

Atherosclerosis Risk in Communities Study Protocol

Manual 1

General Description and Study Management

Visit 4

Version 3.0

August 1997

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## FOREWORD

This manual, entitled General Description and Study Management, Version 3 (covering the cohort examination Visit 4) is one of a series of protocols and manuals of operation for the Atherosclerosis Risk in Communities (ARIC) Study.

The complexity of the ARIC Study requires that a sizeable number of procedures be described, thus this rather extensive list of materials has been organized into the set of manuals listed below. Manual 1 provides the background, organization, and general objectives of the ARIC Study. Manuals 2 and 3 describe the operation of the Cohort and Surveillance Components of the study, respectively. Detailed Manuals of Operation for specific procedures, including those of reading centers and central laboratories, make up Manuals 4 through 11 and 13 through 18. Manual 12 on Quality Assurance contains a general description of the study's approach to quality assurance as well as the details for quality assurance for the different study procedures.

### ARIC Study Protocols and Manuals of Operation

| <u>MANUAL</u> | <u>TITLE</u>                                  |
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# Manual 1. General Description and Study Management

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## 1.0 INTRODUCTION AND BACKGROUND

The Atherosclerosis Risk in Communities (ARIC) Study is a prospective study conducted in four U.S. communities to (1) investigate the etiology and natural history of atherosclerosis, (2) investigate the etiology of clinical atherosclerotic diseases, and (3) measure variation in cardiovascular risk factors, medical care and disease by race, sex, place, and time. It includes a Cohort Component and a Community Surveillance Component.

Community surveillance planning began as a consequence of recommendations of the 1978 National Heart, Lung and Blood Institute (NHLBI) Workshop on the Decline in Coronary Heart Disease (CHD) Mortality. A protocol for community surveillance was developed and pilot tested in the NHLBI Community Cardiovascular Surveillance Program (1980-1984).

The cohort component was subsequently added to the surveillance component to create the current ARIC Study for two reasons. Cohorts can enhance the information value of incidence rates derived from community surveillance by validating them using events ascertained by the standard methods of prospective studies, and by providing information with which to interpret them, e.g. information on risk factors and out-of-hospital medical care. Community surveillance can enhance the generalizability of cohort findings by comparing incidence rates and the characteristics of clinical events in residents who do and who do not participate in cohort follow-up, and by relating CHD experience of the study community to that of other vital statistics reporting areas of the U.S.

Atherosclerosis is assessed in the ARIC Study by imaging lesions through b-mode ultrasound. This permits assessment of (1) the association of risk factors with the underlying arterial disease, (2) the association of the same factors with clinically recognized diseases and (3) the value of ultrasound diagnosis in predicting these diseases. The major atherogenic processes, lipid metabolism and thrombosis, are investigated by using laboratory procedures only recently made available. Storage of blood for future prospective case-control analysis increases the chance of discovering unsuspected precursors of cardiovascular disease.

In the Cohort Component, four random samples, totaling 15,800 persons, ages 45-64 years, were selected for the baseline visit, one from each community. These persons received three examinations (Visits 1, 2 and 3). An additional examination is in progress (Visit 4). The four communities are Forsyth County, North Carolina; Jackson, Mississippi; Suburban Minneapolis, Minnesota; and Washington County, Maryland. The communities are clearly defined geographical entities, have well delineated medical care referral patterns, and provide an opportunity to study blacks and whites, males and females in urban and rural settings. The Jackson cohort is a sample of blacks, while the other field centers sample from their entire defined communities.

The cohort study progresses in the following steps: definition of sampling frames, enumeration of households to determine study eligibility, interview in the household of all study eligibles, recruitment, clinical examination in each community, interview of participant annually to determine health status, contact of health care providers and family members and review of medical records of participants and clinical examinations every three years. Coinciding with the last year of Visit 4, a cross-sectional sample will be

chosen and studied in each community to provide information on traditional risk factors for the total population free of intervention bias. The cross-sectional survey has been named the ARIC Heart Survey.

In Community Surveillance, these four communities are investigated to determine the occurrence of hospitalized myocardial infarction and coronary heart disease death in men and women age 35-74 years. Hospital records are reviewed for all age-eligible residents of each community with a discharge diagnosis of myocardial infarction or one of several related screening diagnoses. All age- and residence-eligible death certificates with various manifestations of coronary heart disease coded as the cause of death are reviewed. For deaths not occurring in a hospital, the decedent's physician and next-of-kin are queried about the circumstances around the time of death. The timetable for the second phase of the ARIC Study covering cohort Visits 3 and 4 is shown in Figure 1.

**Figure 1. ARIC Study: Timetable for Visits 3 and 4**

| <b>YEAR</b>                   | 1993                     | 1994 | 1995 | 1996                      | 1997   | 1998 | 1999                                    |
|-------------------------------|--------------------------|------|------|---------------------------|--|------|---|
|                               | <b>THIRD COHORT EXAM</b> |      |      | <b>FOURTH COHORT EXAM</b> |  |      | <b>Analysis<br/>and<br/>Publication</b> |
| <b>COMMUNITY SURVEILLANCE</b> |                          |      |      |                           |  |      |   |
|                               |                          |      |      |                           | <b>CROSS-<br/>SEC-<br/>TIONAL<br/>SURVEY</b> |      |   |

## 2.0 STUDY DESIGN

### 2.1 Cohort Component Design

The Cohort component is divided into 8 operational sections: (1) sampling, (2) enumeration, (3) home interview, (4) recruitment, (5) first exam, (6) annual follow-up, (7) clinical review and diagnostic classification and (8) subsequent exams. Sampling, enumeration and recruitment were carried out in 1986-89. The first cohort baseline exam was carried out in 1986-89. The second and third exams were carried out in 1990-92 and 1993-95 respectively. The fourth cohort exam has been scheduled for 1996-98.

#### 2.1.1 Sampling

Probability sampling, with high coverage rates, was used to select the cohorts in each of the four communities. Although the sampling methods differ among areas, randomized selection methods and current or updated frames were used in each design. The designs differ among the communities primarily by how the frames are constructed and in which units the sample is chosen.

#### 2.1.2 Cohort Enumeration Procedures

Interviewers located the designated sample housing units (Forsyth County) or sample individuals (Jackson, Minneapolis and Washington County) in each area to determine eligibility status. When contact was made with an occupant of a designated household, the interviewer introduced him/herself, showed the respondent his/her credentials, briefly described the purpose of the visit, and proceeded with enumeration. Enumeration is the process of completing a household roster needed to select the sample member(s). All members of the designated households ages 45-64 were asked to participate in the cohort study.

The enumerator listed all the persons at least 18 years old who resided in the sample household. Persons who indicated that their permanent residence was outside the study area were excluded, as were individuals who were physically or mentally incapable of full participation in the study.

#### 2.1.3 Cohort Home Interview

Cohort home interviews with each eligible participant were conducted after enumeration, but are not being conducted during Visits 3 and 4. The original home interviews had 6 sections: Health Status and Risk Factors, Family Medical History, Smoking, Employment, Education, and Home Interviewer Debriefing. The purpose of each section is described in Table 1.

#### 2.1.4 Cohort Recruitment and Scheduling for the Clinic Examination

Prior to the baseline visit, and during the home interview (see Table 1 for contents), eligible cohort members were given a written and verbal description of the study. They were asked to participate in the complete study, which includes two clinical examinations and the annual telephone follow-up. Prior to Visits 3 and 4, scheduling for the clinic examinations are set up during the annual follow-up telephone call. The clinic return visit is scheduled for within one month of the third anniversary of the previous clinic examination.

**Table 1. The Home Interview in the ARIC Study Cohort Component**

| Section                   | Purpose  |
|---------------------------|--|
| Health Status             | Obtain general knowledge of the participant's health status; determine prior hospitalization(s) within the past year;                            |
| Risk Factors              | Determine selected risk factors for CVD. <sup>1</sup>  |
| Family Medical History    | Obtain general knowledge of the participant's family health status; determine past history or cause of death due to CVD, cancer or diabetes.     |
| Smoking                   | Determine smoking status and amount.   |
| Employment                | Determine the participant's current employment status.   |
| Education                 | Determine the participant's level of education.  |
| Home Interview Debriefing | Assess the participant's cooperation during the interview; assess the quality of the interview; assess the participant's literacy/comprehension. |

<sup>1</sup>Cardiovascular disease

The cohort member is scheduled for the clinical examination at the ARIC Field Center, which is located at or near a hospital in each study community. The participant is asked to come to the clinic after a 12 hour fast and to bring all medications (prescription and nonprescription) which he/she has used in the last two weeks.

#### 2.1.5 Cohort Clinic Examination

The clinic examination takes approximately 3 ½ hours. The sequence of the exam is flexible so one, two or three participants can be examined concurrently, in accordance with the available personnel and work station configuration. The following sequencing restraints are necessary. (1) Fasting and abstinence from smoking and alcohol are required prior to venipuncture, blood pressure measurements, and collection of heart rate variability (HRV) data. (2) Sitting blood pressure must be measured before venipuncture. (3) Interviewing and Examination must precede the Medical Review. Participants must fast and abstain from alcohol and tobacco for not less than 12 hours. A snack, however, is provided during the exam. It was planned to have one random half of the cohort have the ultrasound exam on Visit 3 and the other half on Visit 4 in Washington County and Minneapolis field centers. However, due to delays, the random assignment could not be

pursued. The Ultrasound schedule for Visits 3 and 4 is such that at the end of Visit 4, all cohort participants are expected to have at least 3 ultrasound measurements. All cohort members in Jackson and Forsyth County field centers receive the ultrasound examination. New measurements added to Visit 3 include retinal photography (all field centers), magnetic resonance imaging (MRI) in Jackson and Forsyth County only, and echocardiography in Jackson. Table 2 identifies and describes the components of all ARIC visits.

In Visit 4, retinal photography, MRI and echocardiography are not done. New procedures added to Visit 4 include periodontal examination and heart rate variability measurement, urine sample for measurement of albumin/creatinine and hemostatic metabolism, and oral glucose tolerance test. In addition, the Health and Life Profile Part C (trait anger) used in Visit 2 is being repeated.

Table 2. The ARIC STUDY: Interviews and Procedures by Examination

| PROCEDURES                     | VISIT 1 | VISIT 2 | VISIT 3 | VISIT 4 |
|--------------------------------|---------|---------|---------|---------|
| <b>ANTHROPOMETRY</b>           |         |         |         |         |
| HEIGHT                         |         |         |         |         |
| Sitting Height                 | X       |         |         |         |
| Standing Height                | X       |         | X       | X       |
| FRAME SIZE                     |         |         |         |         |
| Elbow                          |         | X       |         |         |
| Wrist                          | X       |         |         |         |
| GIRTHS                         |         |         |         |         |
| Calf                           | X       |         |         |         |
| Hip                            | X       | X       | X       | X       |
| Waist                          | X       | X       | X       | X       |
| SKINFOLDS                      |         |         |         |         |
| Subscapular                    | X       | X       |         |         |
| Triceps                        | X       | X       |         |         |
| WEIGHT                         |         |         |         |         |
| Weight                         | X       | X       | X       | X       |
| MALE BALDNESS                  |         |         |         | X       |
| <b>BLOOD PRESSURE</b>          |         |         |         |         |
| SITTING                        | X       | X       | X       | X       |
| SUPINE                         | X       |         | S       | S       |
| STANDING                       | X       |         | S       | S       |
| ANKLE                          | X       |         | S       | S       |
| <b>ECHOCARDIOGRAPHY</b>        |         |         |         |         |
| Jackson                        |         |         | X       |         |
| <b>ELECTROCARDIOGRAMS</b>      |         |         |         |         |
| 2 MINUTE RHYTHM STRIP          | X       |         |         |         |
| 12 LEAD                        | X       | X       | X       | X       |
| HEART RATE VARIABILITY         | S       |         |         | A       |
| <b>GLYCEMIC LOAD</b>           |         |         |         |         |
|                                |         |         |         | X       |
| <b>MEDICAL DATA REVIEW</b>     |         |         |         |         |
|                                | X       | X       | X       | X       |
| <b>MRI, CEREBRAL</b>           |         |         |         |         |
| Forsyth County                 |         |         | X       |         |
| Jackson                        |         |         | X       |         |
| <b>PERIODONTAL EXAMINATION</b> |         |         |         |         |
|                                |         |         |         | A       |
| <b>PHYSICAL EXAMINATION</b>    |         |         |         |         |
| Walking/standing               | X       | X       | X       | X       |
| Neck                           | X       | X       |         |         |
| Cardio/pulmonary               | X       | X       |         |         |
| Breast                         | X       | Opt.    |         |         |
| Lower extremities              | X       | X       |         |         |

S=Sample of the cohort; A=Ancillary study mechanism

Table 2 cont. The ARIC STUDY: Interviews and Procedures by Examination

| <u>PROCEDURES</u>          | <u>VISIT 1</u> | <u>VISIT 2</u> | <u>VISIT 3</u> | <u>VISIT 4</u> |
|----------------------------|----------------|----------------|----------------|----------------|
| <b>PULMONARY FUNCTION</b>  |                |                |                |                |
| FEV <sub>1</sub>           | X              | X              |                |                |
| FVC                        | X              | X              |                |                |
| Max. Inspir. Pressure      |                | X              |                |                |
| <b>RETINAL PHOTOGRAPHY</b> |                |                |                |                |
|                            |                |                | X              |                |
| <b>ULTRASOUND, B-MODE</b>  |                |                |                |                |
| CAROTID ARTERIES           | X              | X              | S              | S              |
| DISTENSIBILITY             | X              | X              |                |                |
| POPLITEAL ARTERY           | X              |                |                |                |
| <b>VENIPUNCTURE</b>        |                |                |                |                |
| CHEMISTRIES                |                |                |                |                |
| Core                       | X              | X              |                |                |
| Case/Control               | X              | X              | X              | X              |
| HEMATOLOGY                 |                |                |                |                |
| Core                       | X              | X              | Opt.           | Opt.           |
| HEMOSTASIS                 |                |                |                |                |
| Core                       | X              |                |                |                |
| Case/Control               | X              | X              | X              | X              |
| LIPIDS                     |                |                |                |                |
| Core                       | X              | X              | X              | X              |
| Case/Control               | X              | X              | X              | X              |
| <b>INTERVIEWS</b>          |                |                |                |                |
| Annual Follow-up           | X              | X              | X              | X              |
| Blood Transfusion          |                |                |                | X              |
| CHD events/procedures      | X              | X              | X              | X              |
| Cognitive Function         |                | X              | MRI            | X              |
| Dietary Intake             | X              | S              | X              | S              |
| Family History of CHD      |                | X              |                |                |
| Fasting Status             | X              | X              | X              | X              |
| Health History             | X              | X              | X              | X              |
| Home Interview             | X              |                |                |                |
| Identification             | X              | Updated        | Updated        | Updated        |
| Inflammation               |                |                |                | X              |
| Informed Consent           | X              | X              | X              | X              |
| Medication Survey          | X              | X              | X              | X              |
| Personal History           | X              | X              | X              | X              |
| Physical Activity          | X              |                | X              |                |
| Reproductive History       | X              | X              | X              | X              |
| Respiratory Symptoms       | X              | X              |                |                |
| Social Support             |                | X              |                |                |
| Socioeconomic Status       | X              | X              | X              | X              |
| TIA/Stroke                 | X              | X              | X              | X              |
| TIA/Stroke Summary         | X              | X              |                |                |
| Tracking                   | X              | X              | X              | X              |
| Trait Anger                |                | X              |                | X              |
| Vital Exhaustion           |                | X              |                |                |
| Vitamin Survey             |                |                | X              |                |

S=Sample of the cohort; A=Ancillary study mechanism

### 2.1.6 Cohort Follow-Up

Annual follow-up of the cohort is used to maintain contact, to correct address information, to ascertain medical events between examinations, and to schedule clinic visits.

Follow-up contacts are made yearly within a month of the anniversary of the previous examination.

The telephone interview asks about hospitalizations for illness or surgery, diagnoses and symptoms. The participant is asked a version of the Rose Questionnaire for angina, possible MI, and intermittent claudication. Address and phone number are verified and other contact information is updated. If the participant cannot be reached by telephone, a home interview is attempted. Similar procedures are used after the second exam. Every attempt is made to identify cohort participants who have died in advance of the annual contact, through regular review of obituaries and death certificates.

### 2.1.7 Cohort Event Identification and Diagnostic Classification

During the initial home interview, the examination or the follow-up contact, the cohort participant may indicate that he or she has been hospitalized. Records are obtained for all hospitalizations which occur after the baseline visit. ARIC abstractors record all discharge diagnoses and clinical information related to coronary or cerebrovascular diseases. Discharge diagnoses only are recorded for other events. The participant will have signed a medical release form allowing the study to access medical records.

Similarly, during the obituary review, a follow-up contact, or the community death certificate surveillance, it may be determined that the participant has died. In these cases, the death certificate is obtained and the place of death is determined. For in-hospital deaths, the hospital record is reviewed. For out-of-hospital deaths and decedents admitted without vital signs, the participant's family and physician are contacted to provide information on the circumstances surrounding the death. At entry to the study, the participant will have given consent to contact family members and physicians in the event of his or her death.

A special Morbidity and Mortality Classification Committee (MMCC) reviews the information on hospitalizations and provides the study diagnosis for coronary heart disease or cerebral vascular disease according to defined criteria. The MMCC also provides a classification of cause of death.

### 2.1.8 Follow-up Clinic Examination

Examinations take place with an interval of three years.

## 2.2 Community Surveillance

The community surveillance component provides measures of the geographical and temporal variation of the occurrence of clinical CHD in ARIC communities and will suggest reasons for the patterns observed. The distributions of demographic characteristics, as well as the changes in these measurements,

will provide a set of possible explanatory factors for the atherosclerosis and CHD profiles of the communities under surveillance.

It is the aim of community surveillance to estimate the incidence and obtain a valid diagnostic classification of fatal CHD and non-fatal myocardial infarction (MI) in residents aged 35 to 74 years in the four communities for the period January 1, 1987 to December 31, 1998.

Community surveillance for hospitalized myocardial infarction involves a review of hospital records of age-eligible residents with either a diagnosis of MI or a related illness. All ICD-9 410 and 411 discharge diagnoses are included, and other diagnoses are sampled. Hospital records identified through this process are abstracted for information relating to history, symptoms, signs, times of onset and admission, enzymes, ECG and treatment. This information is used in a diagnostic algorithm which classifies each event as "Definite MI", "Probable MI", "Possible MI", or "No MI". Selected events are reviewed by the MMCC for validation.

The surveillance of CHD deaths is accomplished by abstracting all age- and residence-eligible death certificates with various manifestations of CHD coded as the underlying cause of death. An additional subset of death certificates is sampled from a group with related ICD codes. Sources of validation for out-of-hospital deaths include interviews with the physician and next of kin, coroner or medical examiner reports, and hospital records. Deaths occurring in the hospital are classified by abstracting information from the medical record. CHD deaths identified undergo review by the MMCC. A diagnostic algorithm is also applied, providing a preliminary classification, as well as identifying events either with insufficient information or with unequivocally diagnostic information that do not require interpretation by the committee.

#### 2.2.1 Cross-sectional Survey (ARIC Heart Survey)

Field centers will each recruit 300 persons aged 45-64 years, and examine them once over a 12 month period (February 1, 1998 through January 31, 1999). Examinees will be representative of persons currently living in the study communities, excluding cohort members. Only blacks will be selected in Jackson. Data from the survey sample will be used for comparisons with the cohort at baseline exam, to assess temporal trends in the communities. Information collected will be comparable to similar information collected at baseline.

The ARIC Heart Survey will include a home interview and a clinic visit. The survey will include:

- I. Informed consent, reception.
- ii. Sitting blood pressure.
- iii. Fasting cholesterol, triglycerides, HDL-cholesterol, fibrogen, stored blood.

- iv. Interview for social and demographic characteristics, educational status, diet, smoking, cardiovascular history, Rose questionnaire, use of cardiovascular medications, medical care.
- v. Medical data review.

A summary of the ARIC Heart Survey sampling designs by site, and estimated sample sizes at different stages of the sampling are shown in Tables 3a, 3b and 3c.

**Table 3a. Summary of the ARIC Heart Survey Sampling Designs**

| Community               | Sampling Units | Source of Frame                        |
|-------------------------|----------------|--|
| Forsyth County, NC      | Households     | NC drivers license list                |
| Jackson, MS             | Households     | MS drivers license list                |
| Minneapolis suburbs, MN | Households     | MN drivers license list                |
| Washington County, MD   | Individuals    | Drivers' licenses, 1975 private census |

**Table 3b. Numerical Estimates and Sample Respondents**

| Community               | Number in Community ages 45-64 | Number Sampled and Attending Clinic Examination |
|-------------------------|--------------------------------|---|
| Forsyth County, NC      | 31,535                         | 300   |
| Jackson, MS             | 13,768*                        | 300   |
| Minneapolis suburbs, MN | 41,944                         | 300   |
| Washington County, MD   | 23,935                         | 300   |

\*African American residents

Source: 1990 Census of Population: Social and Economic Characteristics: Tables 57 and 79. Issued September 1993.

**Table 3c. Estimated Number of Respondents at Specified Stages of AHS**

| Community               | Housing units with <u>members enumerated</u> |                            | Age-eligible persons <u>interviewed</u> |                   | Age-eligible persons <u>attending clinic exam</u> |                   |
|-------------------------|--|----------------------------|---|-------------------|---|-------------------|
|                         | # units enumerated                           | # units refused or missing | # persons interviewed                   | # persons refused | # persons attending                               | # persons refused |
| Forsyth County, NC      | 374  | 85                         | 400                                     | 120               | 300   | 95                |
| Jackson, MS             | 402  | 98                         | 509                                     | 48                | 300   | 132               |
| Minneapolis suburbs, MN | 275  | 30                         | 375                                     | 66                | 300   | 75                |
| Washington County, MD   | 353  | 65                         | 317                                     | 150               | 300   | 17                |
| <b>TOTAL</b>            | 1,405  | 278                        | 1,601                                   | 384               | 1,200   | 319               |

### 2.2.2 Study Communities

The ARIC Study collects data in four diverse communities. This design was chosen so that data could be obtained for groups which differ by geography, race, and socio-economic status. The ARIC Study was not designed to select a random or representative sample of the entire U.S. population. Each community provides information on the occurrence of coronary heart disease in a unique environmental setting. The cohorts representing each community are studied so that inferences about risk factors and disease relationships can be made from diverse population groups. This diversity permits the evaluation of the consistency of observed association.

The four communities studied are: Forsyth County, North Carolina; the city of Jackson, Mississippi; selected northwestern suburbs of Minneapolis, Minnesota; and Washington County, Maryland. Each community contributes a cohort at baseline of approximately 4,000 men and women between the ages of 45 and 64. The cohort in Jackson, Mississippi was sampled and recruited to have an all-black population. The 1990 population size and socio-economic characteristics of the communities are summarized in Table 4.

**Table 4. ARIC Study Communities: Demographic Characteristics, 1990**

| Community                  | Population |            | % Black | % Urban | % education<br>12 or more<br>years* | Median<br>Household<br>Income |
|----------------------------|------------|------------|---------|---------|-------------------------------------|-------------------------------|
|                            | Total      | Ages 45-64 |         |         |                                     |                               |
| Forsyth<br>County, NC      | 265,878    | 31,535     | 24.9    | 75.1    | 77.6                                | \$30,449                      |
| Jackson, MS                | 196,637    | 32,600     | 55.7    | 100.0   | 75.0                                | \$23,270                      |
| Minneapolis<br>suburbs, MN | 217,568    | 41,944     | 3.0     | 100.0   | 90.0                                | \$41,282                      |
| Washington<br>County, MD   | 113,345    | 23,935     | 2.8     | 59.0    | 69.2                                | \$29,586                      |

\*for persons age 25 and older

Sources: 1990 Census of Population: General Population Characteristics, Table 1. Issued June 1992.

1990 Census of Population: Social and Economic Characteristics: Tables 57, 79, 148. Issued September 1993.

These communities were selected using criteria which included location, availability of census data, study population size, population stability, ischemic heart disease mortality rates, the cooperativeness of the population, the cooperativeness and accessibility of other agencies, and the medical facilities within the community. Table 5 provides age-adjusted all-cause and ischemic heart disease mortality rates for the four ARIC communities.

### 2.2.3 Forsyth County, North Carolina

Forsyth County is a single-county State Economic Area, located in the North Carolina Piedmont in the center of the state. Winston-Salem is the only large urban area in the county. The county constitutes a contiguous area with census-based boundaries and a relatively stable total population of about 250,000 persons.

The population of Forsyth County grew 13.3 percent between 1970 and 1980. In spite of this growth, 73.8 percent of the people surveyed in 1980 were born in North Carolina. The 1975-1980 migration patterns are similar to the patterns for the U.S., the southeast and North Carolina.

Medical care facilities are of high quality and highly concentrated for purposes of surveillance. The referral pattern is optimal with respect to outmigration of patients. In Forsyth County there are two major and one smaller general hospitals that serve this community. The complement of acute and general hospital care is thus highly concentrated. Of salient importance to the ARIC Study, residents of this community seek and obtain hospital care within Forsyth County. The place of hospitalization of 95 percent of Forsyth County residents is one of the three hospitals in Winston-Salem. These establishments have general and intensive care medical surgical beds, and a high rate of autopsies. CAT scan procedures are available in the two main hospitals for the documentation of cerebrovascular endpoints. The two main hospitals in the study area have active cardiology medical staff, and the community has a favorable ratio of population to active providers of medical care.

**Table 5. Age-Adjusted Mortality Rates<sup>1</sup> for Men and Women, Ages 35-74, in the ARIC Study Communities, 1980**

| ARIC Study Communities            | <u>All-cause Mortality</u> |       | <u>Heart disease mortality<sup>2</sup></u> |       |
|-----------------------------------|----------------------------|-------|--|-------|
|                                   | Men                        | Women | Men  | Women |
| Forsyth County, North Carolina    | 16.3                       | 8.7   | 6.7  | 2.7   |
| Jackson, Mississippi (Black only) | 20.8                       | 10.0  | 6.6  | 2.9   |
| Minneapolis Suburbs, Minnesota    | 9.4                        | 6.3   | 4.2  | 1.3   |
| Washington County, Maryland       | 16.1                       | 8.2   | 7.8  | 2.8   |
| U.S. TOTAL                        | 14.4                       | 8.0   | 5.7  | 2.6   |

<sup>1</sup>Indirect age-adjustment; annual rate per 1,000

<sup>2</sup>ICD-9, International Classification of Diseases, Ninth Edition: 390-398, 402, 404-429

#### 2.2.4 Jackson, Mississippi

Jackson, Mississippi lies approximately midway between New Orleans to the south and Memphis, Tennessee to the north. Its location makes Jackson a major distribution center for the deep South. Jackson is a major retail and financial center for the state. In addition, Jackson is a major medical center offering a full range of educational, research, diagnostic and treatment facilities and services.

While the population of Jackson has grown 32 percent from 1970 to 1980, it is, nevertheless, a relatively stable population. In 1985, the Center for Population Studies at the University of Mississippi estimated that, for the period 1970 to 1980, of the total population in Hinds County for ages 45-64, 2,680 persons would migrate in and 2,360 would migrate out, for a net gain of 320 persons. This would represent an increase of 1.4 percent. Across the spectrum, from ages 25-69 among the total population of Hinds County, there was a net decrease of 1,960 persons representing less than one percent of the population. Most of the out migration occurred between the ages of 25-44 with either increases or stability beyond age 45. Among the black population, there was a net increase of 240 individuals between the ages of 25-70, an increase of less than one percent. These numbers reflect extrapolation to the population base, but the actual data used a 2.5 percent sample of the population. Thus the population is particularly stable between the ages of 45 and 64 and across all ages of interest. Of particular pertinence to the surveillance activities is the fact that of 3,687 deaths which occurred in Hinds County, 2,058 were residents of Hinds County. This reflects the referral into the Jackson area of patients rather than the referral of Jackson area residents to other areas.

Jackson is the largest city in Mississippi and the major medical area. Hinds County, in which Jackson is located, has 8 general and 3 specialty hospitals, a total of 2,932 hospital beds. There is little need for patients from the Jackson area to seek medical attention elsewhere for reasons of available facilities, manpower, or services.

There are five emergency rooms within the Jackson area which have approximately 130,000 visits a year. There are three coronary care units within the Jackson area and one coronary care unit in Vicksburg, 45 miles distant. Of the cardiac catheterizations performed in the state in 1983, 57 percent were performed in Jackson hospitals, while of 1,058 open heart surgery procedures on adults, 83 percent were carried out in Jackson hospitals. One of the four special stroke care units established in the state is located in Jackson. In previous population studies, the proportion of patients seeking medical care outside the Jackson area has been less than 3 percent.

#### 2.2.5 Minneapolis Suburbs, Minnesota

The study community is a collection of seven geographically contiguous Minneapolis suburbs: Golden Valley, Robbinsdale, Crystal, New Hope, Plymouth, Brooklyn Center, and Brooklyn Park. The community constitutes the first tier of suburbs lying to the northwest of the city of Minneapolis. All of the individual suburbs lie within Hennepin County and are U.S. Census-defined cities of greater than 10,000 population. The community is located about 10 miles northwest of the University of Minnesota. At the eastern border of the community lies the Mississippi River or the city of Minneapolis; the north is bounded by Anoka County; at the west and south borders lie other suburban areas in Hennepin County.

While the population in the Twin Cities (Minneapolis-St. Paul) has grown 5.9 percent from 1970 to 1980, the percentage change in the ARIC Study communities for the same period was 21.9 percent. In spite of this growth, for the period 1975 to 1980, 53.1 percent of the persons surveyed were in the same house, 81.6 percent were in the same county and 89.8 percent were in the same state. This compares favorably with census data for the U.S. as a whole.

Originally, 17 area hospitals were identified in 1986 that admitted patients from the ARIC study community. With mergers and elimination of rare admissions, ten are being surveyed as of 1994. About one-half of the admissions are to North Memorial Medical Center, a 500-bed facility.

The Twin Cities metropolitan area has a wide range of primary, secondary, and tertiary care hospitals and physicians. There is a uniform emergency medical system which responds to 911 dispatching. A full range of cardiovascular diagnostic and treatment procedures, including cardiac transplants and artificial heart implantation are available in the area.

The Minnesota State Health Department is within one block of the University of Minnesota. The Department of Epidemiology has an excellent working relationship with the Department of Health and has ready access to death certificates. Each county in the Twin Cities has a coroner whose records are available for research purposes.

### 2.2.6 Washington County, Maryland

Washington County is located in western Maryland, 75 miles northwest of Baltimore and Washington, DC. Most of the county is located in the broad valley between the Blue Ridge on the east and the Allegheny Mountains on the west. These mountains and the Potomac River on the county's southern edge tend to decrease inter-county travel.

Industry is light and diversified. The largest employer is the Mack Truck engine and transmission plant with approximately 3,500 employees. Because of the intersection of major east-west and north-south interstate highways and rail lines, transportation is another large source of jobs. Agriculture is also important, especially dairying in the valley and orchards on the mountain slopes.

The adult population of Washington County is very stable. Census data for 1980 showed that 60 percent of non-institutionalized persons 5 years of age or older had lived in the same house, and 89 percent in the same county for five years or more. Follow-up of 4,328 persons enumerated in a private census in 1963 showed that 93 percent of persons initially aged 45 to 65 years who were still alive were residing in Washington County eight years later, the proportion being nearly the same for males and females. Among 130 persons aged 50 to 70 years in 1973, 85 percent were living in the same house they had occupied in the 1963 private census.

In 1983-84, 148 persons were selected from the 1975 private census listings as age-matched controls for a study of colon cancer. Of these, 5 were known to have died in the county, and 133 were known to be living in the county. Comparable information from 229 controls selected at the same time for a study of lung cancer indicated that 8 had died and 212 were still living in the county. Among controls in the two studies combined, there was a 5.0 percent loss from emigration over an 8 ½ year period, a rate of only 0.6 percent per year for these middle-aged and older residents.

There are 165 practicing physicians in the county with virtually every specialty represented. An efficient medical examiner service for investigating sudden and unattended deaths is part of a state-wide system. Washington County Hospital, the only general hospital in the county, has 415 beds. It serves as the medical center for the surrounding area so that few local residents go elsewhere for treatment. However, several patients admitted initially with an eligible ICD code to Washington County Hospital are subsequently transferred to the following Washington, D.C., and Baltimore hospitals, which are therefore also included in surveillance: Georgetown University Hospital, George Washington Hospital, Washington Hospital Center, University of Maryland Hospital and Johns Hopkins Hospital. Referral patterns are being monitored and, thus, other hospitals may be added. Western Maryland Center, a state rehabilitation hospital, and a private psychiatric hospital, Brook Lane Center, are the other two hospitals in the county. It is estimated that 95 percent of non-fatal MIs are hospitalized in Washington County Hospital.

Washington County Health Department provides clinic and home nursing services to the community. The Department also houses the Training Center for Public Health Research which acts as the custodian of death certificates for the county. The Training Center also keeps a current file of obituaries.

### 2.3 Central Agencies

In addition to the four field centers described above, the ARIC study includes ten central agencies. The protocols for the procedures performed by each of these agencies are contained in separate manuals: echocardiography (Manual 15), retinal photography (Manual 14), magnetic resonance imaging (Manual 13), clinical chemistry (Manual 10), hemostasis (Manual 9), lipids (Manual 8), electrocardiography (Manual 5), pulmonary function (Manual 4), ultrasound (Manual 6), and quality control (Manual 12). The role of these agencies is summarized in this section.

#### 2.3.1 Central Clinical Chemistry Laboratory

The clinical chemistry measurements performed at exam one by the Central Clinical Chemistry Laboratory were: glucose, creatinine at exam one, urea, calcium, magnesium, sodium, potassium, phosphorus, total protein, albumin, uric acid, and insulin (Table 5). The determinations are made on frozen sera for all cohort participants which are shipped from the Field Centers. The analytical methods and quality control programs (both internal and external) follow those of the University of Minnesota Hospital Laboratories. In addition, blind replicate samples are submitted by the Field Centers as an additional means of monitoring laboratory performance.

#### 2.3.2 Central Hemostasis Laboratory

Atherosclerosis, long recognized as a disease of lipid deposition into arterial walls, is increasingly believed to involve the hemostasis system. Hemostasis may be critical both for the onset of clinical disease (thrombotic occlusion leading to cerebral or myocardial infarction) and for initiation and progression of the underlying atherosclerotic lesions. Since the hemostasis system is highly reactive, prospective studies, rather than studies of clinical cases, are necessary to test this hypothesis. The Central Hemostasis Laboratory evaluates each component of the hemostasis system in ARIC cohort participants: coagulation proteins and platelets (which promote arterial clot formation) and coagulation inhibitors and the fibrinolytic system (which prevent or lyse clots). The specific measurements to be made (Table 6) are classified as follows:

1. Platelets - plasma levels of Beta-thromboglobulin ( $\beta$ -TG).
2. Coagulation
  - a. Pro-enzymes - plasma levels of fibrinogen and VIII activity ( $VIII_c$ ); von Willebrand factor antigen; activity of factor VII, activated VII ( $VII_a$ ) and VII antigen.
  - b. Coagulation inhibitors - plasma levels of Antithrombin III (AT-III) and prothrombin fragment  $F_{1+2}$ .
3. Coagulation inhibitors - plasma levels of Antithrombin III (AT-III), and protein C and protein S.
4. Fibrinolysis - plasma levels of Tissue plasminogen activator (tPA) and plasminogen activator, inhibitor-1 (PAI-1) and D-dimer.

5. Fibrinogen, PAI-1 and factor VII gene polymorphs.
6. Others - C reactive protein, thrombomodulin, aPTT.

**Table 6. Measurements Performed at the ARIC Central Laboratories**

| Central Clinical<br>Chemistry<br>Laboratory | Central Hemostasis<br>Laboratory  | Central Lipid<br>Laboratory                                     |
|---|---|---|
| Glucose                                     | Activated PTT (aPTT)  | Total cholesterol<br>Total triglyceride                         |
| Creatinine                                  | Fibrinogen  | HDL cholesterol   |
| Insulin                                     | Factor VII <sub>a</sub> *, VII <sub>c</sub> , and<br>VII antigen                            | LDL cholesterol<br>Glucose                                      |
| Total protein                               | Factor VIII C   | Lipoprotein [a]   |
| Albumin                                     | von Willebrand factor<br>antigen  | Apo[a] phenotype*   |
| Uric acid                                   | Protein C + Protein S   | Apolipoprotein<br>A-I*<br>Apolipoprotein B*                     |
| Urea nitrogen                               | Antithrombin III<br>(AT-III)  | ApoE genotype*  |
| Calcium                                     | Fibrinopeptide A* (FPA)   | Lipoproteins Lp-AI<br>and LpA-I/A-II*                           |
| Phosphorous                                 | Beta-thromboglobulin*   | LDL size*   |
| Magnesium                                   | Plasminogen activator<br>inhibitor*   | Apolipoprotein<br>C-II*   |
| Sodium                                      | D-dimer*  | Apolipoprotein<br>C-III*  |
| Potassium                                   | Tissue plasminogen<br>activator* (tPA)<br>Factor VII, PAI-1<br>and fibrinogen<br>polymorphs | Polymorphisms in<br>genes<br>controlling<br>lipid<br>transport* |

\*Performed only for case control studies.

Seven of these measurements (fibrinogen, factors VII and VIII, von Willebrand factor antigen, aPTT, protein C and AT-III) are made on blood from every cohort participant; the remainder, on blood from selected cases and controls only.

Methods used at the field centers for blood collection and processing, designed to minimize activation of the hemostasis system, were pretested at the Central Hemostasis Laboratory. The remaining tests use plasma. Aliquots are processed differently (different anticoagulants and methods of centrifugation and filtration) for the three sets of plasma tests. Aliquots are shipped frozen to the Central Hemostasis Laboratory.

The assay procedures are summarized as follows:

1. Fibrinogen, Factors VII<sub>c</sub>, VII<sub>a</sub>, VIII<sub>c</sub>, and aPTT by automated clotting time.
2. Von Willebrand factor antigen, tPa, PAI-1, F<sub>1,2</sub>, D-dimer,  $\beta$ -TG, Protein C, Protein S, factor VII antigen, C-reactive protein, thrombomodulin by enzyme linked immunosorbent assay.
3. AT-III by chromogenic substrate technique.
4. Factor VII, PAI-1 and fibrinogen polymorphism by polymerase chain reaction.

Field center laboratory technicians were trained in proper venipuncture and processing methods and are certified and periodically recertified by the chief technologist from the Central Hemostasis Laboratory.

Sample collection, processing, storage and analysis are monitored using an internal and external quality control program and through the analysis of blind duplicates. An added check on drift or shifts in laboratory performance is provided by analysis of blood from monthly random subsamples of the cohort in each community.

### 2.3.3 Central Lipid Laboratory

Central Lipid Laboratory measurements of lipids, cholesterol, cholesterol in lipoprotein fractions, and glucose permits ARIC to maintain a characterization of study participants during the course of the study. Total cholesterol, triglyceride, HDL cholesterol and glucose are measured directly. LDL cholesterol is a derived quantity. Each of these determinations is made for all cohort participants on frozen plasma. Additional, newer lipid measurements are made on selected cases and controls, using stored plasma.

Methods of collection, processing and storage were developed and tested, and limits for accuracy and precision were established prior to analysis of specimens from ARIC participants. Assay methods are as follows:

1. Cholesterol and triglyceride by enzymatic methods.
2. HDL by enzymatic method following precipitation of VLDL + LDL by magnesium and dextran sulfate.
3. Glucose by enzymatic method.

Studies to be performed in cases and controls include apolipoprotein[a] phenotype, apolipoproteins A-I, B, C-II, and C-III, apoE genotype, lipoproteins LpA-I and LpA-I/A-II, LDL size, and studies on polymorphisms of candidate genes controlling key regulatory steps in lipid metabolism.

#### 2.3.4 ECG Reading Center

Electrocardiograms (ECGs) are collected in the ARIC Study both for the cohort and in community surveillance. There are two ECG reading centers: the ECG Computer Center at the Bowman-Gray School of Medicine, Wake Forest University, Winston-Salem, North Carolina (EPICARE), and the ECG Reading Center at the University of Minnesota Division of Epidemiology.

##### 2.3.4.1 ECG data collection and coding in the cohort component

A standard supine ECG and a two-minute rhythm strip were obtained on each subject at baseline and the standard ECG is obtained at all subsequent clinic visits. The purpose of the initial test is to determine ECG status of each participant at baseline. Subsequent tests determine changing ECG status with regard to myocardial ischemias, left ventricular hypertrophy, and arrhythmias.

The examination ECGs are recorded electronically and transmitted to the EPICARE ECG center where continuous computer measurements are made on the ECG wave forms (including the Minnesota Code and additional indices of electrocardiographic findings). All abnormal ECGs and a sample of normal ECGs are also read manually in Minneapolis, using the method described below.

ECGs of hospitalized cohort members are photocopied locally and coded manually by the Minnesota ECG Reading Center. Each ECG is read independently by two technician readers, and unresolved disagreements are adjudicated by the ECG supervisor and/or an electrocardiographer at the reading center. Serial change rules are used for suspected MI. All readings are made without knowledge of clinical or laboratory findings for the subject. At periodic intervals, a subsample of hospital and clinic examination ECGs are re-submitted for masked reading to monitor the ECG Center performance.

##### 2.3.4.2 ECG data collection and coding in the community surveillance component

The Minnesota ECG Reading Center performs Minnesota coding for surveillance in hospitals in each community.

##### 2.3.4.3 Pulmonary function center

Pulmonary function studies were done in Visits 1 and 2. The Pulmonary Function Center provided centralized processing of all pulmonary function studies performed in the cohort component in exams 1 and 2 and the standardization of pulmonary testing in the four field centers through (1) a protocol for testing procedures; (2) the training and certification of field center pulmonary function technicians; and (3) ongoing quality control.

The Pulmonary Function Center reviews every 10th spirogram. The paper graphic volume-time tracing of every 10th participant is sent to the Pulmonary Function Center (including previous tracings for this participant for comparison). It electronically reviews each participant's results. A floppy disk copy of the digitized records of the three best spiograms of each

participant is also sent to the Pulmonary Function Center. These digitized spiromgrams are electronically reviewed for quality and reproducibility. Appropriate indices of volume and flow are derived. An electronic consistency check of each participant's result is made against his previous spirometry.

The Pulmonary Function Center also reviews the data distributions of each field center. A routine comparison of sex and race specific regressions on age and height is programmed into the electronic review. This permits comparison of results between field centers, with the same center on previous occasions and with predicted values.

#### 2.3.5 Ultrasound Reading Center

The Ultrasound Reading Center performs a centralized reading of the cohort ultrasound scans recorded on videotapes at the four Field Centers. The scans are obtained at the field centers following procedures detailed in the protocol. Studies are read at the Ultrasound Reading Center following a standardized protocol.

Each reader uses a reader station to evaluate the images. The reader station consists of a computer controlled VCR, a 15" monitor, a personal computer, and a graphics board for cursor control. The personal computer is also the input device for participant data, date, frame number, reader identification, artery identification, site, angle, cursor location, etc. The reader station is designed so that no electronic error in the reader station is more than one-half the axial resolution of the instrument. This requires electronic position accuracy of greater than 0.1 mm in biological tissue. After the personal computer generates the data file on the study, the file is transmitted to the central computer for storage on hard disk with backup copy on a floppy disk.

Measurements are made in the common carotid, the carotid bulb and the internal carotid arteries. The measurements at each site include far wall thickness and near wall thickness.

The Ultrasound Center also provides estimates of arterial distensibility in the carotid artery.

#### 2.3.6 Retinal Photography Reading Center

Retinal photography was done in Visit 3. Retinal photography is used to evaluate changes in the retinal microvasculature, particularly those related to hypertension and arteriosclerosis, that may be prognostic for cerebrovascular and other various cardiovascular outcomes. A retinal photograph is attempted, by a specially trained and certified member of the field center staff, on one randomly-selected eye for each cohort participant.

Generalized narrowing of arterioles, though primarily due to hypertension and aging, is assessed quantitatively by measuring the caliber of arterioles and venules on digitalized images of the photographs. This innovative technique provides an unprecedented opportunity to examine the prognostic significance of generalized arteriolar narrowing. Such narrowing may reflect the lifetime impact of hypertension on the microvasculature (arteriosclerosis), even where blood pressure has been lowered with antihypertensive medications.

The qualitative reading features semi-quantitative scoring of hypertensive retinal changes, including focal arteriolar narrowing and arteriovenous crossing changes. Other significant retinal conditions will also be noted, such as diabetic retinopathy or vascular occlusions. Conditions prompting medical concern will be reported directly to the field centers, urgently where appropriate.

#### 2.3.7 Echocardiography Reading Center

Echocardiography was done in one field center (Jackson) in Visit 3. The ARIC Echo Reading Center is organized to provide the analysis, quality control, archival, and distribution of data generated by the ARIC echocardiography substudy. The echocardiography study characterizes a variety of cardiac structural and functional parameters in a large population-based sample of black men and women, ages 51 to 70. Participants undergo an echocardiographic exam in the Jackson ARIC Clinic, designed to collect data needed for structural and functional measurements, as well as clinical screening data to discover abnormalities, such as ventricular or valvular dysfunction, which may affect the measured parameters. The echo protocol incorporates currently accepted standard echocardiographic techniques to enhance comparison with preceding and future studies. Structural parameters include left ventricular (LV) wall and chamber dimension, and LV mass (calculated from dimensions). Cardiac functional data is derived from measurements of systolic performance such as fractional shortening, from qualitative or semiquantitative interpretations such as regional wall motion and estimated ejection fraction, and from Doppler data describing left ventricular diastolic filling.

#### 2.3.8 Magnetic Resonance Imaging (MR) Reading Center

Cerebral MRIs were done in Forsyth County and Jackson on a sample of Visit 3 examinees. The MR Reading Center (RC) was responsible for the management and interpretation of MR image data from scans of 2,000 participants enrolled in the Atherosclerosis Risk in Communities Study (ARIC). The RC is also responsible for maintaining the quality of the data acquisition (scanning) at the Field Centers, as well as insuring the quality of the interpretive results in terms of accuracy and reproducibility.

The MR images, obtained at the Jackson and Forsyth Field Centers according to protocol and copied onto magnetic tape were sent to the MR Reading Center for interpretation. An MRI completion form with identifying information was generated by the FC and accompanies each scan sent to the Reading Center.

Interpretive readings of MR scans were performed at a Kodak Personal Display System (PDS). Each PDS has 4 monitors which measure 16 inches diagonally with 1,024 X 1,024 pixel elements and 256 gray scale intensities. A mouse or trackball is used to select and manipulate images. The system software allows a number of image manipulations (e.g., zoom, measure, invert, select a scout line, etc.).

Results of interpretive readings were entered into a database on a separate Macintosh computer at the time of the reading. Interpretive results recorded for a complete reading included indication of presence and anatomic location of *large infarct*, *small infarct*, *focal brain atrophy*, and *parenchymal hematoma*. For large infarcts noted, the size and location (including

hemisphere) of each was recorded. If one or more small infarcts was detected, the number (frequency) and hemisphere of small infarcts were recorded for each of three anatomic categories (basal ganglia, white matter, and brain stem). Interpretive readings also included the rating of *ventricles, sulci* and *white matter* on a 0-9 scale, with "0" representing the optimal end of the scale. Other data collected include *bifront distance (cm), inner table width (cm), central sulcus width (cm),* and rating of *relative volume* and *symmetry of white matter*. *Perivascular spaces* were rated according to size and number. Finally, *other diagnoses* (e.g., congenital, inflammatory/infectious, neoplasm, hydrocephalus, hemorrhage) and *alert status* were indicated.

In addition to the complete interpretive reading, a partial reading was completed for each scan. Partial readings included indication of presence/absence of *large infarct* and *small infarct*. If the partial reading results differed from those of the complete reading, the case was adjudicated by the readers. Adjudications of a case resulted in a new "adjudicated complete reading" file which reflects agreement reached between the full and partial reader.

For further quality control, a number of scans were read a second time by a reader blind to the QC status of the scan. Second readings included complete, partial, and if necessary, adjudicated readings. Additional quality control evaluations included the reading of a standard set of scans at periodic intervals, to insure that a systematic "interpretive drift" has not occurred over time.

Data from each of the readings of a given scan were sent on floppy disk to the ARIC Coordinating Center. Data disks were normally sent to the Coordinating Center on a weekly basis. Backups were maintained at the MR RC on two separate hard drive systems, as well as on optical disc (total backup sites).

#### 2.3.9 Coordinating Center

The Coordinating Center provides centralized administration, planning, and management for all components of the ARIC Study. Its administrative functions include supporting the Project Office and the chairman of the Steering Committee and Executive Committee in convening meetings, documenting decision and action items, preparing and distributing meeting minutes and coordinating the work of the various subcommittees. The central computer for electronic mail is housed at the Coordinating Center and technical support for the installation, use and maintenance of local equipment and software is provided by in-house staff. The Coordinating Center serves as the official repository for all ARIC Steering Committee records, manuals of operations, data collection instruments, research data and publications.

During the initial phases of the study, Coordination Center staff participate in the activities of the Steering Committee and all subcommittees providing technical assistance in study design; data collection, processing and analysis; training and certification; quality assurance; pilot testing and evaluation; and study implementation. Once the study collects data, the Coordinating Center supports the Morbidity and Mortality Classification Committee in monitoring the status of each study endpoint, preparing documentation of events to be verified and creating a final diagnosis file.

The Coordinating Center's responsibility for the centralized management of the study includes the provision and tracking of training and certification;

monitoring protocol adherence in the field centers and central agencies; the design, implementation and monitoring of quality assurance programs in the field centers, laboratories and reading centers; and data management, including the development of a computerized data collection system, on-site and centralized data processing and data analysis. Training and certification, protocol adherence and quality control programs are discussed in detail in Manual 12, Quality Assurance. The specific procedures for the distributed data management systems and data analysis are described in the following section of this manual.

The Coordinating Center also supports the design, management, and analysis of case control studies, and the publication of results of the collaborative study.

### 3.0 DATA MANAGEMENT

This section describes the distributed data management systems used for the collection, processing and distribution of data and materials among the various ARIC study components. The data management system has three major components: a Computer Assisted Data Collection (CADC) system, a local data base management system (DBMS) and the collaborative DBMS. The CADC system uses a DOS network of 486-based personal computers (PCs) and compatible laptop computers for data collection, data editing and correction during the cohort examination, for record abstraction, and for entering data collected on paper forms. Two PCs on the network each hold a copy of the local database. These PCs are used for local database management, reporting, printer sharing, scheduling, and communication with the Coordinating Center and other study agencies. The collaborative DBMS is maintained at the Coordinating Center and is used to store, update, and access the data from the field centers, central laboratories, and reading centers.

#### 3.1 Overview of ARIC Data Flow

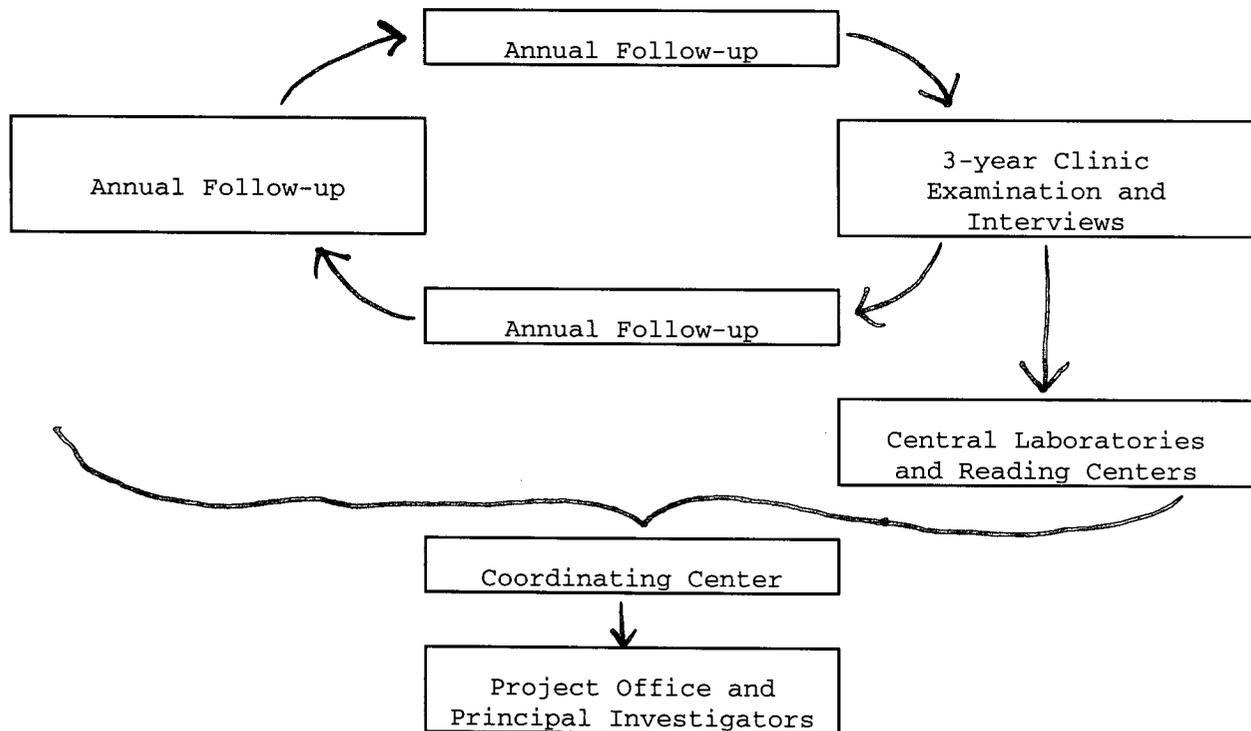
The data and materials flow for the ARIC Study can be grouped into four main categories: 1) the study data and materials collected and processed by the various study components; 2) inventory and study management information used to monitor the study data and materials and to schedule various study activities; 3) various types of reports on performance and quality control; and, 4) study publications. A large portion of the study data is collected and processed using the CADC system described above. These data, as well as some of the inventory information and reports, are transferred to the Coordinating Center by mailing diskettes or by telecommunications. Study materials, including blood samples, tapes and tracings from various examination procedures are transferred to the appropriate study agency electronically, by mail, or by other carrier as described in the detailed protocol.

##### 3.1.1 Cohort Component

As shown in Figure 2, the flow of study data for the cohort component is a continuous cycle of annual telephone follow-up interviews and clinic examinations at 3-year intervals. Data from the annual follow-up are collected on paper and then entered directly into the CADC system; some data are collected on paper for later entry into the system. Data from the local DBMS are transferred to the Coordinating Center on diskette by mail on a regular schedule.

Participant specimens (e.g., blood samples, ECG tracings, ultrasound scans) are collected and transferred to the appropriate central laboratory or reading center according to the detailed protocol. After the laboratories and reading centers have made their respective determinations, the results are sent to the Coordinating Center where they are added to the consolidated database. Central agencies also send selected results to the field centers for subsequent reporting to the participants.

Figure 2. ARIC Cohort Data Collection and Data Flow



The data collected during the clinic examination and interview are used to identify existing cardiovascular disease and other diagnoses of interest. In addition, the participant is contacted annually to ascertain his or her health status. Data collected during the annual follow-up precipitate the collection of additional data from medical records, death certificates, and interviews with physicians or next-of-kin. These data are sent to the Coordinating Center and added to the consolidated database. Potential events are classified with the appropriate diagnostic criteria by applying diagnostic algorithms either by computer or, in some instances, by a Mortality and Morbidity Classification Committee (MMCC).

In addition to the data and materials transferred among the study components, inventory, identification and study management information is also produced. A complete inventory of records entered into the CADC system is maintained and updated automatically. A sample inventory records the collection and transfer dates of all participant specimens. Paper shipment inventories generated by the local DBMS accompany all specimen transfers from the field centers to the central agencies, enabling the immediate identification and investigation of missing materials. After a suitable time delay, inventory information is compared with the results received at the Coordination Center and discrepancies investigated.

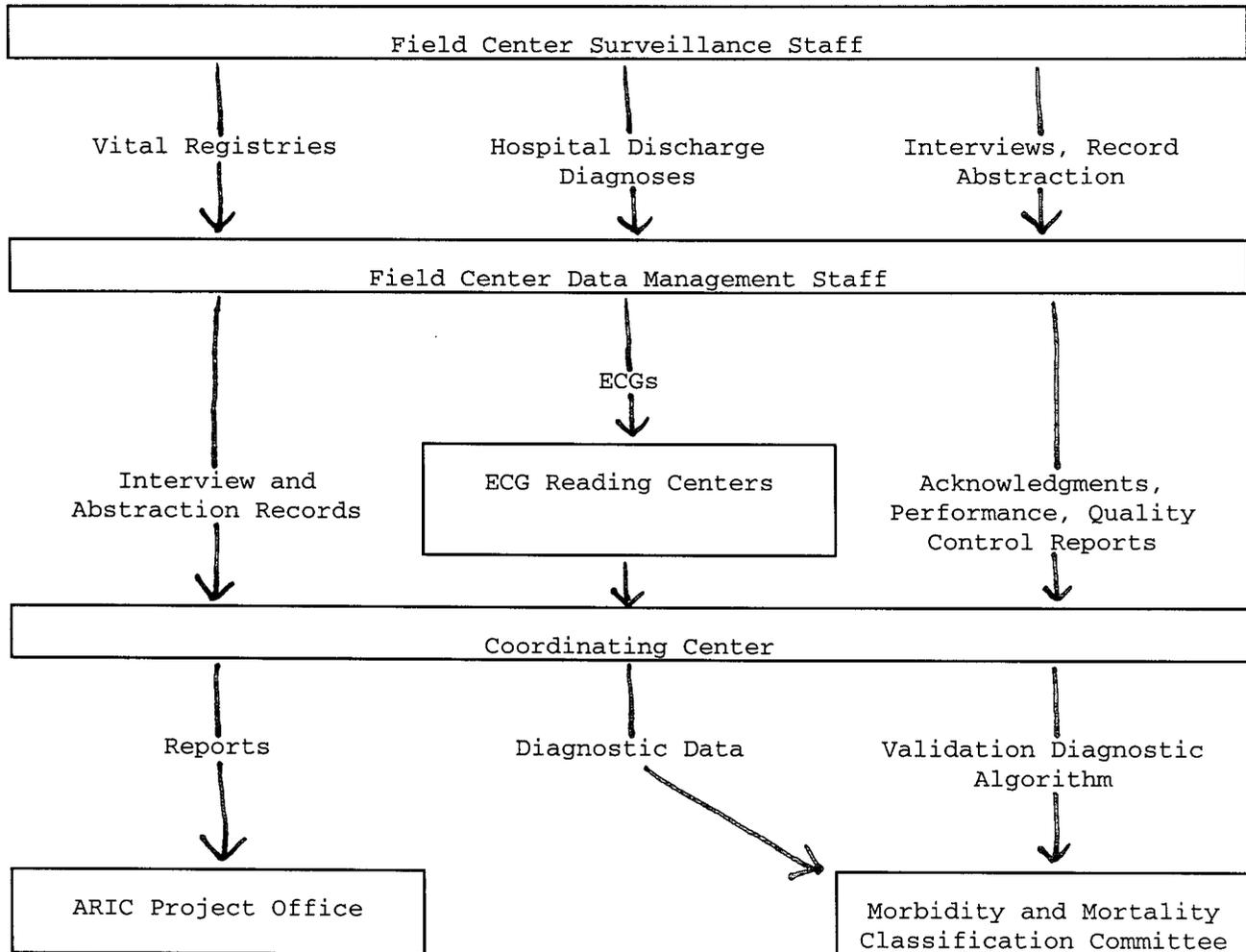
Selected components of the clinic examination and interview are repeated for quality control purposes. Additional quality assurance measures are also in place at each of the central agencies and are described in detailed ARIC

Quality Control Protocol Manual. Routine performance and quality control reports are generated by the Coordinating Center and distributed to the other study components. Special reports are prepared when problems are identified and immediate action required.

In addition to data management and quality assurance reports, a number of materials are produced to facilitate conduct of the study. Participant information sheets are generated prior to each clinic examination. Information relevant to the timing and contact of participants for the annual follow-up telephone call are routinely prepared. Other operational materials are prepared by the Coordinating Center as requested.

All study investigators are involved with the preparation of manuscripts for publication. The Coordinating Center is particularly active in terms of data closure, data analyses, statistical review, data verification, and other essential activities.

Figure 3. ARIC Study Community Surveillance Data and Report Flow



### 3.1.2 Community Surveillance

Data flow for community surveillance begins with the identification of potential cases from vital statistics registries, hospital discharge diagnoses and other sources as shown in Figure 3. These cases are added to the local database at each field center. Cases meeting the eligibility criteria are investigated and additional data are collected from hospital records and interviews. The data are keyed directly into microcomputers when feasible. Paper forms are used when direct entry is not possible or desirable. These data are then transferred to the Coordinating Center in the same manner as the cohort data. Once at the Coordinating Center, the diagnostic criteria are applied to the data using the appropriate diagnostic algorithm. In addition, the data are summarized and presented to the Mortality and Morbidity Classification Committee for validation.

Various inventory control systems ensure that all potential cases are classified and all appropriate data are collected. Performance and quality control reports are generated and distributed in a manner similar to that described for the cohort component of the study.

### 3.2 Field Center Data Management

In the distributed data management system, each ARIC Field Center is responsible for managing the data collected during the cohort examinations and event abstractions in its community. This includes the initial recording, keying, editing, correction, and transmission of data to the ARIC Coordinating Center. It also includes maintaining an inventory of data forms and other materials collected (e.g., blood, ultrasonography tapes) and sent to the ARIC Central Agencies and Coordinating Center. Each center maintains a cumulative database for clinic management.

The CADC work station allows field center personnel to enter, edit and correct data values directly eliminating the need for paper forms, except as a back-up. During the cohort examination, the CADC system is used to collect, interview and enumerate data in this manner. The portable lap top computers use the same system to abstract, cohort and surveillance data from medical records library in the study hospitals. In those situations where use of CADC is not desirable or possible, the same system can be used to enter data from completed paper forms.

### 3.3 Ultrasound Reading Center Data Management

B-mode scan ultrasonography is performed on each subject with results sent weekly to the Ultrasound Reading Center on 1/2 inch sVHS video cassettes and floppy disks. The B-mode images are captured at the Reading Center in a frame grabber and displayed on a 15" monitor; wall thickness calculations are then made. Blood pressures are obtained during the B-mode examination by an automated blood pressure machine. After the B-mode examination, supine and postural blood pressures are recorded using an automated blood pressure machine and the measurements are transferred to a floppy disk. All data files are sent weekly on floppy disks to the Ultrasound Reading Center for appropriate calculations and for quality assurance. Completed test results for all ultrasound measurements are sent monthly from the Ultrasound Reading

Center to the Coordinating Center on floppy disks for transfer into the main study database.

Inventory records listing ID numbers of subjects tested are sent weekly from the field centers to the Coordinating Center. The Coordinating Center stores all data received from the Ultrasound Reading Center in the collaborative database and sends weekly to each field center a floppy disk containing study results of its participants in order to update the local databases.

### **3.4 Central Hemostasis Laboratory Data Management**

Eight aliquots of plasma and serum per subject are sent in weekly batches from each field center to the Hemostasis Laboratory. Donor Information Forms and an inventory record on paper accompanies each batch of specimens. Specimen analyses are performed on a gamma counter, a Coag-A-Mate analyzer and an ELISA reader; software written for each machine permits transmittal of results directly onto the Hemostasis database. Results are sent weekly from the Hemostasis Laboratory to the Coordinating Center on paper for transfer into the main study database.

Inventory records listing participant ID numbers for blood specimens are sent weekly from the field centers to the Coordinating Center. Data backup at the field centers includes electronic copies of the inventory records of specimens sent. The study has elected not to draw extra blood specimens as backup in case of loss or damage during processing or shipping. The Coordinating Center stores all data received from the Hemostasis Laboratory in the collaborative database and sends weekly to each field center a floppy disk containing study results of its participants in order to update the local databases.

In addition to the blood samples processed by the central laboratories, one sample of whole blood is analyzed in local laboratories in each field center for routine hematology determinations. Results are returned to the field centers on paper, entered into the DMBS and sent to the Coordinating Center on floppy disks containing other baseline interview and examination data.

### **3.5 Central Lipid Laboratory Data Management**

Ten aliquots of plasma and two tubes of buffy coat per subject are sent in weekly batches from each field center to the Lipid Laboratory. An inventory record on paper accompanies each batch of specimens.

### **3.6 Central Clinical Chemistry Laboratory Data Management**

A central Clinical Chemistry Laboratory was used in cohort Visits 1 and 2, but is not being used in Visits 3 and 4.

### **3.7 ECG Reading Center Data Management**

Twelve lead ECG tracings recorded in field center clinics are transmitted by phone daily from the PC ECG machine at each field center to the MAC/12 ECG machine at the ECG Computer Center (approximately 6 ECGs per field center per

day). Confirmation of receipt is received at the field centers via electronic mail early the next morning prior to erasing a day's tracings from the PC memory. The 12 lead ECGs are coded by computer. Tracings of all records with abnormal Minnesota Codes and a sample of records with normal codes are sent weekly as paper tracings to the Minnesota ECG Reading Center for Minnesota Coding and for quality control. In addition, two minute paper ECG rhythm strips recorded in the clinics are sent weekly from the Field Centers to Minnesota for coding. Results of 12 lead ECGs (approximately 300 variables per subject) are sent weekly from Halifax to the Coordinating Center on floppy disks for transfer into the main study database.

ECGs recorded in study community hospitals are also coded by the Minnesota ECG Reading Center, and implemented by means of photocopied ECGs mailed to the Reading Center. ECG codes are recorded on paper forms and mailed to the Coordinating Center for data entry.

Inventory records listing ID numbers of subjects tested are sent weekly from the field centers to the Coordinating Center. Data backup at the Field Centers includes paper ECG tracings which can be read by the Minnesota ECG Reading Center if necessary, but does not include an electronic backup initially. The Coordinating Center stores all data received from the ECG Reading Center in the collaborative database and sends weekly to each field center a floppy disk containing study results of its participants in order to update the local databases.

### **3.8 Pulmonary Function Center Data Management**

A pulmonary function center was used in cohort Visits 1 and 2, but is not being used in Visits 3 and 4.

### **3.9 Retinal Photography Reading Center Data Management**

Retinal photography was done in Visit 3 only. The field centers ship a batch of developed retinal photographs every 1-1.5 weeks. The Retinal Reading Center maintains the ARIC data set in Paradox for Windows in a Windows/DOS environment. Data are entered at personal computers linked by Novell network software. Photographs are inventoried in a Paradox database within 8 working days of receipt. The inventory is entered from the shipping list and verified with a second entry. The RLB (Retinal Light Box) data are entered directly by the photograph readers. Verification of identifying information with inventory and completeness are checked at the time of the grading. All Paradox databases are backed up nightly. The RIP (Retinal Image Processing) data are collected in a Solaris/Unix environment on a Sun workstation. The digitized images and all related data files are backed up on tape as each photo batch is completed. Measurement data only are transferred to the DOS environment over the network.

Data are exported to the ARIC Coordinating Center monthly. Checkers and processors are set up in Paradox. The inventory is checked for duplicate records. The RLB data are checked for internal inconsistencies. Any edits are returned with the photographs to the original readers for corrections. Any record failing the consistency edits is held out of the data set until the inconsistencies are resolved. The RIP data set is formatted to the

Coordinating Center's specifications and the derived variables are calculated. RIP records are deleted from the data set if there are inconsistencies. These photographs are returned to the original readers to measure again. Verification of identifying information with the inventory is checked at the time of export.

The RLB and RIP data are exported to the Foxpro format specified by the Coordinating Center. The data records in Paradox are locked at the time of export. The Foxpro data sets are copied on to a 3.5" diskette and shipped to the Coordinating Center monthly.

### **3.10 Echocardiography Reading Center Data Management**

Echocardiography was done in Jackson and in Visit 3 only. Participant identification data, analog videotape and digital images on optical disks are delivered to the reading center for analysis. The videotape is reviewed for qualitative and semiquantitative assessments, including a clinical interpretation of the study. The digital data are retrieved into the image workstation for measurement of dimensional and Doppler data, and these images and analysis results are copied onto permanent digital archival media. The data are consolidated into a PC-based data management system; qualitative data are entered by keyboard from the Technician and Reading Worksheets; quantitative data are directly imported from data files generated by the image workstation. Quality control measures are incorporated to the PC database, and several means of backup or redundancy are employed for data security. The consolidated data are periodically delivered to the Coordinating Center where the official analyses are conducted. The study protocol also includes ongoing quality monitoring, including measurements of means and variability among study readers and technicians.

### **3.11 Magnetic Resonance Imaging (MRI) Reader Center Data Management**

MRI was done in Jackson and in Forsyth County in visit 3 only. Two databases will be maintained at the Magnetic Resonance Imaging Reading Center:

#### MRI Image Database

Image archival and retrieval system (IARS)

#### Reading Center Results Database (Macintosh Filemake Pro)

ARIC Cohorts

Image Results

QC Readings

Image Results

MR scans generated by the field centers are copied to standard ½ inch magnetic tape or optical disc. The preferred image data transmission and archiving format will be ACR/NEMA 2.0. If field centers have instruments incapable of creating ACR/NEMA 2.0 headers, the reading center will convert the original vendor header format to ACR/NEMA 2.0. Once received at the reading center, and if necessary, converted to the ACR/NEMA 2.0 format, the images will be archived in our Image Archival and Retrieval System (IARS). The IARS will store the images on optical media for retrieval at a later date, providing both immediate and long term storage.

After conversion of images to ACR/NEMA format, images will be displayed on a Personal Display System. Reader interpretation data are entered directly into a Macintosh Computer running under A/UX 2.0 (Apple Unix) onto spreadsheet software and converted to ASCII file format. The ASCII data files will then be copied to floppy disks, which are sent to the ARIC Coordinating Center at weekly intervals. Backups of interpretive data are maintained at the reading center on two separate hard drive systems, as well as on optical disc (total of 3 backup sites). The original magnetic and optical media from the field centers will be stored in a secure Johns Hopkins Hospital storage site. IARS optical disks related to the ARIC study will be stored in a locked diskette cabinet, which is locked in a larger optical disc file cabinet in a Neuroradiology section of the Johns Hopkins Medical Institutions.

### **3.12 Collaborative Database**

The collaborative portion of the database management system is used to store, update, and access the data from the four field centers, the central laboratories, and the central reading centers. Since each data item is edited, corrected, and verified at the data collection site, editing by the collaborative system largely consists of record level "data base closure" checks, such as ensuring the receipt of all expected records from each exam, contact, hospitalization, and death. The focus of the collaborative DBMS is retrieval for analyses. The DBMS directly generates analysis files in SAS data set, BMD save file, and SPSS save file formats. It includes a relational query language, a programming language, and a full-screen forms-oriented retrieval facility. It includes comprehensive security and confidentiality facilities including passwords, encryption, and audit trails.

## **4.0 STUDY MANAGEMENT**

### **4.1 Introduction**

The ARIC Study is funded by the National Heart, Lung, and Blood Institute, and directed by the Epidemiology and Biometry Program of the Division of Epidemiology and Clinical Applications. Principal investigators, directors, and their affiliations are listed in Appendix I. The operations of the study are directed by the ARIC Study Steering Committee whose members are the Principal Investigators of the Field Centers, Coordinating Center, the Ultrasound Reading Center, the Lipid and Hemostasis Laboratories, and the NHLBI Project Officer.

The Steering Committee is supported by subcommittees responsible for the details of study design and implementation, and a Morbidity and Mortality Classification Committee (MMCC). These committees report and make recommendations to the Steering Committee. The subcommittees and their charges are listed in the section below. The composition of each committee is given in Appendix II.

### **4.2 ARIC Study Subcommittees and Charges**

The Criteria and Diagnoses subcommittee (DX) decided which events were to be ascertained in the cohort and what specific information was to be collected for each type of diagnosis. It established criteria for diagnosing these events as well as the procedures by which the Morbidity and Mortality Classification Committee makes these diagnoses. Other functions included the review of criteria provided by the Surveillance and Medical Care Subcommittee for surveillance events (acute hospitalized MI, CHD death) and the establishment of guidelines for safety, ethics, medical referrals, confidentiality, and quality control in the study.

The Laboratory and Sample Processing subcommittee (LAB) was responsible for developing the procedures for laboratory measurements and ensuring the quality control of all procedures associated with the laboratories. The subcommittee makes recommendations for lipid and hemostasis measurements, insulin, and routine chemistries. It directs the field center hematology laboratories, the measurement of stored blood, quality control, technician training, interpretation, monitoring, and the collection, processing, and transport of samples.

The Risk Factors and Cohort subcommittee (EXM) developed protocols for clinic operations and risk factor measurement for the cohort component: blood pressure and postural effects, anthropometry, ECG, pulmonary function, questionnaires, interviews, and the physical exam. In matters pertaining to the examination, the committee was also responsible for equipment, exam flow, training (nurses, technicians, physicians, interviewers), quality control, pretests, pilot study, interpretation, monitoring, and the second examination.

The Sampling, Recruitment, and Follow-Up subcommittee (SRF) established guidelines for sampling and recruitment, and for the characterization of non-respondents. It developed the protocol for follow-up. The subcommittee is

responsible for training, quality control, interpretation, the pilot study, and monitoring in matters pertaining to sampling, recruitment, and follow-up.

The Surveillance and Medical Care subcommittee (SMC) reviewed the surveillance pilot study and developed diagnostic criteria for community surveillance. The subcommittee refined the protocol for the areas of hospital surveillance, death investigations, and medical care in hospital, and developed the protocol for recording care received from physicians and hospitals by the cohort participants. In matters pertaining to surveillance, the subcommittee is responsible for training for interviewers, abstractors, and ECG coders; pretesting direct data entry; quality control; data interpretation; and monitoring and protocol adherence.

The Ultrasound subcommittee (US) was responsible for preparing the Ultrasound Manual of Operations. Areas covered include the scanning protocol, instrumentation, sonographer training, quality control, the pretest, pilot study, interpretation, monitoring, and protocol for the second examination. It also provides a forum for discussing new concepts in ultrasonography, equipment, software, and workstation design.

The Executive Committee meets biweekly to direct and oversee Field Center operations and their relationship with the Coordinating Center for both community surveillance and the cohort study.

#### **4.3 Morbidity and Mortality Classification Committee**

The Morbidity and Mortality Classification Committee (MMCC), comprised of physicians from the Coordinating Center and each field center, is responsible for the process of assigning all medical events of interest in the ARIC Study into diagnostic classes defined by the study. Hospitalized events are classified into MI categories by computer algorithm. The MMCC reviews this process by independent diagnoses of all cohort events and a sample of surveillance events. For fatal events, computer assignment is limited to events with insufficient information to merit physician review and events whose information is unequivocal and sufficient to produce a certain diagnosis. MMCC classifies the cause of death wherever classification cannot be done by computer and independently reviews the computer classification for most cohort deaths and a sample of the surveillance deaths.

The MMCC operates by assessing medical information received from each field center. In most cases this involves independent assessment by two committee members with differences adjudicated by the full committee. Problems in classification may result from lack of clarity in the study diagnostic criteria. Under these circumstances the committee recommends appropriate modifications in the criteria.

#### **4.4 Communications**

##### **4.4.1 Periodic Reports**

The field centers and central agencies prepare routine periodic reports to the ARIC Study Project Office which document the progress to date in each major activity, administrative matters, staffing changes, and current or anticipated

problems. The Coordinating Center also provides reports on the data collection at the field and laboratory centers, quality control findings on examinations, reabstracted records, recertification, laboratory determinations, and protocol adherence. Status reports on recruitment and data collection prepared for the Project Officer are also sent to the field centers. Quality control reports are likewise sent to the central laboratories and reading centers.

#### 4.4.2 Newsletter

The Field Centers prepare and distribute a periodic newsletter to facilitate communication among ARIC Study staff. In general, each edition includes (1) reports from the Project Office, the Coordinating Center, at least one of the central laboratories or reading centers, and the Steering Committee, (2) a description of the facilities and staff of one field center or central agency, (3) general information on data management and (4) a calendar of events. The newsletter also provides reports on issues such as recruitment and participant follow-up rates, the development and the use of new ECG, laboratory, pulmonary function, or ultrasound methods and equipment, and preliminary study results and abstracts.

#### 4.4.3 Electronic Mail

All field centers, central agencies, the Coordinating Center and the Project Office are linked by electronic mail using microcomputers at each center. The electronic mail network is used to facilitate rapid and efficient communication among centers for messages such as announcements, meeting agendas, abstracts for clearance and acknowledgments of receipt of data.

#### 4.4.4 Field Center Visits

Project Office and Coordinating Center staff conduct periodic monitoring visits to field centers as needed to (1) maintain channels of communication with field center investigators and staff, (2) solve participant recruitment or follow-up problems, (3) monitor adherence to the protocol and (4) provide technical support for activities such as data management and quality control.

### 4.5 Publication Policy

Overall responsibility for manuscript and abstract generation and approval for the ARIC Study lies with the Steering Committee and one of its subdivisions, the Publications Committee. The Steering Committee and Publications Committee have developed procedures for generating manuscripts and abstracts as well as the formal requirements for manuscript approval prior to submission for publication or prior to abstract submission for presentation.

The overall aim of this process is to encourage the preparation of manuscripts and abstracts while also providing appropriate control over their quality and content.

Central to all of these activities is the Publications Committee referred to above. The latter is composed of four members, all of whom are active in the ARIC Project. One member serves as chairman and another as the committee's editor. The committee holds conference calls an average of once every two

weeks. If an abstract needs urgent approval between calls, this is usually accomplished through fax messages. Other urgent business is similarly transacted.

Periodically, the committee checks on the progress of previously approved manuscripts. For this purpose, it has developed a series of tracking tables, generated by the Coordinating Center, using the committee's database stored there. The Publications Committee also maintains through the Coordinating Center a list of ARIC manuscripts which have been published or are in press as well as a list of abstracts/presentations. These materials are updated on a quarterly basis and distributed to the Steering Committee. To guide it in dealing with out of the ordinary circumstances related to manuscripts or abstracts, the committee has developed a series of special policies. This list is available through the Coordinating Center.

The Publications Committee oversees all aspects of study publications and presentations, from the formation of writing groups and approval of proposals for publications through final ARIC approval of final manuscripts and ready for submission to journals. The approval of manuscripts is delegated to the ARIC editor, Dr. Szklo, who assigns reviewers and communicates all decisions to the authors.

#### 4.5.1 Types of Publications and Presentations

There are several types of publications and presentations for which approval procedures are established. These include:

1. Major descriptions of the design and conduct of the ARIC Study.
2. Major descriptions of results, based on data from all field centers, addressing the main objectives of the ARIC Study.
3. Descriptions of results, based on data from all field centers, addressing issues other than the main objectives of the ARIC Study.
4. Descriptions of results based on data collected from a single field center.
5. Descriptions of methodological developments required to meet the needs of the ARIC Study.
6. Articles to appear in proceedings of meetings for which no abstract was required.
7. Manuscripts/abstracts generated collaboratively between ARIC and other studies.
8. Invited presentations for which no abstract is submitted and for which there are to be no published proceedings.
9. Press releases or discussions with the media.
10. Lectures or other informal presentations.

The Publications Committee is responsible for resolving any uncertainties as to which category a specific presentation or publication belongs.

#### 4.5.2 Outline of the Preparation and Approval Process

1. The Steering Committee designates a topic and selects a writing group and its chairman.
2. Publications and presentations may also arise from individual investigators (the most common route).

3. The lead author prepares a list of coauthors and obtains their willingness to participate.
4. The manuscript proposal, including the list of authors, is submitted to the Publications Committee for approval. The study has a standardized form which is used to submit all manuscript proposals (a copy may be obtained through the Coordinating Center). For abstracts no further approval beyond the Publications Committee is required before submission to a scientific meeting. Manuscript proposals, however, when approved by the Publications Committee are passed on to the Steering Committee for final approval to be granted.
5. The writing group prepares and communicates computational specifications to the Coordinating Center, or it prepares statistical computations using the data set distributed by the Coordinating Center.
6. The Coordinating Center prepares statistical computations according to priorities specified by the Publications Committee.
7. The working group prepares, reviews internally, and submits the completed document to the Steering Committee for review and approval.
8. An in-house (i.e., ARIC) reviewer is assigned by the Publications Committee's editor to review this manuscript and to convey to the editor the results of his review.
9. Members of the Steering Committee review and approve the document.
10. NHLBI review occurs concurrently with Steering Committee review.
11. The manuscript is sent to the Coordinating Center for final data verification.
12. The manuscript/abstract is formally submitted to a journal or scientific meeting selection process. However, upon receiving Steering Committee approval to submit a manuscript to a journal, the lead author must first complete a final checklist of items (copy available through the Coordinating Center) to ensure all appropriate procedures have been followed.

The overall responsibility for managing the entire process lies ultimately with the Steering Committee; however, for some steps a subgroup may be given responsibility. Further, the nature of the approval process varies according to the type of document. These issues are discussed below.

#### 4.5.3 Authorship

The authorship policy varies according to the type of publication or presentation being considered. For some publications, the author is listed as the "The ARIC Study Investigators," with the preparers clearly indicated. In other cases, the persons preparing the manuscript are listed as authors followed by the words, "for the ARIC Study Group." Similarly, for some presentations, the paper is listed as presented by someone for the ARIC Study. In other cases the individual is listed as the lead author. In all cases, however, the person who assumed the lead responsibility for a particular publication or presentation is to be listed as the first author or preparer. In addition, the phrase "ARIC Study" is to be included in the title and listed whenever possible.

The Steering Committee is responsible for resolving any conflicts or confusion that occur with respect to appropriate recognition of authorship.

#### 4.5.4 Manuscript and Abstract Generation

For the purpose of generating manuscripts or abstracts, the Steering Committee may designate a writing group with the charge to develop the manuscript for publication or presentation. The impetus for this designation may come directly from the Steering Committee or may be in response to a request or suggestion from outside the committee. Once it is decided that a specific manuscript will be developed, the writing group and its chairperson will be specified.

Under normal circumstances, the chairperson, who has the lead responsibility for this task, will also be listed as the first author for those documents where individual recognition is appropriate or as the first preparer for those where the ARIC Study is listed as the author. The chairperson also has the responsibility for listing the co-authors in the appropriate order. As indicated above, the Steering Committee serves as final arbitrator of any conflicts.

Individuals interested in preparing a manuscript or abstract on a specific topic must submit their proposals, which must include the names of the writing group members, to the Publications Committee for approval. The proposal must include a clear statement of the nature of the publication, the hypotheses to be addressed, and the types of statistical computations or data summarizations likely to be required.

The Steering Committee has the responsibility for reviewing and approving these proposals, both for appropriateness and for a priority designation. The Steering Committee also ensures that the different participating centers and groups are appropriately represented and that appropriate recognition is provided.

Once the specifications for the manuscript have been approved, the requirements for statistical computing can be formally communicated to the Coordinating Center. Requests will be processed according to the priorities specified by the Publications Committee. The Coordinating Center has representation on the writing group whenever possible and this person serves as the liaison to the writing group, both for communications about computing issues and for providing or obtaining appropriate statistical input.

The Publications Committee reviews the progress that each writing group is making toward the completion of its task and makes those changes required for the timely completion of each manuscript or abstract.

#### 4.5.5 Approval Procedures

A manuscript stemming from the ARIC study is submitted to the editor of the Publications Committee, who sends copies of the manuscript to a primary reviewer, a coordinating center's statistical reviewer and Steering Committee members for their critiques. A detailed critique is expected from the primary reviewer(s). Upon receiving the critiques, two courses of action are possible: (1) If the editor deems the reviewers' suggestions to be mainly editorial in nature, he may approve the manuscript and request that the authors incorporate suggested changes to the final version, or submit in writing reasons for not doing so. No further action is needed from the Steering Committee; or (2) If, in the editor's judgement, critiques entail

substantive changes, the revised manuscript must be further reviewed by the primary reviewer, the coordinating center's reviewer and the Steering Committee before approval is granted.

The approval procedures are presented separately for each type of publication or presentation listed in section 4.5.1.

#### 4.5.5.1 Publication types 1, 2, and 6

The procedures described here are to be followed prior to submitting for publication any document describing the design and conduct of the ARIC Study or including results, based on data from all field centers and addressing the main objectives of the study. All such documents are to be processed through each of the preparation and approval steps listed above. This includes the data verification step. Abstracts are a special case of this procedure and are discussed separately later.

All papers meeting the conditions of this section (publication types 1, 2, and 6) are to be published under the by-line "The ARIC Study Investigators." In addition, a statement that the article was "prepared by (Writing Group Chairperson, then other members, listed in order specified by the chairperson)" is also to be included.

The above specifications for authorship apply also to abstracts submitted for presentations, whether or not they are to be published. They also apply to articles to be published in the proceedings of meetings (type 6). In this case the presenter can also be identified.

#### 4.5.5.2 Presentation types 1 and 2

The same conditions apply to abstracts for presentations of type 1 or 2 as apply for manuscripts for these publication types except that the Publications Committee has full authority to give approval or to reject, i.e., no Steering Committee action is required.

Authorship is to be listed as described for publications above with the exception that the designation "presented by ..." may be added.

#### 4.5.5.3 Publication or presentation type 3

The preparation and approval procedures for publications and presentations of results based on data from all field centers which do not address one of the main objectives of the ARIC Study are identical to those which do address one of these objectives. However, the listing of the authors can be different. For these publications, it is permissible for individual investigators to be listed as authors. The order of this listing follows guidelines consistent with those for other papers. Namely, the working group chairperson is listed as the lead author with the other authors listed in the order that the lead author designates. Following the name listed, the words "for the ARIC Study Group" are added.

#### 4.5.5.4 Publication or presentation type 4

The ARIC Study discourages the publication or presentation of results based on data from a single field center or from a collection of field centers that is less than the full dataset. Should this appear desirable for some reason, the nature of what is to be prepared and presented or published will be submitted to the Publications Committee by way of manuscript proposal, clearly indicating therein, that the proposal incorporates plans for a manuscript using less than a full dataset. The Publications Committee will accept or reject the proposal or pass it on to the Steering Committee for decision if this is felt to be the best course of action. However, even if approved by the Publications Committee, the proposal (as with all manuscript proposals) will still require Steering Committee ratification.

#### 4.5.5.5 Publication or presentation type 5

Publications or presentations describing methodology developed to meet the needs of the ARIC Study are to be prepared and approved by the same procedures as those based on data collected by the study.

#### 4.5.5.6 Presentation type 7

For those presentations for which the formal submission of an abstract is not required and for which no proceedings are to be published, the invited or otherwise designated presenter is to submit a letter containing information equivalent to that of a typical abstract to the Publications Committee for review and approval. The Publications Committee will treat the letter in the same way that it treats an abstract.

If an abstract is subsequently required, it should be submitted for review as other abstracts are. In a similar fashion, if it should be decided later to publish the proceedings, then the document detailing the presentation is to be submitted for review as are other publications.

#### 4.5.5.7 Press releases and media discussions type 8

In general, scientific findings from ARIC made available to the media will involve those findings being presented at scientific meetings and being published in the scientific literature. Such presentations and publications require prior clearance as noted above. In some circumstances, media discussions and press releases may be appropriate to clarify scientific findings for the lay public, but they should not be used as forums to release new information. Investigators are requested to keep the Project Office informed of contacts with representatives of the major national media and of major national media coverage of information which they have supplied. If a situation arises in which it appears desirable to release to the media new information not otherwise cleared for presentation or publication, or if such has been cleared for scientific presentation or publication, but this has not yet transpired, prior clearance from both the Steering Committee and the Project Office is required.

Release of general descriptive information about the ARIC Study for local use (such as a local newspaper, university newsletter or state medical society journal) does not require prior approval. Use of centrally prepared materials for such purposes is encouraged. A copy of any resultant article should be sent to the Project Office.

4.5.5.8 Lectures and other informal presentations type 9

No formal approval is required for lectures and informal presentations so long as they do not constitute the initial release of ARIC results. Otherwise, the rules for presentation type 7 apply.

## **5.0 ANCILLARY STUDIES POLICY**

### **5.1 General Policy**

To enhance the value of ARIC and to ensure the continued interest of the investigators, the Steering Committee welcomes proposals from individual investigators to carry out ancillary studies. Nevertheless, to protect the integrity of ARIC, such ancillary studies must be reviewed and approved by the Steering Committee, and by NHLBI through its ARIC Policy Advisory Board, before their inception. In general, ancillary studies require outside (non-ARIC) funding.

### **5.2 Definition of Ancillary Study**

An ancillary study is one based on information from ARIC participants in an investigation which is not described in the ARIC protocol and involves data which are not collected as part of the routine ARIC data set. The core ARIC study includes the use of blood stored for case-control studies selected by the Steering Committee; these are not considered ancillary studies.

### **5.3 Requirements for Approval of an Ancillary Study**

Before an ancillary study can be approved, it must be shown that the ancillary study will have scientific merit but will not do any of the following:

1. Interfere with the completion of the main objectives of ARIC.
2. Adversely affect participant cooperation in compliance in ARIC.
3. Create a serious diversion of study resources (personnel, equipment or study samples), either locally or centrally.
4. Jeopardize the public image of ARIC.

#### **5.3.1 Preparation of Request for Approval of an Ancillary Study**

A written request for approval of an ancillary study should be submitted to the Steering Committee and should contain the following information:

1. Description of objectives.
2. Scientific merit of study.
3. Methodology for data collection.
4. Proposed statistical analyses.
5. Names of definite or possible collaborators.
6. Proposed funding sources.
7. Discussion of impact on main ARIC study.

#### **5.3.2 Review of Ancillary Study Proposals**

The Steering Committee will review and will approve, reject or request modification of ancillary study proposals in a timely manner. Approval by the ARIC Policy Board is also required. At least one ARIC investigator must be included as a co-investigator in each proposal. ARIC investigators other than those submitting the proposal may request to become collaborators on a

proposal if they have a specific interest in the topic. The key criteria for approval of proposals are scientific merit and impact on the main ARIC study.

#### **5.4 Analysis and Publication of Results of Ancillary Studies**

The investigator of the ancillary study, and if necessary the Steering Committee, will consult with the Coordinating Center during data analysis to ensure that all study data used in analysis of ancillary study results are consistent with data in the main study database. Manuscripts resulting from ancillary studies shall be submitted for review and require approval by the Steering Committee and by NHLBI prior to submission for publication or presentation. The investigator who assumes lead responsibility for the ancillary study shall be listed as senior author. The phrase "ARIC Study" should be included in the title and listed as a key word whenever possible. Manuscripts will also contain an appendix listing ARIC investigators deemed appropriate.

#### **5.5 Feedback of Results of Ancillary Studies to Participants**

Results of ancillary studies shall be reported to participants and/or their physicians if medically useful. Such reporting should follow standard ARIC protocol for notification of participants.

**Appendix I. ARIC Principal Investigators and Directors**

R. Nick Bryan, M.D., Ph.D., Director  
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## **Appendix II. ARIC Committee and Subcommittee Members**

### **1. ARIC Study Steering Committee**

Moyses Szklo, M.D., Washington County Field Center, Principal Investigator,  
Chairperson  
 Greg Evans, Ultrasound Reading Center, Director  
 Aaron Folsom, M.D., Minneapolis Field Center, Principal Investigator  
 Gerardo Heiss, M.D., Forsyth County Field Center, Principal Investigator  
 Daniel Jones, M.D., Jackson Field Center, Principal Investigator  
 Louis Smith, M.D., Central Lipid Lab, Principal Investigator  
 A. Richey Sharrett, M.D., ARIC Project Office, NHLBI  
 Lloyd Chambless, Ph.D., Interim Director, Coordinating Center,  
Principal Investigator  
 Kenneth Wu, M.D., Central Hemostasis Lab, Principal Investigator

### **2. ARIC Study Policy Board**

Richard Carleton, M.D., The Memorial Hospital in Pawtucket, RI, Chairperson  
 Stephen Fortmann, M.D., Stanford University School of Medicine  
 C. Morton Hawkins, Ph.D., University of Texas School of Public Health  
 William B. Kannel, M.D., Boston University School of Medicine  
 Karen Kaplan, M.D., Columbia University, Health Sciences Division  
 Ernst J. Schaefer, M.D., Tufts University, Human Nutrition Research Center  
on Aging  
 Jeremiah Stamler, M.D., Northwestern University Medical School  
 Marvin C. Ziskin, M.D., Temple University Medical School  
 Diane E. Bild, M.D., MPH, National Heart, Lung, and Blood Institute,  
Executive Secretary

### **3. Morbidity and Mortality Classification Committee**

David Conwill, M.D., M.P.H., University of Mississippi  
 Lawton Cooper, National Heart, Lung, and Blood Institute  
 Richard Crow, M.D., University of Minnesota  
 Aaron Folsom, M.D., University of Minnesota  
 David Goff, M.D., Bowman Gray School of Medicine  
 Gerardo Heiss, M.D., University of North Carolina  
 Azmi Nabulsi, M.D., Epidemiology and Outcomes Research Department  
 Eyal Shahar, M.D., University of Minnesota  
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 William Sigmund, M.D., M.H.S, Warner-Lambert Medical Research  
 Thomas N. Skelton, M.D., FACC, University of Mississippi Medical Center  
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### **4. Criteria and Diagnoses Subcommittee**

Daniel Jones, M.D., University of Mississippi, Chairperson  
 Linda Fried, M.D., Johns Hopkins University  
 James Toole, M.D., Bowman Gray School of Medicine

**5. Laboratory and Sample Processing Subcommittee**

Kenneth Wu, Ph.D., University of Texas, Chairperson  
Nena Aleksic, University of Texas  
Eric Boerwinkle, Ph.D., University of Texas  
Myra Carpenter, M.S., University of North Carolina  
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**6. Risk Factors and Cohort Subcommittee**

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Aaron Folsom, M.D., University of Minnesota  
Daniel Jones, M.D., University of Mississippi  
Moyses Szklo, M.D., Johns Hopkins University  
Lloyd Chambless, Ph.D., University of North Carolina

**7. Sampling, Recruitment, and Follow-Up Subcommittee**

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William Kalsbeek, Ph.D., University of North Carolina  
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**8. Surveillance and Medical Care Subcommittee**

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**9. Ultrasound Subcommittee**

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**10. Executive Committee**

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**11. Cohort Operations Committee**

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Gerardo Heiss, M.D., University of North Carolina  
Joel Hill, M.S., Johns Hopkins University  
Jane Johnson, University of Mississippi  
Doris Jones, University of North Carolina  
Gail Murton, University of Minnesota  
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**12. Publications Committee**

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