Clinical question.

In patients with suspected ACS in the prehospital, emergency department or in-hospital settings (P), can non-physicians (e.g. paramedics and nurses) (I) accurately diagnose STEMI (O), when compared to physicians (C)?

Conflict of interest specific to this question

Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet? No

Search strategy (including electronic databases searched).

Databases searched: Cochrane, Medline, Embase

Search Strategy:

--------------------------------------------------------------------------------
1  STEMI.mp. (1226)
2  exp Heart Infarction/ (117032)
3  Acute Coronary Syndrome/ (4925)
4  Thorax Pain/ (19703)
5  exp Angina Pectoris/ (38562)
6  ("ST elevation" or "ST segment elevation" or "ST-segment elevation" or "myocardial infarction" or ACS or "acute coronary syndrome" or "chest pain" or angina).mp. (130328)
7  6 or 4 or 1 or 3 or 2 or 5 (183080)
8  emergency ward/ (21592)
9  emergency health service/ (12970)
10  ambulance/ (2629)
11  exp hospital patient/ (19761)
12  exp Hospital/ (146143)
13  ("prehospital" or "pre-hospital" or ambulance$ or "emergency room$" or "emergency department$" or "accident adj3 department$" or "AE department$" ).mp. (35254)
14  8 or 11 or 13 or 10 or 9 or 12 (187727)
15  exp Paramedical Personnel/ (72601)
16  exp nurse/ (17904)
17  rescue personnel/ (1336)
18  exp Physician Assistant/ (697)
19  (paramedic$ or nurse$ or RNS or "physician assistant$" or non-physician$ or "non physician").mp. (473361)
20  18 or 19 or 16 or 17 or 15 (522766)
21  7 and 20 and 14 (516)
22  limit 21 to yr="1980 - 2009" (515)
• **State inclusion and exclusion criteria**

Inclusions:
Year = 1980-2009
Human subjects only
Include all languages

Exclusions: Studies where paramedic-acquired electrocardiograms were transmitted remotely for physician interpretation.

• **Number of articles/sources meeting criteria for further review:**

Databases searched:
Medline 438 titles being reviewed
Embase 515 titles being reviewed
Cochrane 35 titles being reviewed
### Summary of evidence

#### Evidence Supporting Clinical Question

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- Feldman, 2005 D3 (Paramedic)
- van ‘t Hof, 2006 D3 (Paramedic)
- Millar-Craig, 1997 D4 (Paramedic)
- Trivedi K, 2009 D4 (Paramedic)
- Pitt, 2002 D4 (Paramedic)
- Bouten 1992 D4 (Nurse)
- LeMay, 2006 D3 (Paramedic)
- Lloyd, 2000 D3 (Nurse)
- Foster, 1994 D4 (Paramedic + Nurse)
- Qassim, 2002 D4 (Nurse)
- Heath, 2003 D4 (Nurse)
- Wilmhurst, 2000 D4 (Nurse)
- Whitbread, 2002 D4 (Paramedic)
- Kresmer, 2005 D4 (Nurse)
- Quinn, 1998 D4 (Nurse)

#### Level of evidence

- **A** = Return of spontaneous circulation
- **B** = Survival of event
- **C** = Survival to hospital discharge
- **D** = Intact neurological survival
- **E** = Other endpoint

*Italics = Animal studies*

### Evidence Neutral to Clinical question

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- **A** = Return of spontaneous circulation
- **B** = Survival of event
- **C** = Survival to hospital discharge
- **D** = Intact neurological survival
- **E** = Other endpoint

*Italics = Animal studies*
### Evidence Opposing Clinical Question

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<tr>
<th>Good</th>
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**Level of evidence**

A = Return of spontaneous circulation  
B = Survival of event  
C = Survival to hospital discharge  
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E = Other endpoint  
*Italic* = Animal studies
REVIEWER'S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:

The question asks for a comparison of the diagnostic accuracy of nurses and paramedics compared to that of physicians. Since substantial rates of false positives and false negatives are known to commonly exist in physician-diagnosed STEMI, the clinical significance of the worksheet (and the studies described) is necessarily limited by the failure to assess physician accuracy against a durable objective "gold standard" for diagnostic accuracy, such as peak troponin levels or proof of lesion on angiography. At best, the studies describe a level of inter-rater agreement, without evidence that either rater was diagnostically correct.

With respect to paramedic diagnosis of STEMI:

Evidence supporting the ability of paramedics to accurately diagnose STEMI is provided by 3 LOE D3, 4 LOE D4, 1 LOE D5 studies. This evidence includes paramedic diagnosis by manual interpretation of 12-lead EKG alone or diagnosis guided by computerized EKG interpretation such as the GE/Marquette 12-SL algorithm. In dissent, Davis et al reported superior results using remote physician diagnosis based on tele-transmitted EKG when compared to paramedic diagnosis.

Studies where the EKG was always tele-transmitted for interpretation by a physician at a remote location were excluded as the pre-hospital providers were not themselves diagnosing STEMI, but in fact only acquiring the EKG.

The evidence encourages the view that paramedics could be trained to perform this diagnosis accurately; Davis's result raises the important question of whether this success of paramedic STEMI diagnosis is community-specific, perhaps reflecting variations in the diagnostic skill and experience of the paramedics in question. Millar-Craig, supported by Feldman and Foster, urges that "only experienced, fully-qualified paramedics" be trained in STEMI diagnosis. Further work is required to define the factors which differentiate EMS systems where paramedics are shown to accurately diagnose STEMI (when compared to physicians) from those who are likely to demonstrate inferior diagnostic results.

The literature would be strengthened by studies which considered the comprehensive accuracy of paramedics in diagnosing STEMI among all patients seen by EMS. The literature largely examines the accuracy of diagnosis in patients self-reported by paramedics as warranting a 12-lead EKG. No studies addressed whether paramedics may fail to identify certain patients who should have a prehospital/12-lead EKG such as atypical presenters who are later found to have a STEMI. For instance, Foster specifically excluded patients without classic pain or discomfort from paramedic consideration. Paramedic false negatives are not benign as they may harmfully delay access to reperfusion or even dissuade a patient from going to hospital. This is an important limitation as the absence of data on missed patients may artificially inflate the diagnostic accuracy reported in these studies.

The relative importance of the balance between sensitivity and specificity depends on the clinical setting. As Feldman points out, high specificity is of particular importance in pre-hospital fibrinolysis programs since treatment, with its attendant risks, often proceeds without physician ratification. However, in systems favoring primary PCI, paramedic false positives are likely to be detected on arrival at the PCI site, despite the inconvenience and cost they may incur. Since both reperfusion strategies are in wide use, the literature would be stronger if both the sensitivity and the specificity of paramedic diagnosis were established, with the weight given to each influenced by the local reperfusion strategies.

With respect to nurse diagnosis of STEMI:

Eight observational studies support nurse diagnosis of STEMI, although all are based on a composite end-point of both STEMI diagnosis and determining eligibility for thrombolysis (1 LOE D3; 4 LOE D4 and 3 LOE D5). Determining the ability of nurses to diagnose STEMI in a broad population of patients was significantly confounded in four studies (Heath, 2003; Lloyd, 2000; Qasim, 2002, Quinn, 1998) as the study patients had already been pre-selected as ACS patients by other practitioners before the subject nurses undertook their diagnosis. While the studies demonstrate that nurse can accurately determine which of these pre-selected patients has both a STEMI and should receive thrombolysis, further work is required which addresses the specific question of how overall nurse diagnosis of STEMI compares with physician diagnosis.
Acknowledgements:

I would like to acknowledge the advice and assistance of Dr. Steven Brooks (Sunnybrook Health Science Centre, Toronto), Henry Lam (Librarian/Information Specialist, Library Services, Sunnybrook Health Sciences Centre, Toronto), and Tanya Semenko (American Heart Association) in locating research materials.

Citation List


LOE D4, fair, supportive; concurrent case series report for nurse-diagnosed STEMI using computerized EKG diagnostic algorithm with pre-hospital thrombolysis. Large sample without randomization; Choice of controls complicates study (defined as cases rejected for lysis in the field but ultimately receiving lysis in the receiving hospital) as controls differ clinically from the treated patients in all but 17 of 220 cases.


Level D3, good, not supportive; study considers only the positive predictive value of these two strategies of STEMI diagnosis (independent paramedic diagnosis and physician diagnosis based on transmitted 12-lead EKG). Strengthened by reporting both cardiologist agreement with paramedic interpretation and agreement with gold standard finding of lesion on angiography. Overall accuracy of diagnosis is not reported nor are data regarding the total number of patients screened by paramedic in order to find paramedic postives. Other limitations are small sample size (~50 pts per arm) and before/after design.


Level D3, good, supportive; strengthened by blinded adjudication of paramedic diagnosis; potential selection bias introduced by requiring 12-lead only if paramedic possessed “a reasonable suspicion” of AMI, and by paramedic training to report a STEMI only if very certain the ECK was positive, potentially masking false negatives.


Level D4, poor, supportive – Adjudicators not blinded to paramedic/nurse initial interpretation. Study endpoint is not diagnosis of STEMI, but decision that thrombolytic therapy was indicated. Further, patients without classic chest pain/discomfort were excluded from consideration, potentially missing atypical presenters. Author notes study paramedics/EMS nurses were highly experienced 12-lead interpreters as they worked in a hospital emergency department and cautions the accuracy of diagnosis may not be reproduced in other provider populations.


Level D4, poor, supportive – Retrospective review of 91nurse-diagnosed cases with no reported missed cases or inappropriate thrombolysis. Potential for significant selection bias as all patients were pre-selected for nurse consideration by paramedics who had conducted prehospital assessments and recommended these patients as likely to be AMIs.


Level D5, poor, supportive – Study considers only the ability of nurses to select historical ECGs which they felt represented patients warranting thrombolysis.

of ST-segment elevation myocardial infarction in the field, CJEM Canadian Journal of Emergency Medical Care. 8(6):401-7, 2006 Nov.

Level D3, fair, supportive; Low paramedic compliance (43%) with the study protocol may have introduced a potentially significant selection bias by excluding data from 556 of 967 patients with paramedic-identified chest pain.


Level D3, fair, supportive; Audit study. Limitations: Before-and-after design, used Nurse-Practitioners limiting comparability with other nurse-based studies, nurse over-prescription of lytic in 8/78 cases, no data on sensitivity (cases missed by nurse) Significant potential for selection bias as all patients were pre-identified as AMI candidates by emergency department staff.


Level D4, fair, supportive - Audit study with no control group. Limitation: Analysis restricted to patients identified by paramedics as warranting 12-lead EKG investigation with no data on patients who ought to have been so identified but were not. The study limited training in paramedic STEMI diagnosis to highly experienced, specially screened paramedics. This cohort of paramedics may have produced results hard to duplicate in the general population of EMS paramedics.


Level D4, fair, supportive. Limitations: The study enrolled only a subset of patients who paramedics might have considered potential STEMs. Patients close to hospital (<15 min travel time) and those without frank chest pain were, among others, excluded. Low sensitivity of diagnosis (46.7%) warrants greater consideration despite authors’ enthusiasm for high specificity to avoid inappropriate interventions.


Level D4, poor, supportive – 93 cases of nurse assessment and administration of thrombolytic are reported with no inappropriate thrombolytic administration. Missed eligible cases are not described. Substantial potential for selection bias as all patients assessed by the subject nurses had been pre-screened as likely AMI candidates by others. No distinction is drawn between the process of diagnosis of STEMI and assessment for eligibility for thrombolysis.


Level D5, poor, supportive – Small notional assessment of nurse intention to treat with thrombolytic. Significant potential for selection bias as all patients had already been admitted to a CCU for AMI care. Diagnostic skill examined is limited to conformity with ECG criteria and indications for thrombolysis without description of the ability to identify STEMI as a separate end-point.


Level D4, good, supportive, While study reports high sensitivity and specificity, it is seriously limited by the use of only five test EKG scenarios. This appears insufficient to draw conclusions about how paramedics would perform when reading larger numbers of EKGs in real patient settings.

Level D3, good, supportive. Paramedic diagnosis (95% accurate) was assisted by computer EKG analysis. Study has unusually strict “correct diagnosis” criteria including proven lesion on angiography while most studies simply consider an EKG consistent with STEMI to be a “correct” diagnosis.


Level D5, fair, supportive, Limitation: This paper describes only the paramedics’ ability to read paper 12-lead EKGs with no other knowledge of the patient. While this evidence is supportive to the broader concept of paramedic diagnosis of STEMI, it does not assess their ability to conduct a complete clinical diagnosis, most particularly, recognizing patients in whom 12-lead investigation is warranted.


Level D5, poor, supportive; Primary purpose of the study is description of process changes made to speed access to thrombolysis following admission. No data presented on numbers of patients treated. Sole contribution to the review was the statement that no patients received nurse-initiated lysis who should not have received the drug.