
# PRACTICE MANAGEMENT GUIDELINES FOR

# SCREENING OF BLUNT CARDIAC INJURY

EAST Practice Parameter Workgroup for Screening of Blunt Cardiac Injury

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**Practice Management Guidelines for Screening of Blunt Cardiac Injury**

## I. Statement of the problem

The reported incidence of blunt cardiac injury (BCI), formerly called myocardial contusion, depends on the modality and criteria used for diagnosis and ranges from 8% to 71% in those patients sustaining blunt chest trauma. The true incidence remains unknown as there is no diagnostic gold standard, i.e. the available data is conflicting with respect to how the diagnosis should be made (EKG, enzyme analysis, echocardiogram, etc.) The lack of such a standard leads to confusion with respect to making a diagnosis and makes the literature difficult to interpret. Key issues involve identifying a patient population at risk for adverse events from BCI and then appropriately monitoring and treating them. Conversely, patients not at risk could potentially be discharged from the hospital with appropriate follow-up.

## II. Process

A Medline search from January 1986 through February 1997 was performed. All English language citations during this time period with the subject words "myocardial contusion", "blunt cardiac injury", and "cardiac trauma" were retrieved. Letters to the editor, isolated case reports, series of patients presenting in cardiac arrest, and articles focusing on emergency room thoracotomy were deleted from the review. This left 56 articles which were primarily well-conducted studies or reviews involving the identification of BCI.

## III. Recommendations

A. Level I

An admission EKG should be performed on all patients in whom there is suspected BCI.

B. Level II

1. If the admission EKG is abnormal (arrhythmia, ST changes, ischemia, heart block, unexplained ST), the patient should be admitted for continuous EKG monitoring for 24 to 48 hours. Conversely, if the admission EKG is normal, the risk of having a BCI that requires treatment is insignificant, and the pursuit of diagnosis should be terminated.

2. If the patient is hemodynamically unstable, an imaging study (echocardiogram) should be obtained. If an optimal transthoracic echocardiogram cannot be performed, then the patient should have a transesophageal echocardiogram.

3. Nuclear medicine studies add little when compared to echocardiography and, thus, are not useful if an echocardiogram has been performed.

C. Level III

1. Elderly patients with known cardiac disease, unstable patients, and those with an abnormal admission EKG can be safely operated on provided they are appropriately monitored. Consideration should be given to placement of a pulmonary artery catheter in such cases.

2. The presence of a sternal fracture does not predict the presence of BCI and, thus, does not necessarily indicate that monitoring should be performed.

3. Neither creatinine phosphokinase with isoenzyme analysis nor measurement of circulating cardiac troponin T are useful in predicting which patients have or will have complications related to BCI.

## IV. Scientific Foundation

In a consensus statement published in the Journal of Trauma in 1992 by Mattox et al, it was felt that the terms "cardiac contusion" and "cardiac concussion" should cease to be used as a diagnosis for admission, injury severity scoring, billing, or reimbursement purposes.[39]

Alternatively, specific descriptions were recommended and are as follows:

Blunt cardiac injury with septal rupture
Blunt cardiac injury with free wall rupture
Blunt cardiac injury with coronary artery thrombosis
Blunt cardiac injury with cardiac failure
Blunt cardiac injury with minor ECG or enzyme abnormality
Blunt cardiac injury with complex arrhythmia

Based on this recommendation, the following discussion will utilize the term blunt cardiac injury (BCI) as opposed to cardiac contusion or concussion for purposes of clarity.

Clinically, there are few reliable signs and symptoms that are specific for BCI. Many patients have evidence of external chest trauma, such as fractures or the imprint of a steering wheel, or other causative agent on their chest. Chest pain, usually due to associated injuries, is common, and occasionally patients will describe anginal-type pain that is unrelieved by nitrates. The diagnosis is entertained by maintaining a high index of suspicion in patients with an appropriate mechanism of injury or in those who manifest an inappropriate or abnormally poor cardiovascular response to their injury. Well-defined and uniformly accepted diagnostic criteria do not exist, and the optimal diagnostic evaluation remains controversial. At present, no single test or combination of tests has proven consistently reliable in detecting cardiac injury. The diagnosis of BCI will be directly proportional to the aggressiveness with which it is sought. The appropriate choice demands achieving a balance between cost-effectiveness of the tests employed and the impact of the information acquired on clinical management decisions.

### EKG

In a meta-analysis of 43 studies published in English from 1967 through 1993, it was found that ECG and CPK-MB analyses were more useful in diagnosing clinically significant BCIs (those that result in a complication that requires treatment) than were radionuclide scans and echocardiograms.[53]

The Pediatric Emergency Medicine Collaborative Research Committee published a multicenter retrospective review of 184 patients admitted with BCI in 1996.[52] The authors noted that no hemodynamically stable patient who presented with a normal admission ECG developed a cardiac arrhythmia or cardiac failure. The lack of subsequent development of pump failure or serious arrhythmia in hemodynamically stable patients who presented in normal sinus rhythm is evidence that serious, unsuspected acute complications are truly very rare. This agrees with a previous investigation of adults that found clinically significant life-threatening complications after BCI were rare and that patients at risk for such complications can be identified when they present to the emergency department.[28] Recommendations from these groups were that stable patients who do not require monitoring for other injuries should only be monitored if there are conduction abnormalities on admission ECG.[28,52]

In a separate review of hemodynamically stable blunt chest trauma patients with a completely normal ECG and no evidence of additional somatic injury, it was concluded that no further testing for BCI was required.[49] In-hospital monitoring should be reserved for patients with clinical evidence of dysfunction or in whom significant arrhythmias were apparent. Likewise, several other studies have confirmed that stable patients with a normal admission ECG require no further work-up with respect to BCI.[20,22,24,31,35,38,41,42,45,48] In a prospective evaluation of 100 patients admitted to a level 1 trauma unit with a clinical suspicion of BCI, it was recommended that if patients were hemodynamically stable, less than 55 years of age with no history of cardiac disease, required no surgery or neurological observation, and had a normal admission ECG, they could be discharged to home.[48] If patients did not meet one or more of the above mentioned criteria, cardiac monitoring for 24 hours was recommended with treatment as necessary.[48] Although 74% of patients did not meet one or more of the criteria, no patient developed a complication requiring therapy. It was felt that limiting the cardiac evaluation in these patients to an admission ECG and 24 hours of monitoring would greatly reduce the cost of care without increasing the risk of missing potentially serious complications. In a separate prospective evaluation of 336 patients with suspected BCI, Cachecho et al. concluded that young trauma victims without major thoracic or extrathoracic injury and a normal admission ECG do no benefit from admission to the SICU, routine echocardiography, or radionuclide studies.[35] The authors also stated that young, minimally injured patients with an abnormal admission ECG are unlikely to develop subsequent cardiac decompensation and that a brief period of monitored observation may be indicated. Cardiac imaging studies should only be requested to answer specific clinical questions that cannot otherwise be explained and are not useful to confirm the diagnosis of myocardial contusion in a stable patient or for screening purposes. McLean et al., in a prospective analysis of outcome of 312 patients with blunt chest trauma, noted that there were no deaths secondary to dysrhythmias or cardiac failure and felt that the incidence of clinically significant dysrhythmias or other cardiac complications resulting from blunt trauma to the heart may be overestimated.[40] The authors recommended ECG monitoring only if dysrhythmias were documented on admission ECG or if the patient was unstable. Enzyme analysis and routine RNA studies were not useful. In a separate meta-analysis by Christensen, the admission ECG was seen as the most important diagnostic tool in determining the presence of BCI.[41] The authors identified and reviewed 18 studies from January 1986 through January 1992 noting that 80% of all arrhythmias requiring treatment were present in the emergency department. Later arrhythmic events, such as those described by Foil et al., and Norton et al., were usually ascribed to pre-existing cardiac disease or myocardial infarction.[24,26,41] Both Foil and Norton suggest that an abnormal ECG requires further investigation as these are the patients at risk for sequelae.[24,26]

## Enzyme Analysis

While several studies suggest that CPK isoenzyme analysis may be useful in determining which patient would benefit from further imaging studies,[1,21,47] the overwhelming majority of studies conclude that such analysis is not warranted.[3,5,9,10,12,14,15,17,22,28-31,38,40-43,49] Keller et al., in a retrospective evaluation of 182 patients, noted no correlation between an abnormal isoenzyme and ECG and went on to recommend a MUGA scan in patients with

an abnormal ECG or pump failure.[17] Fabian et al., in a prospective evaluation of 92 patients with evidence of anterior chest trauma, concluded that CPK-MB determinations should not be routinely used for screening and diagnosis of BCI.[29] Biffl et al., in a retrospective analysis of 359 patients admitted with a diagnosis of rule out BCI, noted that an abnormal admission ECG was the most significant independent predictor of a complication of myocardial contusion while isolated elevations in cardiac enzymes did not predict complications from BCI.[43] The authors, in fact, concluded that cardiac enzymes were irrelevant in the patient with suspected myocardial contusion. More recently, the use of cardiac troponin I (cTnI) has been suggested as a screening test for BCI.[50] In an effort to determine whether its measurement would improve the ability to detect cardiac injury in patients with blunt chest trauma, 44 patients were studied with serial echocardiograms and serial blood samples.[50] Six patients had evidence of cardiac injury by echocardiography, and all had elevations of CPK-MB and cTnI while one patient with elevations of both enzymes had only pericardial effusion; 26 of 37 patients without contusion had elevations of CPK-MB but not cTnI. The authors concluded that measurement of cTnI accurately detects cardiac injury in patients with blunt chest trauma. It should be noted that all 6 patients with evidence of cardiac injury had abnormal admission ECGs, and that in two cases the injury was felt to be due to infarct rather than trauma. Based on this data, it appears as though cTnI did not contribute significantly to management of these patients. In a more recent prospective study, it was concluded that circulating cardiac troponin T has no important clinical value in the diagnosis of BCI.[56]

Echocardiogram

Almost all of the data analyzed suggest that echocardiography is not useful as a primary screening modality, however, should be recommended as a complementary test in selected patients.[2,9,28,30,35,38,41,44,45,51,52] Specifically, it has been emphasized that echocardiography adds little in hemodynamically stable patients but rather should be reserved for those with clinical compromise in which specific clinical questions cannot be explained.[15,35,41,44,45,52] In a prospective evaluation of 96 patients with blunt chest trauma, Helling et al. suggested that ECG, CPK-MB, and echocardiography should be routinely performed within 24 hours of admission.[21] It must be noted, however, that no patient in this study developed complications related to BCI. In a meta-analysis, Christensen et al. found that while no data supported echocardiography for the diagnosis of BCI, it was useful in several instances for the diagnosis of apical thrombi, localization of pericardial effusions, and identification of cardiac structural abnormalities.[41] In a prospective study of 105 consecutive patients with severe blunt chest trauma, Karalis et al. evaluated the role of echocardiography and found that screening echocardiography was not of value as most patients remain asymptomatic.[44] The authors did state that a transthoracic echocardiogram should be performed in any patient who develops symptoms or has abnormal results on physical exam that suggest underlying cardiac disease. Further, if the transthoracic echocardiogram is suboptimal, a transesophageal echocardiogram should be performed. This is in accordance with Brooks et al.'s prospective evaluation of 50 patients and Weiss et al.'s retrospective review of 81 patients with suspected BCI which showed that, overall, transesophageal echocardiography more accurately detected BCI than transthoracic evaluations because of the suboptimal results encountered with some of the transthoracic studies.[34,54] Malangoni et al.'s retrospective study confirmed that echocardiogram is useful in patients with arrhythmias or cardiac failure.[45] The pediatric data likewise noted that echocardiography was a sensitive diagnostic tool for hemodynamically significant disease and should be performed promptly when patients have unexplained hypotension, abnormal ECG, or evidence of pump failure.[51,52]

Other Imaging Studies

Radionuclide imaging has not been shown to be useful on a routine basis and in several studies has been shown to add no benefit over ECG or echocardiography.[18,20,35,41,53] MUGA scans have not been shown to be useful in predicting complications from BCI however, in one study was recommended if patients had an abnormal ECG or pump failure.[17,30] In this study, no comparison was made with echocardiography.[17] Abnormal thallium-201 scanning was shown to correlate with abnormal ECG, but was no better than echocardiography with respect to the prediction of complications from BCI.[13] SPECT scanning was shown to be a useful predictor of the development of arrhythmias secondary to BCI in two studies, however, in another, admission ECG was shown to be a better predictor of outcome.[32,36,55] Lastly, one study evaluating antimyosin scintigraphy showed potential of this modality as a second line test.[37] In all, these other modalities require further investigation and at this time cannot be recommended over ECG and selected echocardiography.

Pulmonary Artery Catheter

Several studies evaluated the use of invasive monitoring in patients with suspected BCI, recommending that in certain populations, (i.e. age greater than 60, hemodynamic instability, multisystem trauma, those with abnormal ECGs, and those who are going to receive general anesthesia) a preoperative pulmonary artery catheter should be placed and monitoring continued based on clinical judgement.[12,22,23,47] Based on these studies, the use of invasive monitoring should be considered in these patient populations.

## V. Summary

In general, the diagnosis of BCI should be suspected in patients with an appropriate mechanism of injury or in those who manifest an inappropriately or abnormally poor cardiovascular response to their injury. At present, no single test or combination of tests has proven consistently reliable in detecting cardiac injury. The diagnosis of BCI will be directly proportional to the aggressiveness with which it is sought. The appropriate choice demands achieving a balance between cost-effectiveness of the tests employed and the impact of the information acquired on clinical management decisions.

## VI. Future Investigation

Future studies should focus on patients who develop complications secondary to BCI. Diagnostic testing should be compared with the less invasive and less expensive tests currently recommended. A cost-benefit analyses should be considered in all future studies.

## VII. References


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| First Author | Year | Reference Title | Class | Conclusions |
|---|---|---|---|---|
| Kettunen P | 1985 | Creatine kinase MB and M-mode echocardiographic changes in cardiac contusion. *Ann Clin Research 17:292-8* | II | Retrospective review of 95 patients with blunt cardiac injury (BCI) and rib fractures who had CPK with isoenzymes and 12-lead EKG on admission and 1-2 weeks later. Patients also had an echocardiogram within 24 hrs of admission. An abnormal CPK was found to correlate with an abnormal ECHO. |
| Markiewicz W | 1985 | Echocardiographic evaluation after blunt trauma of the chest *Int J Cardiol 8:269-74* | II | Prospective evaluation of 27 patients with blunt chest trauma who had an echocardiogram within 24 hrs of admission. 83% of patients with an abnormal echocardiogram had transient EKG abnormalities. 1 patient with septal akinesia had cardiac death. Echocardiogram was found to be a useful complementary test in selected patients. |
| Andersen PT | 1986 | Comparisons between CK-B and other clinical indicators of cardiac contusion following multiple trauma. *Scand J Thorac Cardiovasc Surg 20:93-6* | II | Prospective evaluation of 17 ICU patients with blunt chest trauma. EKG and CPK isoenzymes were done for 72 hrs. All T-wave changes normalized within 3 days. CPK-MB was a poor indicator of cardiac contusion. |
| Flancbaum L | 1986 | Emergency surgery in patients with post-traumatic myocardial contusion. *J Trauma 26:795-803* | II | Prospective evaluation of 19 patients with diagnosis of cardiac contusion by abnormal EKG, CPK-MB, or RNA study. No periop complications were due to cardiac contusion. EKG was the best predictor of cardiac contusion. General anesthesia was considered safe with appropriate monitoring and inotropic support. |
| Frazee RC | 1986 | Objective evaluation of blunt cardiac trauma. *J Trauma 26:510-20* | I | Prospective evaluation of 291 patients with blunt chest trauma who had EKG and CPK isoenzymes done on admission. Those with abnormal isoenzymes had echocardiogram performed. 60% of patients with abnormal MB had normal echocardiogram. 40% of patients with abnormal MB had abnormal echocardiogram. 39% of patients with abnormal echo-cardiograms had arrhythmias. 3% of patients with a normal echo had arrhythmias. Follow-up echo at 10 wks showed resolution. Recommendation was that patients only needed to be monitored if they had abnormal isoenzymes and an abnormal echocardiogram. |
| Rosenbaum RC | 1986 | Posttraumatic cardiac dysfunction: Assessment with radionuclide ventriculography. *Radiology 160:91-4* | II | Prospective evaluation of 54 patients with blunt chest trauma who had EKG and CPK isoenzymes for 72 hours. RNA study was done within 7 days when patient was stable. 48% of patients had an abnormal RNA study, however, there was no association with an abnormal EKG. If the RNA study was normal there was no need to monitor the patient. |

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| Rothstein RJ | 1986 | Myocardial contusion diagnosed by first-pass radionuclide angiography. *Am J Emerg Med 4:210-3* | III | Case series of 10 patients with blunt chest trauma, all had abnormal EKG and abnormal RNA study. Follow-up RNA studies were within normal limits. RNA studies can be done to rule-out cardiac injury, and if normal, the patient can be discharged. |
| Waxman K | 1986 | Diagnosis of traumatic cardiac contusion. *Arch Surg 121:689-92* | II | Prospective evaluation of 48 patients with a diagnosis of cardiac contusion and received 3 days of EKG and CPK studies and SPECT. 52% of SPECT were abnormal, 20% of abnormals had subsequent arrhythmias. If SPECT was within normal limits, no patients developed arrhythmias. SPECT should be used as a screening tool for those patients at risk for arrhythmia. |
| Beggs CW | 1987 | Early evaluation of cardiac injury by two-dimensional echocardiography in patients suffering blunt chest trauma. *Ann Emerg Med 16:542-5* | III | Retrospective evaluation of 40 patients with blunt chest trauma. Patients had EKG, CPK, and echocardiograms performed. No association was found between abnormal echocardiograms and abnormal EKG or CPK. Echocardiogram is recommended as a complementary but not primary diagnostic test. |
| Reid CL | 1987 | Chest trauma: Evaluation by 2-dimensional echocardiography. *Am Heart J 113:971-6* | III | Retrospective study of 39 patients with blunt chest trauma. 85% had an adequate echocardiogram, 24% of which had pericardial fluid. 10 patients with abnormal CPK-MB had normal echocardiogram. 61% of all patients had abnormal EKG. No specific recommendations made. |
| Soliman MH | 1987 | Value of a conventional approach to the diagnosis of traumatic cardiac contusion after chest injury. *Crit Care Med 15:218-20* | II | Retrospective evaluation of 104 patients with blunt chest trauma. EKG and isoenzyme monitoring were performed for 72 hrs with monitoring. Clinical findings, CXR, and EKG were nonpredictive of complications. |
| Bodin L | 1988 | Myocardial contusion: When does it have clinical significance? *J Trauma 28:64-8* | III | Retrospective evaluation of 53 patients with diagnosis of cardiac contusion, 2% of which developed arrhythmias requiring treatment. All patients had abnormal isoenzymes but normal MUGA studies. Patients at risk should be monitored for 24 hrs. If patient is elderly, unstable, or has multiple injuries, PA catheter and MUGA study should be performed. |
| Brunel W | 1988 | Myocardial contusion in patients with blunt chest trauma as evaluated by thallium 201 myocardial scintigraphy. *Chest 94:72-6* | II | Prospective evaluation of 55 patients with blunt chest trauma and no cardiac history. EKG, echocardiogram, and thallium 201 were performed on day 8. All patients with abnormal thallium 201 studies had abnormal EKG or dysrhythmia. 55% of patients with abnormal thallium 201 had abnormal echocardiogram but all patients with abnormal echocardiogram had abnormal thallium 201. Thallium 201 was not accurate enough to visualize RV, therefore it underestimates frequency of cardiac contusion. |

| First Author | Year | Reference Title | Class | Conclusions |
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| Brunel W | 1988 | Routine intensive care unit admission is not indicated for suspected myocardial contusion. *J Int Care Med 3:253-7* | II | Retrospective evaluation of 72 patients with isolated blunt chest trauma. Diagnosis of cardiac contusion was made if there was both abnormal EKG and CPK-MB. No patient had abnormal MB isoenzyme but 5% had arrhythmias requiring treatment. ICU monitoring should be done only if there is an abnormal EKG or the patient is unstable. |
| Fabian TC | 1988 | Myocardial contusion in blunt trauma: Clinical characteristics, means of diagnosis, and implications for patient management. *J Trauma 28:50-7* | II | Prospective evaluation of 140 patients with blunt chest trauma and no cardiac history. EKG, CPK, echocardiogram, and GVA were performed within 48 hrs of admission. 40% of patients had abnormal MB or EKG and most abnormal MB's at 6 hrs had normalized at 12 hrs. 32% of patients with abnormal MB had normal EKG. 7% of patients had abnormal GVA. No patient had problems with general anesthesia. Abnormal EKG should alert clinician to the diagnosis, early MB was most reliable. Echo-cardiogram and GVA add little clinical information. |
| Hiatt JR | 1988 | The value of echocardiography in blunt chest trauma. *J Trauma 28:914-22* | II | Prospective evaluation of 73 patients with blunt chest trauma. EKG, CPK, echocardiogram, and monitoring were performed over initial 24 hrs. EKG was frequently abnormal but nonpredictive. CPK was nonspecific. ICU admission was recommended for abnormal echocardiogram, instability, or acute EKG changes. If echocardiogram and EKG are within normal limits, ICU admission is not necessary. |
| Keller KD | 1988 | Creatine phosphokinase-MB assays in patients with suspected myocardial contusion: Diagnostic test or test of diagnosis? *J Trauma 28:58-63* | II | Retrospective evaluation of 182 patients with blunt chest trauma. EKG, isoenzymes, and monitoring for 24 hrs were performed with echo-cardiogram and MUGA scan. 10 patients had confirmed myocardial injury by MUGA or pump failure with no mortalities. No correlation was found between abnormal isoenzyme and EKG. MUGA was recommended in patients with abnormal EKG's or pump failure. |
| Schamp DJ | 1988 | Clinical significance of radionuclide angiographically-determined abnormalities following acute blunt chest trauma. *Am Heart J 116:500-4* | II | Prospective evaluation of 111 patients with blunt chest trauma and no cardiac history. 36% of patients had abnormal RNA study with direct correlation between RBBB and abnormal RVEF. Most RNA studies normalized at 10 days. RNA studies were more sensitive than EKG and/or CPK but should not be used routinely. |
| Baxter BT | 1989 | A plea for sensible management of myocardial contusion. *Am J Surg 158:557-61* | II | Based on retrospective analysis of 50 patients admitted to surgical ICU for suspicion of myocardial contusion, a protocol to rule out myocardial contusion was developed and applied prospectively to the next 230 consecutive patients admitted. Patients were evaluated by ECG and CK-MB enzyme levels and diagnosed as having a contusion if ECG showed transient changes, CK-MB more than 3%, or both. 35 patients had myocardial contusion, 9 required treatment. 5/9 patients with increased CPK isoenzymes had normal ECGs; all but one patient requiring treatment for contusion had either electrical or hemodynamic instability on admission. This patient also had normal CK-MB analysis. No patient developed complication more than 12 hrs post-admission. In patients with suspected blunt cardiac trauma, admission for 24-hr with continuous ECG monitoring, serial ECGs, and CK-MB analysis should be performed. |

| First Author | Year | Reference Title | Class | Conclusions |
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| Dubrow TJ | 1989 | Myocardial contusion in the stable patient: What level of care is appropriate? *Surgery 106:267-74* | II | Retrospective study of 243 patients with blunt chest trauma, all stable on admission. EKG and monitoring were performed for 72 hrs and RNA study was performed. 71% of patients had abnormal RNA study and 17% had abnormal admission EKG. If patient has normal admission EKG, no ICU monitoring is necessary as EKG is best indicator of subsequent complications. RNA studies are not necessary. Patients should be admitted to ICU if unstable, have arrhythmias, abnormal EKGs, old or new cardiac disease. |
| Helling TS | 1989 | A prospective evaluation of 68 patients suffering blunt chest trauma for evidence of cardiac injury. *J Trauma 29:961-6* | II | Prospective evaluation of 96 patients with blunt chest trauma who had EKG, CPK, and echocardiograms performed within 24 hrs of admission. 72% had some abnormality. No cardiac complications developed, all tolerated anesthesia. Evaluation should be performed utilizing EKG, CPK, and echocardiogram. |
| Miller FB | 1989 | Myocardial contusion. When can the diagnosis be eliminated? *Arch Surg 124:805-7* | II | Prospective evaluation of 172 patients with blunt chest trauma. Patients should be monitored if unstable, abnormal EKG, or multiple injuries. PA catheters should be placed when age> 60 years, cardiac history, will have general anesthesia, or unstable. CPK-MB's are not helpful, and echo-cardiograms should be performed only if the patient is unstable. |
| Ross P Jr | 1989 | Cardiac contusion: The effect on operative management of the patient with trauma injuries. *Arch Surg 124:506-7* | II | Retrospective study of 64 patients with abnormal admission CPK-MB or EKG. 30 patients had general anesthesia with 4 complications (3 arrhythmia, 1 CHF). Recommend placement of PA catheter if patient has abnormal EKG or CPK-MB and is going to the OR. |
| Holness R | 1990 | Diagnosis of traumatic cardiac contusion utilizing single photon-emission computed tomography. *Crit Care Med 18:1-3* | II | Prospective evaluation of 125 consecutive patients with diagnosis of blunt chest trauma. 11/75 patients with positive studies developed serious arrhythmias (mult PVCs, A-fib). 3/48 patients with negative studies developed serious arrhythmias. Single photon-emission CT was useful for screening patients at risk for arrhythmias. No comment re: Rx. |
| Foil MB | 1990 | The asymptomatic patient with suspected myocardial contusion. *Am J Surg 160:638-42* | II | Retrospective evaluation of 524 blunt chest trauma patients monitored for 72 hrs, with EKGs and CPK. 85% of patients with complications, mostly arrhythmias, had abnormal EKG on admission. No association between MB bands and complications. More complications with age. If EKG was normal, D/C from ED if no other injury, no cardiac history, and patient age < 45 years. Abnormal EKG was the best indicator of sequelae. |

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| Healey MA | 1990 | Blunt cardiac injury: Is this diagnosis necessary? *J Trauma 30:137-46* | II | Retrospective evaluation of 342 patients with blunt chest trauma; all had EKG and CPK with isoenzymes, some had echocardiograms or MUGA scans. 13% had diagnosis of cardiac contusion, 6% with abnormal cardiac function. 36% of OR patients had complications including V-fib. Admission EKG and isoenzymes correlated with complications. If admission EKG is abnormal, monitor patient; if isoenzymes are also abnormal, delay OR. |
| Norton MJ | 1990 | Early detection of myocardial contusion and its complications in patients with blunt trauma. *Am J Surg 160:577-81* | II | Retrospective evaluation of 88 patients with blunt chest trauma. 31% had diagnosis of cardiac contusion by abnormal EKG, isoenzyme, or echocardiogram. No operative complications. There was increased risk of cardiac contusion if ISS>10 and abnormal EKG. If ISS<10 and EKG was abnormal only 35% had positive diagnosis. If EKG was normal, only 4% had positive diagnosis. Only patients with abnormal EKG and ISS>10 should have further evaluation. |
| Reif J | 1990 | Selective monitoring of patients with suspected blunt cardiac injury. *Ann Thorac Surg 50:530-2* | I | Prospective evaluation of 115 patients with blunt chest injury who had EKG, CPK, and echocardiograms. 15.7% had cardiac complications. If echocardiogram was abnormal, 25.8% had cardiac complications; if it was normal, 1.2% had complications. Recommended that if no ICU monitor-ing is required for other injuries, echocardiogram should be performed and, if normal, patient does not require further monitoring. |
| Wisner DH | 1990 | Suspected myocardial contusion. Triage and indications for monitoring. *Ann Surg 212:82-6* | II | Retrospective study of 95 patients with blunt chest injury who had EKGs and echocardiograms over 48 hrs prior to admission. 20% had arrhyth-mias, no patient with cardiac complication had instability or conduction abnormalities on EKG. If patient is stable and does not require monitoring, only monitor if there are conduction abnormalities on admission EKG. Echocardiograms, RNA studies, and CPK's were not helpful. |
| Fabian TC | 1991 | A prospective evaluation of myocardial contusion: Correlation of significant arrhythmias and cardiac output with CPK-MB measurements. *J Trauma 31:653-60* | II | Prospective evaluation of 92 patients with evidence of anterior chest trauma. 23 patients developed 25 significant arrhythmias, none requiring specific therapy. CPK-MB monitoring should not be routinely used for screening and diagnosis. Continuous arrhythmia monitoring deserves further clinical investigation but not routine application. Stable patients at risk for myocardial contusion should be monitored for 24 hours. |
| Gunnar WP | 1991 | The utility of cardiac evaluation in the hemodynamically stable patient with suspected myocardial contusion. *Am Surg 57:373-7* | I | Prospective evaluation of 123 patients with blunt chest injury who were hemodynamically stable on admission. EKG, CPK, and echocardiogram were performed over 24 hrs after admission. MUGA scans were done within 48 hrs and follow-up MUGA was performed at 6 months if initial was abnormal. Follow-up MUGA scans were normal. In stable patients without other severe injuries, monitoring is useful for 24 hours. EKG, CPK, and MUGA were not useful in predicting complications. |

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| Illig KA | 1991 | A rational screening and treatment strategy based on the electrocardiogram alone for suspected cardiac contusion. *Am J Surg 162:537-44* | II | Retrospective evaluation over 4-yrs of 133 patients admitted with diagnosis to rule out cardiac contusion. 13 patients developed cardiac problems: 2 elderly patients died in ED, others had arrhythmias or, less commonly, pump failure requiring treatment or observation. All patients had EKG changes during ED evaluation: 11 had specific problem on arrival, 1 developed problem while being evaluated in ED, and 13th had iatrogenic problem. CPK-MB analysis was not useful in predicting complications. No patient with normal EKG had subsequent cardiac problems. If EKG was sole screening tool, 25% of patients could have been discharged from ED without missing problems. |
| McCarthy MC | 1991 | The value of SPECT-Thallium scanning in screening for myocardial contusion. *Cardiovasc Intervent Radiol 14:238-40* | II | Prospective evaluation of 40 patients with blunt chest trauma who had EKGs and CPKs over 72 hrs after admission and SPECT study at 48 hrs. 12 patients had diagnosis of cardiac contusion by abnormal EKG and 24 had abnormal SPECT. Admission EKG was best predictor of outcome, if abnormal, patient should be monitored. SPECT were not useful. |
| McLean RF | 1991 | Incidence of abnormal RNA studies and dysrhythmias in patients with blunt chest trauma. *J Trauma 31:968-70* | II | Prospective evaluation of 191 patients with blunt chest trauma who had EKG, CPK, Holter monitoring, and RNA studies in 72 hrs after admission. 67% of patients with a-fib died; 71% of patients with abnormal RNA died. Monitoring and CPKs were not recommended. |
| Brooks SW | 1992 | The use of transesophageal echocardiography in the evaluation of chest trauma. *J Trauma 32:761-7* | II | Prospective evaluation of 50 patients with suspected diagnosis of cardiac contusion (physical findings: chest pain, SQ emphysema, thoracic abrasions; flail chest; x-ray findings of rib, sternal, or clavicular fractures; pulmonary contusion; hemothorax/pneumothorax; elevation of CPK-MB isoenzyme levels.) Transesophageal echocardiography more accurately detected cardiac contusions than transthoracic echocardiography. |
| Cachecho R | 1992 | The clinical significance of myocardial contusion. *J Trauma 33:68-73* | II | Prospective study of 336 patients with suspected myocardial contusion. Young trauma victims without major thoracic/extrathoracic injury and normal trauma floor EKG do not benefit from SICU admission. Routine ECHO and GBP not useful for care of these patients. Young, minimally injured patients with abnormal trauma floor EKG are unlikely to develop cardiac decom-pensation. Brief, monitored observation may be indicated. Cardiac imaging studies are not useful to confirm diagnosis of myocardial contusion in stable patients and are not indicated for screening. Admission to monitored bed should be based on severity of injury and clinical wisdom. Diagnosis of myocardial contusion should not be pursued in a stable trauma patient. |

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| Godbe D | 1992 | Diagnosis of myocardial contusion. Quantitative analysis of single photon emission computed tomographic scans. *Arch Surg 127:888-92* | II | Retrospective analysis of 175 patients with positive SPECT. SPECT was reliable predictor of arrhythmia development; 102/175 with positive SPECT developed arrhythmia. Only 5 of these required specific therapy. |
| Hendel RC | 1992 | Focal myocardial injury following blunt chest trauma: A comparison of indium-111 antimyosin scintigraphy with other noninvasive methods. *Am Heart J 123:1208-15* | II | Prospective evaluation of 17 patients with blunt chest trauma as screened by need for aortography to rule out thoracic aortic dissection. All patients had serial EKGs and CPK-MB analysis over 72 hrs after admission, echocardiogram, and antimyosin scintigraphy. All patients had abnormal EKG's (ST abnormalities, conduction defects, or low voltage EKG); 3 had abnormal CPK-MB's, 1 had abnormal echocardiogram and antimyosin testing. 7 patients developed serious arrhythmias (all had abnormal EKG's, 2 had abnormal CK-MB, 1 had abnormal echocardiogram and antimyosin). Admission EKG was more sensitive to identify patients at risk for complications from blunt chest injury than other studies. CPK-MB and echocardiography were insensitive to development of complications. Antimyosin identified the one patient with focal wall motion abnormality and may be a useful second line test. |
| Krasna MJ | 1992 | Blunt cardiac trauma: Clinical manifestations and management. *Semin Thorac Cardiovasc Surg 4:195-202* | III | Review article (127 refs) in which authors recommend patients with suspected myocardial contusion have admission ECG and CK-MB analysis is probably not needed. Stable patients with abnormal admission ECG should have continuous ECG monitoring for 48 hrs. Arrhythmias or other complications treated as they arise. If indicated, 2-D echo or RNA can be used to better delineate extent of cardiac dysfunction. If no complications after 48 hrs, DC monitoring. Stable patients with normal screening ECG may be admitted to floor without monitoring. Early invasive monitoring and inotropic support required for unstable patients with ECG evidence of myocardial contusion or those with inappropriately depressed cardiovascular response to stress. Patients with myocardial contusion can safely have emergent surgery for associated injuries. |

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| Mattox KL | 1992 | Blunt cardiac injury (Editorial).<br>*J Trauma 33:649-50* | III | Consensus statement regarding blunt cardiac injury. In absence of clinical symptoms or ECG evidence of complex arrhythmias, monitoring in special care area, enzyme determinations, and cardiac imaging are not indicated. Recommendations: 1) Asymptomatic patients with anterior chest wall concussion should not be in ICU for continuous ECG monitoring, serial determinations of CPK-MB enzyme levels, or cardiac imaging unless less intensive facilities are not available. They should be in intermediate care unit or general ward nursing unit for telemetry/ECG monitoring. or ECG monitoring. 2) Terms of cardiac contusion and cardiac concussion cease to be used as diagnosis for admission, ISS, billing, or reimbursement. Alternative suggested diagnoses follow. 3) When traumatic cardiac diagnoses are used for admission, ISS, discharge summary, billing or reimbursement, specific descriptions be used: Blunt cardiac injury with septal rupture; Blunt cardiac injury with free wall rupture; Blunt cardiac injury with coronary artery thrombosis; Blunt cardiac injury with cardiac failure; Blunt cardiac injury with minor ECG or enzyme abnormality; Blunt cardiac injury with complex arrhythmia. 4) AIS scores for blunt cardiac injury should be reworked and blunt cardiac injury with minor ECG abnormality should receive score of 1 not 3 to reflect weight comparison with other AIS scores of 1 or 3. |
| McLean RF | 1992 | Significance of myocardial contusion following blunt chest trauma.<br>*J Trauma 33:240-3* | II | Prospective outcome evaluation of cardiac complications in 312 patients with blunt chest trauma. No deaths occurred secondary to dysrhythmias or cardiac failure. Incidence of clinically significant dysrhythmias or other cardiac complications from blunt trauma to the heart may be overestimated. Routine RNA studies are not useful. CPK isoenzymes are of little use. EKG monitoring recommended for documented dysrhythmias on admission EKG or if patient is critically ill. |
| Christensen MA | 1993 | Myocardial contusion: New concepts in diagnosis and management.<br>*Am J Crit Care 2:28-34* | III | Meta-analysis of 18 studies (1986-1991) in patients with suspected myocardial contusion. Admission EKG was important in determining presence of myocardial contusion and right precordial leads were of little value. CPK-MB fractions were not useful for managing suspected myocardial contusion and are poor predictors of pump failure or arrhythmias needing treatment. ECHO did not clearly diagnose myocardial contusion, however, in several instances ECHO identified apical thrombi and located pericardial effusions. ECHO failed to demonstrate utility and specificity as a screening tool in suspected myocardial contusion, but can detect pump failure, structural abnormalities, thrombi, and effusions. Radionuclide studies do not offer any clinical benefit beyond EKG and ECHO. |

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| Paone RF | 1993 | Diagnosis of myocardial contusion.<br>*South Med J 86:867-70* | II | Prospective study of 159 patients with major blunt chest injury admitted for serial EKG monitoring, isoenzyme measurements, and 2-D echocardiography. Cardiac isoenzyme determinations and echocardiograms are not predictive of physiologic consequences in these patients and should not be used routinely. EKG monitoring with treatment of dysrhythmias as they occur constitutes adequate, appropriate, and cost-effective management for suspected cases of myocardial contusion. |
| Biffl WL | 1994 | Cardiac enzymes are irrelevant in the patient with suspected myocardial contusion.<br>*Am J Surg 168:523-8* | II | 359 patients with diagnosis to rule out myocardial contusion and enrolled in institutional protocol for this diagnosis were retrospectively evaluated. Abnormal admission EKG was most significant independent predictor of myocardial contusion. Isolated elevations in cardiac enzymes do not predict complications in these patients. Patients who present with symptoms of angina, who are hemodynamically unstable, or who have ECG abnormalities, should be admitted to ICU for at least 24 hrs of continuous monitoring. Immediate cardiology consult and early echocardiography should be considered. Patients with noncardiac thoracic findings or nonspecific ECG abnormalities should be admitted to telemetry bed for monitoring and serial electrocardiography. Patients with no specific complaints and no remarkable findings on initial workup are discharged from ED unless they require admission for other injuries. |
| Karalis DG | 1994 | The role of echocardiography in blunt chest trauma: A transthoracic and transesophageal echocardiographic study.<br>*J Trauma 36:53-8* | I | A prospective evaluation of 105 consecutive patients with severe blunt chest trauma (chest wall AIS score of 2 or greater). Recommend that these patients should be monitored in an ICU for 24 hours. Admission ECG and CPK-MB analysis were not predictive of cardiac complications requiring treatment. Screening echocardiography is not of value in blunt chest trauma because the majority of patients with myocardial contusion remain asymptomatic. TTE is indicated in any patient who develops symptoms or has abnormal results on physical examination that suggest underlying cardiac disease. If the TTE examination is suboptimal then TEE should be performed. Patients with myocardial contusion can undergo general anesthesia safely if properly monitored. |

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| Malangoni MA | 1994 | Outcome of serious blunt cardiac injury. *Surgery 116:628-33* | III | Retrospective study of 12 patients with serious blunt cardiac injury. Admission EKG was highly sensitive screening exam to identify patients with blunt cardiac injury who are at risk for complications; specificity is not optimal. CPK isoenzyme determination has not been shown to be accurate screening test for minor types of myocardial contusion and is not reliable predictor of more severe injuries. ECHO has been shown to be useful in patients with arrhythmias or cardiac failure. |
| Roy-Shapira A | 1994 | Sternal fractures: A red flag or a red herring? *J Trauma 37:59-61* | III | Review of 28 patients with sternal fractures secondary to blunt trauma. In patients with normal admission ECG, no associated CXR findings, and hemodynamic stability, a sternal fracture can be treated symptomatically and, if isolated, the patient can be discharged to home. |
| Feghali NT | 1995 | Blunt myocardial injury. *Chest 108:1673-7* | III | Review of 35 blunt cardiac injury articles analyzing the utility of ECG, CPK-MB enzymes, and cardiac imaging studies. ECG has good negative predictive value, especially when combined with normal CK-MB levels. Absolute CK-MB values seem to have good positive predictive value for cardiac complications. Patients may be discharged from the hospital after 24 hrs of monitoring if ECG and CK-MB level are normal with no other major injuries. Until further studies indicate otherwise, it is probably reasonable to reserve imaging studies for patients with abnormal ECG and/or elevated CK-MB level or preexisting cardiac disease. For patients who require emergency surgery, invasive intraoperative monitoring is often advocated although these patients tend to do well. |
| Fildes JJ | 1995 | Limiting cardiac evaluation in patients with suspected myocardial contusion. *Am Surg 61:832-5* | II | Prospective evaluation of 100 patients admitted with mechanism of injury consistent with myocardial contusion. Hemodynamically stable patients with normal admission EKG and no history of cardiac disease, <55 yrs old, and do not require surgery or neurologic observation can have diagnosis of significant cardiac contusion excluded. Patients with abnormal admission EKG should have 24 hrs of monitoring and follow-up EKG with further intervention as per the results of these studies. |

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| Schick EC Jr | 1995 | Nonpenetrating cardiac trauma.<br>*Cardiol Clin 13:241-7* | III | Review article (62 refs) concluding that hemodynamically stable blunt chest trauma patients with completely normal ECG and evidence of negligible additional somatic injury are unlikely candidates for any complication and require only abbreviated observation. Normal ECG, however, does not exclude diagnosis of contusion when evidence of extensive injury exists. Neither CPK-MB nor abnormal wall motion on noninvasive study facilitates prediction of late complications in stable patients, but echocardiography may best assess the extent of injury and identify related and unsuspected problems, (ie. intracavitary thrombi) which may alter subsequent therapy. In-hospital monitoring may be reserved for patients with evidence dysfunction or in whom significant arrhythmias are apparent. |
| Adams JE 3rd | 1996 | Improved detection of cardiac contusion with cardiac troponin I.<br>*Am Heart J 131:308-12* | II | Prospective evaluation of 44 patients with blunt chest trauma. Cardiac Troponin I more accurately predicted cardiac contusion when compared to CPK-MB analysis using echocardiography as the standard to diagnose contusion. |
| Weiss RL | 1996 | The usefulness of transesophageal echocardiography in diagnosing cardiac contusions.<br>*Chest 109:73-7* | II | Review of 81 TEEs over 30 months. TEE was safe and provided excellent quality images where TTE exams were inadequate. |
| Bromberg BI | 1996 | Recognition and management of nonpenetrating cardiac trauma in children.<br>*J Pediatr 128:536-41* | III | Review of medical records of children admitted to St. Louis Children's Hospital from 1987-1992 with traumatic cardiac injury (nonpenetrating). 8 children had nonpenetrating cardiac trauma. CK-MB analysis did not correlate with symptomatic contusions. Admission ECG was abnormal in 3/4 children who required therapy. 2 patients required surgical intervention and one required pericardiocentesis. In the patient with normal admission ECG, diagnosis of dilated right ventricle was made by echocardiogram 1 day after admission when hypotension and peripheral vasoconstriction developed. He had previous splenectomy for splenic rupture. He required 3 days of dopamine, after which myocardial function returned to normal. Echocardiogram was abnormal in all patients requiring therapy. 1 patient with abnormal ECG (ventricular ectopy) required no therapy. Authors concluded that echocardiography is a sensitive diagnostic tool for hemodynamically significant disease, and should be performed promptly when patients have unexplained hypotension or diminished peripheral perfusion. |

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| Dowd MD | 1996 | Pediatric blunt cardiac injury: Epidemiology, clinical features, and diagnosis. Pediatric Emergency Medicine Collaborative Research Committee: Working Group on Blunt Cardiac Injury.<br>*J Trauma 40:61-7* | II | Multicenter retrospective review of 184 patients admitted with blunt cardiac injury [ICD-9-CM 861.0, injury to the heart without open wound into thorax, including 861.00 (unspecified BCI), 861.01 (cardiac contusion), 861.02 (laceration without penetration of the chambers, 861.03 (laceration with penetration of the chambers), and 908.0 (late effects of cardiac injury)]. All children who developed pump failure or serious cardiac arrhythmias during hospital course initially presented to ED either in shock or with serious arrhythmia. This finding agrees with previous investigation of adult patients in which clinically significant life-threatening complications after BCI were rare and patients at high risk for such complications can be identified when they present to ED. Trauma patients with suspected cardiac injury by ab-normal EKG should receive prompt evaluation of chamber function with echocardiography and, if evidence of pump failure is present, fluid management should be adjusted accordingly. Patients in shock or with serious arrhythmia or PVC's should be carefully monitored in an ICU. |
| Maenza RL | 1996 | A meta-analysis of blunt cardiac trauma: Ending myocardial confusion.<br>*Am J Emerg Med 14:237-41* | II | Meta-analysis of all prospective, retrospective, and review articles published in English from 1967 through 1993. Data on ECG, CPK-MB, radionuclide scans, and echocardiogram were analyzed using the Mantel-Haenszel procedure. Data support use of ECG and CPK-MB in diagnosis of clinically significant myocardial contusion (defined as contusion resulting in complication that requires treatment). Radionuclide scanning is not useful in evaluating patients with blunt cardiac trauma. Further studies need to define role of echocardiography. No comment was made on whether ECG or CPK-MB were superior to one another or whether both were necessary. |
| Ferjani M | 1997 | Circulating cardiac troponin T in myocardial contusion.<br>*Chest 111:427-33* | II | Prospective evaluation of 128 blunt trauma patients with circulating cardiac troponin T, echocardiography, and continuous Holter monitoring. BCI was diagnosed by 1) abnormal echo compatible with BCI, 2) severe cardiac rhythm abnormality, 3) severe cardiac conductive abnormality, or 4) hemopericardium. BCI was diagnosed in 29 patients. Although circulating cardiac troponin T had a slightly greater diagnostic value than CK-MB, it had no important clinical value in the diagnosis of BCI. |