1. **Full Title**: Validity of death certificate classification of coronary heart disease

   **Abbreviated Title (Length 26 characters)**: Death certificate validity

2. **Writing Group**:
   Magdalene Assimon, Sydney Jones, Lisa Wruck, Chiadi Ndumele, Wayne Rosamond, others welcome

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

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3. **Timeline**:
   - Data analysis to begin immediately upon proposal approval
   - October 2014: Abstract submission to EPI/NPAM
   - Manuscript to be completed within 1 year of approval

4. **Rationale**:
Coronary heart disease (CHD) is the leading cause of death in the United States (US)\(^1\), thus it is important to accurately describe temporal trends in order to understand disease burden, set national goals for cardiovascular disease reduction and allocate funding. In the absence of a national surveillance system that validates CHD deaths, vital statistics are considered a valuable data source for monitoring trends of CHD mortality over time. However, the underlying cause of death on death certificates is often misclassified\(^2\), leading to bias in the reporting of cause-specific mortality. Given the wide use of the death certificate in surveillance studies, it is paramount that researchers are aware of and understand the inaccuracies and limits of these data.

Several studies\(^2\)\(^-\)\(^6\) have assessed the validity of International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code defined CHD death, as compared to adjudicated events. The sensitivity and positive predictive value of death certificate classifications of CHD were variable, ranging from 74 to 91% and 67 to 96%, respectively. However in 1999, the tenth revision of the International Classification of Diseases (ICD-10-CM) was implemented, indicating the necessity for reevaluation of the validity of nosologist coding of the underlying cause of death. To date, studies assessing the validity of ICD-10-CM code defined CHD death are non-existent, and the impact of the new coding system on mortality trends is unknown. Thus, we aim to determine the sensitivity and positive predictive value of CHD ICD-10-CM codes as the underlying cause of death on death certificates and to calibrate long-term trends of CHD mortality derived from vital statistics, using data from the community surveillance component of the Atherosclerosis Risk in Communities (ARIC) Study.

5. **Main Study Questions and Aims:**

**Aim 1:** Determine the sensitivity, positive predictive value and comparability ratio of death certificate classification of CHD death (presence of any of the following ICD-10-CM codes as the underlying cause of death: I20-25), using ARIC adjudicated definite CHD deaths as the gold standard.

1.1 Describe overall temporal trends of sensitivity, positive predictive value and comparability ratio.

1.2 Determine if trends of sensitivity, positive predictive value and comparability ratio differ within relevant subgroups (i.e. sex, race, ARIC community, age at death, location of death) over time.

**Aim 2:** Determine the impact of comparability ratio calibration on trends of CHD mortality using death certificate data.

2.1 Compute unadjusted and comparability ratio adjusted annual rates of CHD death, overall and within relevant subgroups (i.e. sex, race, ARIC community, age at death, location of death).

2.2 Compare differences in unadjusted and comparability ratio adjusted annual rates of CHD death, overall and within relevant subgroups (i.e. sex, race, ARIC community, age at death, location of death).
2.3 Assess the impact of comparability ratio calibration on annual trends of CHD mortality, overall and within relevant subgroups (i.e. sex, race, ARIC community, age at death, location of death).

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 design**
A retrospective analysis to determine the validity of CHD ICD-10-CM codes as the underlying cause of death on death certificates and to calibrate long-term trends of CHD mortality derived from vital statistics in the four ARIC communities.

**Inclusion criteria**
1. All sampled deaths in the ARIC communities from 2000 to 2011 with the following underlying cause of death ICD-10-CM codes: E10-14, I1-11, I20-25, I46-51, I70, I97 (except I97.2), J81, J96, R96, R98, or R99.
2. Age 35 to 84 years at time of death.

**Exclusion criteria**
1. Race other than black or white.

**Outcomes of interest**
The outcome definitions that will be assessed are:
1. Gold standard: definite CHD death as defined by the ARIC Study (definite fatal MI or definite fatal CHD)
2. CHD death derived from death certificates (the presence of any of the following ICD-10-CM codes as the underlying cause of death: I20-25).

**Other variables of interest**
Other variables of interest include: sex, race, ARIC community, age at death, and location of death (in-hospital or out-of-hospital).

**Summary of data analysis plan**
All estimates will be weighted to account for the complex ARIC Surveillance Study sampling scheme. Separate validity and calibration analyses will be carried for out for the years 2000-2011 (age at death range: 35 to 74 years) and 2005-2011 (age at death range: 35 to 84 years), to account for the age range expansion that occurred in 2005.

**Aim 1**
Computation of sensitivity and positive predictive value
Sensitivity and positive predictive value will be summarized for the entire study period, by year and by relevant subgroups (i.e. sex, race, ARIC community, age at death, and location of death). Sensitivity and positive predictive value will be computed in the usual manner.

*Computation of the comparability ratio*
Comparability ratios will be summarized for the entire study period, by year and by relevant subgroups (i.e. sex, race, ARIC community, age at death, and location of death). Comparability ratios for death due to CHD ($C_{CHD}$) will be calculated as follows$^{8,9}$:

$$C_{CHD} = \frac{D_{CHD,ARIC}}{D_{CHD,ICD-10}}$$

where $D_{CHD,ARIC}$ is the number of definite CHD deaths as classified by ARIC study criteria, and $D_{CHD,ICD-10}$ is the number of CHD deaths derived from death certificates (the presence of any of the following ICD-10-CM codes as the underlying cause of death: I20-25). Briefly, a comparability ratio of 1.00 would indicate that the same number of CHD deaths were identified using the ARIC study criteria and the death certificate underlying cause of death ICD-10-CM codes. A ratio less than 1.00 would indicate that less CHD deaths were classified using ARIC study criteria, and a ratio greater than 1.00 would indicate that more CHD deaths were classified using the ARIC definition.

**Aim 2**

Two datasets will be created. Dataset 1 will contain all CHD deaths identified by ICD-10-CM codes (I20-25) from death certificates ($D_{CHD,ICD-10}$). Dataset 2 will contain the comparability ratio adjusted counts of CHD mortality.

*Computation of calibrated number of CHD deaths*

The comparability ratio adjusted number of deaths will be computed for each calendar year within all relevant subgroups. The comparability-modified number of CHD deaths will be calculated as follows$^{8,9}$:

$$D_{CHD,ICD-10}^{CM} = D_{CHD,ICD-10} \times C_{CHD}$$

where $D_{CHD,ICD-10}^{CM}$ is the comparability-modified number of CHD deaths, $D_{CHD,ICD-10}$ is the number of CHD deaths derived from death certificates (the presence of any of the following ICD-10-CM codes as the underlying cause of death: I20-25), and $C_{CHD}$ is the comparability ratio for death due to CHD.

*Trends CHD mortality*

In both datasets, age and age-race adjusted annual CHD mortality rates will be calculated based upon population denominators estimated by interpolation and extrapolation of United States census population estimates. Poisson regression will be utilized to estimate annual changes in CHD mortality rates.

**Limitations**

Deaths selected for these analyses will be comprised of a group ICD-10 codes likely to yield all likely CHD deaths as defined by the ARIC study. Given that all possible deaths were not sampled, we are unable to determine specificity and false-positive rates.

7. a. **Will the data be used for non-CVD analysis in this manuscript?** 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? N/A

8. a. Will the DNA data be used in this manuscript? No

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”? N/A

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

This is a proposed update to the following manuscript: Coady SA et al. Validation of death certificate diagnosis for coronary heart disease: the Atherosclerosis Risk in Communities (ARIC) Study. J Clin Epidemiol. 2001 Jan;54(1):40-50.

11. 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)?
   - MS #111 (Lead = Cooper): Surveillance validation of death certificate diagnosis for CHD
   - MS #201 (Lead = Rosamond): Validation of MI diagnoses
   - MS #667 (Lead = Rosamond): Comparability of ICD-9 and ICD-10 for underlying cause of death
   - MS #1909 (Lead = Rosamond): Evaluation of ICD codes for determining subclasses of myocardial infarction in a community surveillance study
   - MS #2102 (Lead = Jones): Validity of hospital discharge diagnosis codes for stroke in four US communities
   - MS #2147 (Lead = Bush): Concordance of myocardial infarction events between Medicare coding and ARIC adjudication among cohort participants
   - MS #2260 (Lead = Kalbaugh): The burden of peripheral artery disease: linkage of Medicare claims with the ARIC study

12. a. Is this manuscript proposal associated with any ARIC ancillary studies or use any ancillary study data? No

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 at http://www.cscc.unc.edu/aric/forms/
a. 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.

b. 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