Common biochemical markers for diagnosing heart disease

AN ELECTROCARDIOGRAM (ECG) and clinical features alone are used to diagnose almost 75 per cent of patients presenting with an acute myocardial infarction (MI). But when the clinical picture is less characteristic and the ECG is normal or has non-specific changes, verification may rely on detecting elevated levels of cardiac enzymes.

Myocardial infarction results in the leakage of certain intracellular enzymes through damaged cell membranes into the interstitial spaces. The enzymes are carried by the coronary lymphatic drainage system into the circulating blood where they are detectable by laboratory investigation (Clancy and McVicar, 2002).

Cardiac enzymes are present in high concentrations in myocardial tissue. The rate of liberation of specific enzymes differs following MI and the pattern of enzyme release is, therefore, important (Woods et al, 1995). However, an enzyme rise of more than twice the normal level has traditionally defined an acute MI. When patients with an acute MI have up to 8–19 times the normal level of enzymes, in-hospital mortality rises markedly.

It is worth mentioning that normal values for cardiac enzymes depend on the laboratory methods used to assay them and may vary from hospital to hospital; they are not, therefore, included in this article.

Biochemical markers for cardiac damage

Commonly measured biochemical markers for cardiac damage are:
- Troponin I and T;
- Myoglobin;
- Creatine phosphokinase (CK);
- Lactic dehydrogenase (LDH);
- Aspartate aminotransferase (AST).

An enzyme often has isoenzymes, which catalyse the same reaction but are chemically distinct. They can be separated out by electrophoresis: a process that sorts electrically charged particles in solution by passing electricity through the solution. (Different charges on the particles cause movement through the solution at different rates.) Each isoenzyme is specific for one particular organ tissue; therefore, electrophoretic separation can isolate the organ responsible for the total enzyme elevation.

There are several newer biochemical markers available and it is worth noting that these proteins, called troponins, are gradually replacing the measurement of traditional cardiac enzymes such as CK because of their greater sensitivity and specificity. However, this transition is limited by the increased cost (and complexity of method) of the newer markers. A summary of the common cardiac markers, outlining the degree of cardiac specificity, speed of conducting the assay and relative cost of each, is provided in Table 1.

Troponin T

Troponin T is present in cardiac and skeletal muscle but the cardiac type can be distinguished from the skeletal muscle type. It is a highly sensitive marker and can be useful when there are no apparent ECG changes suggestive of cardiac disease (Moses, 2003). It appears to have prognostic value in patients admitted with unstable angina. Raised levels indicate a high likelihood of subsequent infarction. In addition, measuring serial troponin T levels may give some indication of whether the infarct-related artery has been opened.

Both troponin T and I can be measured at the bedside so there is the potential for improved triage. This enzyme is not useful for monitoring an extension of a cardiac event, where CK-MB remains valuable (Moses, 2003). It may also be falsely elevated in chronic renal failure.

Troponin I

Troponin I can be used to indicate re-perfusion following thrombolytic therapy, as levels are washed into the bloodstream, and as a guide to extension of an MI. It is also very useful for the diagnosis of perioperative MI and is not falsely elevated in chronic renal failure.

Unlike the other cardiac markers the troponins are undetectable in healthy people. Therefore, even small increases indicate myocardial damage.

Myoglobin

Myoglobin is not strictly an enzyme and is not cardiac specific. The myoglobin assay has poor sensitivity and takes 30 minutes before results are available. The process is also relatively expensive. For these reasons it is not used routinely.

Creatine phosphokinase (CK)

This enzyme’s primary function within the cell is that of energy production. There are high concentrations in the heart, skeletal muscle and brain (Clancy and McVicar, 2002). Normal values are higher in men, people with a
large muscle mass, or in those who are physically active. Until recently CK was the most specific cardiac enzyme available. Other clinical situations such as head injury or extreme hypothermia may also cause CK levels to rise. However, the isoenzyme CK-MB, which is more cardiac-specific, helps discriminate an MI at a very early stage when thrombolysis may be needed (Swanton, 1994). Since 1975 CK-MB has been accepted as unequivocal evidence of MI.

There are two types of assay for this isoenzyme: the CK-MB mass assay measures CK-MB protein and the CK-MB activity assay measures enzyme action. Both CK-MB assays detect MI although CK-MB activity is quicker and cheaper but less specific. CK-MB levels do not usually rise with chest pain caused by angina, pulmonary embolism, skeletal muscle injury, shock or intramuscular injections.

Lactic dehydrogenase (LDH)
LDH catalyses the conversion of lactate to pyruvate, providing adenosine triphosphate (ATP) for energy during periods of anaerobic metabolism within cells. This enzyme is not cardiac-specific, unfortunately. LDH is often used to confirm the diagnosis of acute MI, established by CK-MB, and the assay is quick and inexpensive. LDH may also be elevated in haemolysis, leukaemia, megablastic anaemia and renal disease (Woods et al, 1995).

Aspartate aminotransferase (AST)
This enzyme is found in the cell cytoplasm and mitochondria where it catalyses aspartic acid activity. AST is found in all tissues. Raised levels of this enzyme are found in approximately 70 per cent of MI patients (Hatchett and Thompson, 2002). Although it is less specific than the CK-MB assay, it is quick and inexpensive. AST is also elevated in liver disease, pulmonary embolism, skeletal muscle injury, shock or intramuscular injections.

Nursing considerations
■ The purpose of repeated blood tests for cardiac enzymes should be explained to the patient.
■ Intramuscular injections can cause elevation of CK levels and should be avoided in people with suspected MI.
■ It is important to be aware of events that contribute to enzyme elevation and false labelling of necrosis.
■ Blood specimens should be transferred as soon as possible to the laboratory to avoid false assays.
■ Patients who have pain for hours or days at home are suspect for an older MI and the assay should be adjusted.
■ The recurrence of chest pain during the rehabilitation phase of hospitalisation may indicate extension or re-infarction and warrant enzyme re-evaluation.
■ An early peak in cardiac enzymes may be due to the enzymes being washed out of the infarcted area by the re-perfused artery and so indicate successful re-perfusion.

Conclusion
Biochemical markers for heart disease are most useful if they are specific to the heart and are measurable by the laboratory within a time frame sufficiently short to allow for the initiation of suitable treatment. Overall the troponins, although expensive, appear to facilitate the best use of hospital bed space allowing patients who present with chest pain to be labelled as ‘cardiac’ or ‘non-cardiac’ cases early on in their admission.

**KEYWORDS** Myocardial infarction Cardiac enzymes Cardiology

**REFERENCES**


**TABLE 1. SUMMARY OF CARDIAC MARKERS**

<table>
<thead>
<tr>
<th>CARDIAC MARKER</th>
<th>TIME TO RISE</th>
<th>PEAK TIME</th>
<th>TIME RAISED</th>
<th>CARDIAC SPECIFIC</th>
<th>ASSAY SPEED</th>
<th>RELATIVE COST</th>
<th>PROBLEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>AST</td>
<td>8 hours</td>
<td>36 hours</td>
<td>3-4 days</td>
<td>No</td>
<td>10 min</td>
<td>Low</td>
<td>↑ in liver disease, skeletal muscle, metastatic cancer, haemolysis</td>
</tr>
<tr>
<td>LDH</td>
<td>16 hours</td>
<td>48 hours</td>
<td>5 days</td>
<td>No</td>
<td>10 min</td>
<td>Low</td>
<td>↑ in skeletal muscle damage, metastatic cancer, haemolytic anaemias, haemolysis</td>
</tr>
<tr>
<td>CK</td>
<td>6-10 hours</td>
<td>30 hours</td>
<td>3-5 days</td>
<td>No</td>
<td>10 min</td>
<td>Low</td>
<td>↑ in skeletal muscle damage</td>
</tr>
<tr>
<td>CK-MB (mass)</td>
<td>6-10 hours</td>
<td>12-18 hours</td>
<td>2-3 days</td>
<td>No. Better than AST/LDH/CK</td>
<td>20-30 min</td>
<td>Middle</td>
<td>↑ in skeletal muscle damage</td>
</tr>
<tr>
<td>CK-MB (activity)</td>
<td>6-10 hours</td>
<td>12-18 hours</td>
<td>2-3 days</td>
<td>No. Better than AST/LDH/CK</td>
<td>10 min</td>
<td>Low</td>
<td>↑ in skeletal muscle damage</td>
</tr>
<tr>
<td>Myoglobin</td>
<td>6-8 hours</td>
<td>10-18 hours</td>
<td>24-36 hours</td>
<td>No. Better than AST/LDH/CK</td>
<td>20-30 min</td>
<td>High</td>
<td>↑ in skeletal muscle damage</td>
</tr>
<tr>
<td>Troponin T</td>
<td>6-10 hours</td>
<td>12-24 hours</td>
<td>7 days</td>
<td>Yes</td>
<td>15-30 min</td>
<td>High</td>
<td>↑ in some chronic renal failure patients</td>
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<td>Troponin I</td>
<td>6-10 hours</td>
<td>12-24 hours</td>
<td>5-7 days</td>
<td>Yes</td>
<td>15-30 min</td>
<td>High</td>
<td>None</td>
</tr>
</tbody>
</table>

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