4. DIAGNOSTIC CRITERIA

4.1 Fatal Coronary Heart Disease (CHD)

4.1.1 Definite Fatal Myocardial Infarction (MI)

Must meet criteria 1. AND 2. below:

1. No known non-atherosclerotic or non-cardiac atherosclerotic process or event that was probably lethal.

2. Definite hospitalized MI within four weeks of death; use criteria in Section 4.2.2 for Definite Hospitalized MI.

4.1.2 Definite Fatal CHD

Must meet ALL of the following criteria:

1. Lack of sufficient evidence to diagnose Definite Fatal MI according to the criteria given in Section 4.1.1.

2. No known non-atherosclerotic or non-cardiac atherosclerotic process or event that was probably lethal.

3. Presence of one or both of the following findings:
   a) A history of chest pain within 72 hours of death;
   b) A history of ever having had chronic ischemic heart disease such as definite or possible MI, coronary insufficiency, or angina pectoris.

4.1.3 Possible Fatal CHD

Must meet ALL of the following criteria:

1. Lack of sufficient evidence to diagnose Definite Fatal MI or Definite Fatal CHD according to the criteria in Sections 4.1.1 and 4.1.2.

2. No known non-atherosclerotic or non-cardiac atherosclerotic process or event that was probably lethal.

3. Death certificate with consistent underlying cause, i.e., ICD9 codes: 410-414, 427.5, 429.2, and 799.
4.1.4 Non-CHD Death

All deaths that do not meet the above criteria for Definite Fatal MI, Definite Fatal CHD, or Possible Fatal CHD.

4.1.5 Chronology of Death

The time interval from onset of acute symptoms to time of death is recorded, where possible, for all CHD deaths.

4.1.6 Limitation of Activity

For out-of-hospital CHD deaths it is noted whether the decedent's activity was limited in the month before death because of sickness or illness.

4.2 Hospitalized Myocardial Infarction (MI)

4.2.1 Introduction

The aim of the ARIC Study is to establish a well standardized process for the identification of hospitalized coronary disease of an acute nature, allowing for valid inter-community and longitudinal comparisons. Mild and chronic manifestations of ischemic heart disease, such as angina pectoris, congestive heart failure, and arrhythmias are not identified as target diagnoses in community surveillance but are included in the screening process to aid in the identification of acute MI. So-called silent infarctions are excluded.

The criteria presented are based on two source documents: the findings of the CCSP Pilot Study and the results of the Minnesota Heart Survey\(^1\text{--}^3\), as well as other surveillance studies. The diagnostic criteria presented here approximate those contained in the above mentioned documents. The differences in diagnostic criteria are the lack of a duration requirement for cardiac pain, and the use of the more sensitive and specific CK-MB and LDH isoenzymes. The combinations of pain, ECG and enzyme categories required for each diagnosis below are approximately the same as those contained in the above-mentioned documents.
It is recognized that aggressive treatment of early signs and symptoms of acute coronary events, such as coronary artery bypass graft or streptokinase infusion, may prevent the development of the full diagnostic syndrome. In such cases, it may be difficult to diagnose the event accurately. The use of such modalities are recorded and subject to data analysis, but not employed in the criteria for diagnosis.

4.2.2 Definite Hospitalized MI

Must meet one or more of the following criteria:

1. Evolving diagnostic ECG pattern (ED1 - ED7, defined below)

   OR

2. Diagnostic ECG pattern (D1 or D2) and abnormal enzymes (both defined below);

   OR

3. Cardiac pain (defined below) and abnormal enzymes;

   AND

   a) Evolving ST-T pattern (EV1 through EV8)

   OR

   b) Equivocal ECG pattern (E1 through E4)

4.2.3 Probable Hospitalized MI

Must meet one or more of the following criteria in the absence of sufficient evidence for Definite Hospitalized MI:

1. Cardiac pain and abnormal enzymes

   OR

2. Cardiac pain and equivocal enzymes and

   a) Evolving ST-T pattern

   OR

   b) Diagnostic ECG pattern

   OR

3. a) Abnormal enzymes and

   b) Evolving ST-T pattern
4.2.4 Suspect hospitalized MI

Must meet one or more of the following criteria in the absence of sufficient evidence for Definite or Probable Hospitalized MI.

1. Abnormal enzymes

2. Cardiac pain and incomplete enzymes and
   a) Diagnostic ECG pattern

3. Cardiac pain and equivocal enzymes

4. Equivocal enzymes and
   a) Diagnostic ECG pattern

The Criteria for Definite Probable and Suspect Hospitalized MI are summarized in Table 2.

4.2.5. Definition of Cardiac Pain

Pain having both the following characteristics:

1. It occurs anywhere in the anterior chest, left arm or jaw.

2. Absence of a definite non-cardiac cause of cardiac pain.
<table>
<thead>
<tr>
<th>Cardiac Pain</th>
<th>ECG Findings</th>
<th>Enzymes</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present</td>
<td>Evolving Diagnostic</td>
<td>Abnormal</td>
<td>Definite MI</td>
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<tr>
<td></td>
<td>ECG Pattern</td>
<td>Equivocal</td>
<td>Definite MI</td>
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<tr>
<td></td>
<td></td>
<td>Incomplete</td>
<td>Definite MI</td>
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<td></td>
<td></td>
<td>Normal</td>
<td>Definite MI</td>
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<tr>
<td></td>
<td>Diagnostic ECG Pattern</td>
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<td>Equivocal</td>
<td>Probable MI</td>
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<td></td>
<td>Normal</td>
<td>No MI</td>
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<tr>
<td></td>
<td>Evolving ST-T Pattern</td>
<td>Abnormal</td>
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<td></td>
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<tr>
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<td>Not Present, Unknown or Missing</td>
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<td>ECG Pattern</td>
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<td>Diagnostic ECG Pattern</td>
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<td>Evolving ST-T Pattern</td>
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<td>Normal</td>
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<td></td>
<td>Normal</td>
<td>No MI</td>
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</table>
4.2.6 Definitions of Electrocardiographic Criteria

The ECG series is assigned the highest category for which criteria are met, i.e., evolving diagnostic is greater than diagnostic is greater than evolving ST-T patterns are greater than equivocal is greater than other. The ECGs are coded using Minnesota Code (Manual 5, Electrocardiography, Appendix E).

4.2.6.1 Evolving Diagnostic Q Waves

An evolving Diagnostic Q Wave pattern is defined as an evolving pattern on serial ECGs of ECG changes within lead groups, i.e., anterior (V₁ - V₅); lateral (I, aVL, V₆) or inferior (II, III, aVF). Two or more ECG recordings during the hospitalization are needed for this classification.

4.2.6.2 Evolving Diagnostic ECG (Judged within lead group)

ED1 through ED7 cannot be assigned if a 7-1-1 code is present. ED2 through ED7 cannot be assigned if a 7-2-1 or 7-4 code is present.

ED1. No Q-code (no 1 code) in reference ECG followed by a record with a Diagnostic Q-code (Minn. code 1-1-1 through 1-2-5 plus 1-2-7), OR any code 1-3-X in reference ECG followed by a record with any code 1-1-X.

ED2. An Equivocal Q-code [(Minn. code 1-2-8 in the absence of 7-2-1 or 7-4) or (any 1-3 code)] and no major ST-segment depression in reference ECG followed by a record with a Diagnostic Q-code PLUS a major ST-segment depression (Minn. code 4-1-X or 4-2).

ED3. An Equivocal Q-code and no major T-wave inversion in reference ECG followed by a record with a Diagnostic Q-code PLUS a major T-wave inversion (Minn. code 5-1 or 5-2).

ED4. An Equivocal Q-code and no ST-segment elevation in reference ECG followed by a record with a Diagnostic Q-code PLUS an ST segment elevation (Minn. code 9-2).

ED5. No Q-code and neither 4-1-X nor 4-2 in reference ECG followed by a record with an Equivocal Q-code PLUS 4-1-X or 4-2.

ED6. No Q-code and neither 5-1 nor 5-2 in reference ECG followed by a record with an Equivocal Q-code PLUS a 5-1 or 5-2.


4.2.6.3 Evolving ST-T Pattern (Judged within lead group)

This diagnosis cannot be assigned if a 7-1-1 or 7-2-1 or 7-4 code is present.
EV1. Either 4-0 (no 4-code), 4-4 or 4-3 in reference ECG followed by a record with 4-2 or 4-1-2 or 4-1-1 (confirmed by Significant Increase) OR, for hospital ECGs only, 4-2, 4-1-2 or 4-1-1 in reference ECG followed by a record with 4-0, 4-4 or 4-3 (confirmed by Significant Decrease),

PLUS
either no Q-code in both the reference ECG and the follow-up ECG or Q-code(s) present in reference ECG or follow-up ECG but no Significant Increase found.

EV2. Either 4-2 or 4-1-2 in reference ECG followed by a record with 4-1-1 (confirmed by Significant Increase) OR, for hospital ECGs only, 4-1-1 in reference ECG followed by a record with 4-2 or 4-1-2 (confirmed by Significant Decrease),

PLUS
either no Q-code in both the reference ECG and the follow-up ECG or Q-code(s) present in reference ECG or follow-up ECG but no Significant Increase found.

EV3. Either 5-0, 5-4 or 5-3 in reference ECG followed by a record with 5-2 or 5-1 (confirmed by Significant Increase) OR, for hospital ECGs only, 5-2 or 5-1 in reference ECG followed by a record with 5-0, 5-4 or 5-3 (confirmed by Significant Decrease),

PLUS
either no Q-code in both the reference ECG and the follow-up ECG or Q-code(s) present in reference ECG or follow-up ECG but no Significant Increase found.

EV4. Code 5-2 in reference ECG followed by a record with 5-1 (confirmed by Significant Increase) OR, for hospital ECGs only, 5-1 in reference ECG followed by a record with 5-2 (confirmed by Significant Decrease),

PLUS
either no Q-code in both the reference ECG and the follow-up ECG or Q-code(s) present in reference ECG or follow-up ECG but no Significant Increase found.

EV5. Code 9-0 in reference ECG followed by a record with 9-2 (confirmed by Significant Increase) OR 9-2 in reference ECG followed by a record with 9-0 (confirmed by Significant Decrease),

PLUS
either no Q-code in both the reference ECG and the follow-up ECG or Q-code(s) present in reference ECG or follow-up ECG but no Significant Increase found.

EV6. Code 4-1 in reference ECG followed by a record with 4-1 (confirmed by Significant Increase) OR, for hospital ECGs only, 4-1 in reference ECG followed by a record with 4-1 (confirmed by Significant Decrease),

PLUS
either no Q-code in both the reference ECG and the follow-up ECG or Q-code(s) present in reference ECG of follow-up ECG but no Significant Increase in Q-code found.
EV7. Code 5-1-1 in reference ECG followed by a record with 5-1-1 (confirmed by Significant Increase) OR, for hospital ECGs only, 5-1-1 in reference ECG followed by a record with 5-1-1 (confirmed by Significant Decrease),

PLUS

either no Q-code in both the reference ECG and the follow-up ECG or Q-code(s) present in reference ECG or follow-up ECG but no Significant Increase in Q-code found.

EV8. Code 5-1-2 in reference ECG followed by a record with 5-1-2 (confirmed by Significant Increase) OR, for hospital ECGs only, 5-1-2 in reference ECG followed by a record with 5-1-2 (confirmed by Significant Decrease),

PLUS

either no Q-code in both the reference ECG and the follow-up ECG or Q-code(s) present in reference ECG or follow-up ECG but no Significant Increase in Q-code found.

4.2.6.4 Diagnostic ECG

D1. (Diagnostic Q wave)

An ECG record with any Diagnostic Q-code (Minn. code 1-1-1 through 1-2-5 plus 1-2-7).

D2. An ECG record with ST-segment elevation code 9-2 PLUS (T-wave inversion code 5-1 or 5-2 in the absence of 7-2-1 or 7-4).

4.2.6.5 Equivocal ECG

E1. (Equivocal Q wave)

An ECG record with an Equivocal Q-code [(Minn. code 1-2-8 in the absence of 7-2-1 or 7-4) or (any 1-3 code)].

E2. An ECG record with ST-segment depression (code 4-1-X or 4-2 or 4-3 in the absence of 7-2-1 or 7-4).

E3. An ECG record with T-wave inversion (code 5-1 or 5-2 or 5-3 in the absence of 7-2-1 or 7-4).


4.2.6.6 Other ECG

01. Reference ECG coded 7-1-1.

02. Any ECG coded 7-1-1.

03. Normal ECG(s), defined as 1.0 in "clear" field of all ECGs.

04. Other findings including 1-2-6.

4.2.6.7 Uncodable ECG

U1. Technical errors coded 9-8-1 by Minnesota Code.

4.2.6.8 Absent ECG

A1. No ECG available for coding.

4.2.6.9 Minnesota Coding Procedures
The following ECG tracings are identified:

1. The first codable ECG after admission;
2. The last codable ECG recorded before discharge; and
3. The last codable ECG recorded on day 3 (or the first ECG thereafter) following admission or an in-hospital event.

Photocopies of the hospital ECGs are sent to the Minnesota Coding Center in Minneapolis for Minnesota Coding, using the Minnesota Coding for hospitalized ECGs shown in Appendix 0 of Manual 5. Each ECG is read one time blinded. Unlike for cohort, serial change rules are not applied. Minnesota Code criteria are in Appendix E of Manual 5.

4.2.7 Definitions of Cardiac Enzyme Criteria

All pertinent enzyme results (as defined below) recorded on days 1 through 4 after hospital admission or an in-hospital CHD event are abstracted. Information on non-ischemic cause for elevated enzymes is abstracted exclusively from the discharge summary on the medical chart.

4.2.7.1 Abnormal Cardiac Enzymes

Enzymes are classed as "abnormal" if any enzyme values recorded meet any of the following criteria:

1. a) CK-MB is "present" (if laboratory uses the criterion of "present" or "absent" without reporting a more specific value) or CK-MB is twice the upper limits of normal (if the laboratory gives a normal range) or, if no normal range is given, the CK-MB (heart fraction) is greater than or equal to 10% of the total CK value,

   AND

   b) There is no known non-ischemic cause (cardiac surgery, severe muscle trauma, rhabdomyolysis) for the elevated enzyme value.

   OR

2. a) The ratio LDH1 : LDH2 > 1, or if LDH2 is missing LDH1 is at least twice the upper limit of normal,

   AND

   b) There is no evidence of hemolytic disease.

   OR

3. a) Total CK and LDH are both at least twice the upper limit of normal. (These increases do not have to occur on the same day.)

   AND
b) There is no known non-ischemic cause (surgery, severe muscle trauma, rhabdomyolysis) for the elevated enzyme value and no evidence of hemolytic disease.

4.2.7.2 Equivocal Cardiac Enzymes

Enzymes are classed as "equivocal" if the criteria for abnormal enzymes are not met and if:

1. Either total CK or total LDH are at least twice the upper limits of normal.

   OR

2. Both total CK and total LDH are between the upper limits of normal and twice the upper limits of normal. (These increases do not have to occur on the same day.)

   OR

3. CK-MB is "weakly present" or between the upper limits of normal and twice the upper limits of normal or 5-9% of total CK.

   OR

4. If LDH1 is present and LDH2 is missing, and LDH1 is between the upper limits of normal and twice the upper limits of normal.

A summary of the enzyme diagnostic criteria, as related to total CK and LDH is given in the following algorithm, Figure 1.

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<thead>
<tr>
<th>T</th>
<th>Twice Upper Limit of Normal</th>
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<tbody>
<tr>
<td>O</td>
<td>Equivocal</td>
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<tr>
<td>T</td>
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<td>A</td>
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<td>Equivocal</td>
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Figure 1. Algorithm for Total CK and LDH Enzyme Diagnostic Criteria