1.a. Full Title: Patterns of healthcare utilization following an initial diagnosis of heart failure. The Atherosclerosis Risk in Communities (ARIC) Study

b. Abbreviated Title (Length 26 characters): Patterns of care for HF

2. Writing Group:
   Writing group members: Gerardo Heiss, Lloyd Chambless, Patricia Chang, Alice White, Sunil Agarwal, Lisa Wruck, Jackie Wright, Norrina Allen, Eyal Shahar, Sally Stearns, Carlos Rodriguez, Shelly-Ann Love, Carla Sueta (pending approval), others welcome

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

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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).

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3. **Timeline**: Analysis to begin upon approval. Complete the manuscript within eight months of approval by ARIC. This proposal is submitted in conjunction with manuscript proposal titled: “Patterns of healthcare utilization preceding a heart failure diagnosis. The Atherosclerosis Risk in Communities (ARIC) Study”. Results of the proposed analyses will also be informative with respect to analyses proposed for ARIC ms #2253 Heiss et al., “Linked Measures of Outpatient and Inpatient Heart Failure – The ARIC Study”

4. **Rationale**:

Current information on patterns of healthcare utilization among patients with heart failure (HF) in the United States derives primarily from observations of HF hospitalizations. Despite changes in insurance reimbursement patterns [1], lower diagnostic thresholds [2], and increasing availability of imaging equipment [3], contributing to increased management of heart failure in the outpatient setting, an awareness of the extent to which HF is diagnosed and treated in the outpatient setting is significantly lacking.

Data from the Canadian healthcare system suggest that outpatient diagnoses of HF are frequent and constitute approximately half of all first-everHF diagnoses [4]. Furthermore, patients for whom the initial diagnosis occurs at the time of hospitalization have a higher risk of mortality within one year of the diagnosis as compared to patients with the initial diagnosis of heart failure occurring in the outpatient clinic [5].

Similar analyses, aimed at evaluating longitudinal patterns of care for heart failure and their association with outcomes, are needed in the United States. To date, only one U.S. study has examined differences in mortality among HF patients depending on the location of the initial diagnosis [6].

Proposed analyses are aimed at describing rates of diagnosis of heart failure in the inpatient and in the outpatient setting and examining healthcare utilization among heart failure patients with an initial HF diagnosis in the outpatient setting and among those with an initial diagnosis of heart failure in the inpatient setting. The proposed study will be conducted using CMS Medicare data available for all fee-for-service Medicare-eligible residents of the four ARIC Study geographic areas for the years 2003-2012.

5. **Main Hypothesis/Study Questions**:

We aim to describe rates of heart failure diagnosis according to the clinical location (inpatient vs. outpatient) and to examine differences in patterns of hospitalizations, Emergency Department use, observation stays, and outpatient visits occurring within 5 years of the initial heart failure diagnosis according to the clinical location of the first heart failure diagnosis (inpatient versus outpatient).

Specifically we aim to:
1) Examine annual rates of diagnosis of heart failure in the outpatient and inpatient settings.

2) Estimate time to the following events: death, subsequent outpatient visit, first Emergency Department visit, first observation stay, and first hospitalization following an initial heart failure diagnosis in the outpatient setting.

3) Estimate time to the following events: death, first outpatient visit, first Emergency Department visit, first observation stay, and subsequent re-hospitalization following the first heart failure hospitalization.

4) Estimate monthly rates of outpatient visits, Emergency Department visits, observation stays, and hospitalizations following an initial diagnosis of heart failure in the outpatient setting.

5) Estimate monthly rates of outpatient visits, Emergency Department visits, observation stays, and hospitalizations following the first heart failure hospitalization.

6) Describe monthly case fatality among Medicare beneficiaries following an initial diagnosis of heart failure in the outpatient setting.

7) Describe monthly case fatality among Medicare beneficiaries following the first heart failure hospitalization.

All analyses will be performed overall and by gender, race, and age categories.

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:

Analyses will be conducted using CMS Medicare data available for the ARIC Study geographic areas and limited to fee-for-service encounters by selecting Medicare beneficiaries with continuous fee-for-service enrollment during the entire observation period (2003-2012). Medicare enrollment information will be obtained from annual Master Beneficiary Summary files. We will use annual Medicare Provider Analysis and Review (MedPAR) files to identify hospitalized events and Emergency Department visits which resulted in a hospitalization. Ambulatory care encounters, observation stays, and Emergency Department visits which did not result in a hospitalization will be identified using annual Carrier and Outpatient files as described below.

Outpatient claims representing outpatient healthcare encounters will be identified from the Carrier (Part B) files using the following Evaluation and Management (E&M) codes:

<table>
<thead>
<tr>
<th>Table 1. E&amp;M codes for the identification of outpatient events</th>
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<tbody>
<tr>
<td>E&amp;M code</td>
</tr>
<tr>
<td>99201 - 99205</td>
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<tr>
<td>99211 - 99215</td>
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<tr>
<td>99241 - 99245</td>
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Additionally, outpatient events occurring in Federally Qualified Health Centers will be identified from annual Outpatient files using Revenue Center codes 521 and 522.

Observation stays will be identified from annual Outpatient files using Healthcare Common Procedure Coding System (HCPCS) codes. Observation HCPCS codes differ by year, we will therefore use annual CMS Medicare Bulletins to create annual algorithms for the retrieval of claims for observation stays.

**Event identification:**

Heart failure-related events occurring during the years 2003-2012 will be identified using ICD-9 code 428.xx. For hospitalized HF events, we will differentiate between ICD-9 code 428.xx in first position versus ICD-9 code 428.xx in an effort to identify primary heart failure diagnoses. The position of the ICD-9 code in the outpatient setting is not associated with diagnostic priorities.

Presence of heart failure-specific ICD-9 codes will be examined for each Medicare beneficiary in claims available for the 12 months preceding the event. In providing a description of the planned analyses we are assuming that a 12 month look-back period will be sufficient to ascertain lack of prior HF-related clinical encounters and will use that convention throughout this proposal. We will however allow the observed distribution of time elapsed between consecutive HF hospitalizations and HF outpatient encounters to determine the optimal look-back period.

We will consider a diagnosis of heart failure as present if the Medicare beneficiary has had a hospitalization for heart failure (inpatient HF diagnosis) or if the Medicare beneficiary has had at least two claims for outpatient visits with a heart failure code listed on the claim within 12 consecutive months (outpatient HF diagnosis). First HF diagnoses will be defined as the earliest HF hospitalization with no more than one outpatient HF event in the preceding 12 months (first inpatient HF diagnosis), or as the last outpatient event in the series of the two outpatient visits constituting an outpatient HF diagnosis among beneficiaries with no HF events occurring in the preceding 12 months (first outpatient diagnosis).

The encrypted beneficiary ID will be used to link claims across years of observation, creating a staggered-entry cohort of Medicare beneficiaries with a HF diagnosis. Follow-up of this “synthetic” cohort is possible only if the CMS Medicare data for the ARIC communities include the initial claim and all subsequent claims through death or the end of follow-up (December 31, 2012), whichever comes first, for all eligible (fee-for-service) Medicare beneficiaries who have lived at any time during the observation period (2003-2012) in the geographically defined ARIC communities.

**Methods:**
We will understand the term “patterns of healthcare utilization” to identify patterns of HF-specific inpatient and outpatient encounters including rates and time intervals between consecutive encounters. We will estimate monthly rates of outpatient visits, Emergency Department visits, all cause and HF-specific re-hospitalizations, and observation stays occurring up to five years following the first HF diagnosis with censoring at death. Additionally, we will estimate monthly case fatality according to the location of the first HF diagnosis.

We will use product-limit estimation methods to identify time to event (e.g. time to hospitalization, time to re-hospitalization, and time to Emergency Department visit), accounting for the competing risk of death. Information concerning death and death dates will be obtained from the Master Beneficiary Summary file.

All analyses will be conducted in strata of race, gender, age, and ARIC study center. Age, estimated as age at the time of the first HF diagnosis, will be categorized as follows: 65-74, 75-84, and 85 plus years of age. We will evaluate the effect of adjustment for comorbidities, using the Klabunde index, a Charlson comorbidity score adapted for use with ICD-9 codes available from inpatient and outpatient administrative claims [7].

Study size:

Estimates of study size for analyses based on the CMS Medicare data for the ARIC communities are based on Census 2010 estimates and extrapolated to all years of observation (2004-2011; the year 2003 is not considered an observation year as it provides a one year “look-back” period). We estimate that for the year 2004, 102,600 of the residents of the ARIC study communities will have been 65 years or older. We will assume an overall 40% participation in Medicare Advantage plans across all four study centers, leading to an estimate of 61,560 fee-for-service Medicare beneficiaries. We will further assume that outpatient heart failure diagnoses constitute half of all heart failure diagnoses. Trends analyses performed by the ARIC Study Coordinating Center provide a conservative estimate of the annual incidence of hospitalized heart failure events at 10.4 per 1000. On the basis of that estimate, we project an annual incidence of first hospitalized heart failure events among fee-for-service Medicare beneficiaries in the ARIC study communities at 640 events. We therefore, estimate that 5,120 first-ever hospitalized HF diagnoses will have occurred in the ARIC communities in the years 2004 through 2011. An equal number of HF diagnoses is expected to have been made during that time in the outpatient setting, giving a total of 10,240 first-ever inpatient and outpatient HF diagnoses.

We expect to have 80% power to detect at least a 12-day or greater difference in time to hospital admissions (re-admissions) or ED visits between those with the first diagnosis of HF in the inpatient setting as compared to those with the first diagnosis of HF in the outpatient setting.

7.a. Will the data be used for non-CVD analysis in this manuscript?  ____ Yes  ____x__ No
b. If Yes, is the author aware that the file ICTDER03 must be used to exclude persons with a value RES_OTH = “CVD Research” for non-DNA analysis, and for DNA analysis RES_DNA = “CVD Research” would be used?  
   ____ Yes  ____ No
   (This 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 file ICTDER03 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/search.php

   ____x____ 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)?

   ARIC MP1657 “Enumerating the community burden of heart failure”
   ARIC MP1966 “Estimated burden of acute decompensated heart failure hospitalization in the United States: Applying model from the ARIC study to National Databases”

11.a. Is this manuscript proposal associated with any ARIC ancillary studies or use any ancillary study data?  
   ____x____ Yes  ____ No

11.b. If yes, is the proposal
      ____x____ A. primarily the result of an ancillary study (list number* AS 2013.07)
      ____ 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 at http://www.cscc.unc.edu/aric/forms/

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.

References: