coding System) codes for new and established office visits obtained from the annual Medicare Carrier files and as visits to Federally Qualified Health Centers and Rural Health Centers from Outpatient files (Table.1). Unplanned readmissions within 30 days after discharge of index stroke will be identified from the CMS MedPAR file. Planned admissions, i.e. admissions for carotid endarterectomy, carotid stenting, percutaneous carotid stenting, intracranial and intervertebral stenting, patent foramen ovale closure, ablation, aortic or mitral valve replacement, cranioplasty, will not be considered. [15] All-cause and stroke readmissions will be identified from the MedPAR file. Death events will be obtained from ongoing ARIC cohort surveillance.

Table. 1 Classification of Ambulatory Care visits encounters from CMS Medicare claims.

Encounter Type	Code Source	Code Type	Code
New office visit	Carrier	HCPCS	99201-99205
Established office visit	Carrier	HCPCS	99211-99215
Consultation	Carrier	HCPCS	99241-99245
New preventive medicine visit	Carrier	HCPCS	99385-99387
Established preventive medicine visit	Carrier	HCPCS	99395-99397
Federally Qualified Healthcare Center (FQHC)	Outpatient	Revenue Center code	520 and 521
Rural Health Center (RHC)	Outpatient	Revenue Center code	521 and 522

Exposure

Continuity of care will be identified from primary care and specialist provider visits during one year prior to stroke hospitalization obtained from CMS claim files. Primary care will be defined as visits to family medicine, and internal medicine providers. Specialist care will include evidence of outpatient visits to neurologists, neuroradiologists, neurosurgeons, cardiologists, and visits to geriatricians, gerontologists, and rehabilitation care. From the Carrier and Outpatient files, we will obtain the type and number of primary care and specialist care. We will use the Modified Modified Continuity Index (MMCI) to create a continuous measure of continuity of care. [16] This method concentrates on the dispersion between healthcare providers and the number of visits. The MMCI formula is:

$$MMCI = \frac{1 - \frac{k}{N + 0.1}}{1 - \frac{1}{N + 0.1}}$$

Where N = total number of visits to all providers in a given period
k = the number of providers

The range of the MMCI is 0 to 1, with higher values describing greater continuity of care. Continuity of care will be operationalized as a continuous variable and as quantiles (tertiles) of the distribution.

Covariates

Analytical covariates will include demographics, socioeconomic status, and cardiometabolic comorbidities as described in the Table below:

Variables	Time of ascertainment
Demographic	
Age	Age at time of incident stroke hospitalization
Race	Visit 1
Sex	Visit 1
Study Center	Visit 1
Socioeconomic Status	
Education	Visit 1

Income	Visit 1
Neighborhood	ADI at time of stroke hospitalization
Comorbidity	
Hypertension	Nearest visit before stroke event
Diabetes	Nearest visit before stroke event
Cardiometabolic	
Systolic blood pressure	Nearest visit before stroke event
Fasting Glucose	Nearest visit before stroke event
Lipid Profile	Nearest visit before stroke event
Other	
Smoking	Nearest visit before stroke event
Alcohol use	Nearest visit before stroke event
BMI	Nearest visit before stroke event
Medication use (anti-hypertensive, anti-diabetic)	Nearest visit before stroke event

Social determinants of health

We will use the Area Deprivation Index (ADI) to measure stroke survivors' neighborhood SES. The ADI is a contextual socioeconomic status to capture socioeconomic disadvantages integrated with income, education, employment, and housing quality that focuses on the measurement of economic factors in a neighborhood. [17] The ADI consists of 17 socioeconomic indicators as described in the following table:[18]

Category	**Indicator**
Education	Population aged 25+ with <9yr education, %
	Population aged 25+ with at least a high school diploma, %
	Employed population aged 16+ in white-collar occupations, %
Income\Employment	Median family income, $
	Income disparity
	Families below federal poverty level, $
	Population below 150% of federal poverty level, %
	Civilian labor force population aged 16+ who are unemployed, %
Housing	Median house value, $
	Median gross rant, $
	Median monthly mortgage, $
	Owner-occupied housing units, %
	Occupied housing units without complete plumbing, %
Household	Single-parent households with children (<18 yr), %
	Households without a motor vehicle, %
	Households without a telephone, %
	Households with more than 1 person per room, %

The ADI score was calculated by using factor analysis and principal component analysis. The ADI, as a proxy measure for socioeconomic status, has been widely used to evaluate health

outcomes at the neighborhood level.[17,19,20] As an indicator, ADI can reflect the level of local community services and the ability to access to medical services for local residency.[17] Individuals who live in socioeconomically disadvantaged neighborhoods usually experience worse clinical outcomes.[21] Prior studies proved that socioeconomic disparities have a strong association with an increased risk of cardiovascular diseases.[22,23] Researchers have shown that ADI has linked with hospital readmission for Heart Failure and Myocardial Ischemia. [17] In addition, ADI also has been related with poor hospital performance in the health system perspective. [24]
In this study, ADI at the time of stroke hospitalization will be used as the effect modifier in the Cox proportional hazard model, it will be classified into quartiles, the lowest quartile (lower 75%) identifies the least deprived area, and the highest quartile denotes the most deprived area (top 25%). [21]

Analytical approach

Participant characteristics will be examined overall and in stratification by age, race, and sex. Age will be classified into 5-year groups (65-70, 71-75, 76-80, 80+ years). Continuous data will be expressed as mean with standard deviation (SD), and categorical data will be presented with frequency and percentage. We will use the t-test and Chi-square test to compare potential differences. Alpha <0.05 will be considered statistically significant.

Cox proportional hazard models with effect modifier, ADI, will be used to examine the hazard ratios for the association between pre-stroke continuity of care and the time to first ambulatory care visit that includes medical services performed on an outpatient basis. Logistic regression models will be constructed to examine the risk of 30-day and 90-day unplanned readmission and 1-year mortality. All analyses will be conducted in the overall sample with the examination of interaction by age categories, race, center, and sex.

7.a. Will the data be used for non-ARIC analysis or by a for-profit organization in this manuscript? ____ Yes __✓__No

b. If Yes, is the author aware that the current derived consent file ICTDER05 must be used to exclude persons with a value RES_OTH and/or RES_DNA = "ARIC only" and/or "Not for Profit" ? ____ Yes ____ No
(The file ICTDER has been distributed to ARIC PIs, and contains the responses to consent updates related to stored sample use for research.)

8.a. Will the DNA data be used in this manuscript? ____ Yes __✓__No

8.b. If yes, is the author aware that either DNA data distributed by the Coordinating Center must be used, or the current derived consent file ICTDER05 must be used to exclude those with value RES_DNA = "No use/storage DNA"? ____ Yes ____ No

9. The lead author of this manuscript proposal has reviewed the list of existing ARIC Study manuscript proposals and has found no overlap between this proposal and

previously approved manuscript proposals either published or still in active status. ARIC Investigators have access to the publications lists under the Study Members Area of the web site at: http://www.cscc.unc.edu/aric/mantrack/maintain/search/dtSearch.html

__✓__ Yes _____ No

10. What are the most related manuscript proposals in ARIC (authors are encouraged to contact lead authors of these proposals for comments on the new proposal or collaboration)?

None identified

11.a. Is this manuscript proposal associated with any ARIC ancillary studies or use any ancillary study data? ____ Yes __✓__No

11.b. If yes, is the proposal

___ A. primarily the result of an ancillary study (list number* _____)

___ B. primarily based on ARIC data with ancillary data playing a minor role (usually control variables; list number(s)* _____ _____ _____)

*ancillary studies are listed by number https://sites.cscc.unc.edu/aric/approved-ancillary-studies

12a. Manuscript preparation is expected to be completed in one to three years. If a manuscript is not submitted for ARIC review at the end of the 3-years from the date of the approval, the manuscript proposal will expire.

12b. The NIH instituted a Public Access Policy in April, 2008 which ensures that the public has access to the published results of NIH funded research. It is **your responsibility to upload manuscripts to PubMed Central** whenever the journal does not and be in compliance with this policy. Four files about the public access policy from http://publicaccess.nih.gov/ are posted in http://www.cscc.unc.edu/aric/index.php, under Publications, Policies & Forms. http://publicaccess.nih.gov/submit_process_journals.htm shows you which journals automatically upload articles to PubMed central.

Reference:

1. Virani SS, Alonso A, Aparicio HJ, et al. Heart Disease and Stroke Statistics-2021 Update: A Report From the American Heart Association. *Circulation*. Feb 23 2021;143(8):e254-e743. doi:10.1161/CIR.0000000000000950
2. Tsao CW, Aday AW, Almarzooq ZI, et al. Heart Disease and Stroke Statistics-2022 Update: A Report From the American Heart Association. *Circulation*. Feb 22 2022;145(8):e153-e639. doi:10.1161/CIR.0000000000001052
3. Kuriakose D, Xiao Z. Pathophysiology and Treatment of Stroke: Present Status and Future Perspectives. *Int J Mol Sci*. Oct 15 2020;21(20)doi:10.3390/ijms21207609
4. Freburger JK, Holmes GM, Ku LJ, Cutchin MP, Heatwole-Shank K, Edwards LJ. Disparities in postacute rehabilitation care for stroke: an analysis of the state inpatient databases. *Arch Phys Med Rehabil*. Aug 2011;92(8):1220-9. doi:10.1016/j.apmr.2011.03.019

5. Koton S, Sang Y, Schneider ALC, Rosamond WD, Gottesman RF, Coresh J. Trends in Stroke Incidence Rates in Older US Adults: An Update From the Atherosclerosis Risk in Communities (ARIC) Cohort Study. *JAMA Neurol*. Jan 1 2020;77(1):109-113. doi:10.1001/jamaneurol.2019.3258
6. Yang CP, Cheng HM, Lu MC, Lang HC. Association between continuity of care and long-term mortality in Taiwanese first-ever stroke survivors: An 8-year cohort study. *PLoS One*. 2019;14(5):e0216495. doi:10.1371/journal.pone.0216495
7. Shortell SM. Continuity of medical care: conceptualization and measurement. *Med Care*. May 1976;14(5):377-91. doi:10.1097/00005650-197605000-00001
8. van Walraven C, Oake N, Jennings A, Forster AJ. The association between continuity of care and outcomes: a systematic and critical review. *J Eval Clin Pract*. Oct 2010;16(5):947-56. doi:10.1111/j.1365-2753.2009.01235.x
9. Shin DW, Cho J, Yang HK, et al. Impact of continuity of care on mortality and health care costs: a nationwide cohort study in Korea. *Ann Fam Med*. Nov-Dec 2014;12(6):534-41. doi:10.1370/afm.1685
10. Maarsingh OR, Henry Y, van de Ven PM, Deeg DJ. Continuity of care in primary care and association with survival in older people: a 17-year prospective cohort study. *Br J Gen Pract*. Aug 2016;66(649):e531-9. doi:10.3399/bjgp16X686101
11. Nyweide DJ, Anthony DL, Bynum JP, et al. Continuity of care and the risk of preventable hospitalization in older adults. *JAMA Intern Med*. Nov 11 2013;173(20):1879-85. doi:10.1001/jamainternmed.2013.10059
12. de Mooij MJ, Ahayoun I, Leferink J, Kooij MJ, Karapinar-Carkit F, Van den Berg-Vos RM. Transition of care in stroke patients discharged home: a single-center prospective cohort study. *BMC Health Serv Res*. Dec 18 2021;21(1):1350. doi:10.1186/s12913-021-07347-7
13. Bahr SJ, Bang J, Yakusheva O, et al. Nurse Continuity at Discharge and Return to Hospital. *Nurs Res*. May/Jun 2020;69(3):186-196. doi:10.1097/NNR.0000000000000417
14. Berendsen AJ, de Jong GM, Meyboom-de Jong B, Dekker JH, Schuling J. Transition of care: experiences and preferences of patients across the primary/secondary interface - a qualitative study. *BMC Health Serv Res*. Apr 7 2009;9:62. doi:10.1186/1472-6963-9-62
15. Bushnell CD, Kucharska-Newton AM, Jones SB, et al. Hospital Readmissions and Mortality Among Fee-for-Service Medicare Patients With Minor Stroke or Transient Ischemic Attack: Findings From the COMPASS Cluster-Randomized Pragmatic Trial. *J Am Heart Assoc*. Dec 7 2021;10(23):e023394. doi:10.1161/JAHA.121.023394
16. Magill MK, Senf J. A new method for measuring continuity of care in family practice residencies. *J Fam Pract*. Feb 1987;24(2):165-8.
17. Kind AJ, Jencks S, Brock J, et al. Neighborhood socioeconomic disadvantage and 30-day rehospitalization: a retrospective cohort study. *Ann Intern Med*. Dec 2 2014;161(11):765-74. doi:10.7326/M13-2946
18. Maroko AR, Doan TM, Arno PS, Hubel M, Yi S, Viola D. Integrating Social Determinants of Health With Treatment and Prevention: A New Tool to Assess Local Area Deprivation. *Prev Chronic Dis*. Sep 15 2016;13:E128. doi:10.5888/pcd13.160221
19. Kind AJH, Buckingham WR. Making Neighborhood-Disadvantage Metrics Accessible - The Neighborhood Atlas. *N Engl J Med*. Jun 28 2018;378(26):2456-2458. doi:10.1056/NEJMp1802313
20. Hu J, Kind AJH, Nerenz D. Area Deprivation Index Predicts Readmission Risk at an Urban Teaching Hospital. *Am J Med Qual*. Sep/Oct 2018;33(5):493-501. doi:10.1177/1062860617753063
21. Vart P, Coresh J, Kwak L, Ballew SH, Heiss G, Matsushita K. Socioeconomic Status and Incidence of Hospitalization With Lower-Extremity Peripheral Artery Disease: Atherosclerosis Risk in Communities Study. *J Am Heart Assoc*. Aug 10 2017;6(8)doi:10.1161/JAHA.116.004995
22. Diez Roux AV, Merkin SS, Arnett D, et al. Neighborhood of residence and incidence of coronary heart disease. *N Engl J Med*. Jul 12 2001;345(2):99-106. doi:10.1056/NEJM200107123450205
23. Krieger N, Chen JT, Waterman PD, Rehkopf DH, Subramanian SV. Painting a truer picture of US socioeconomic and racial/ethnic health inequalities: the Public Health Disparities Geocoding Project. *Am J Public Health*. Feb 2005;95(2):312-23. doi:10.2105/AJPH.2003.032482
24. Hoyer EH, Padula WV, Brotman DJ, et al. Patterns of Hospital Performance on the Hospital-Wide 30-Day Readmission Metric: Is the Playing Field Level? *J Gen Intern Med*. Jan 2018;33(1):57-64. doi:10.1007/s11606-017-4193-9