Review

How effective are paramedics at interpreting ECGs in order to recognise STEMI? A systematic review

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Abstract

Introduction

The use of an out-of-hospital 12-lead electrocardiograph (ECG) has long been the salient test used when assessing ischaemic chest pain and is the only clinical tool available to paramedics that allows for early diagnosis and triage of acute coronary syndromes. This ultimately indicates whether urgent percutaneous coronary intervention is indicated. Therefore, the ability to apply and interpret a 12-lead ECG are key skills for paramedics with potentially significant effect on patient outcomes. This study's objective was to review and summarise existing literature pertaining to the ability of paramedics to correctly identify STEMI via 12-lead ECGs.

Methods

Ovid Medline, Ovid Emcare and CINAHL Plus were all searched using synonyms of keywords such as paramedic, ECG, diagnosis and STEMI. Two investigators independently screened the titles, abstracts and full texts of the articles against the inclusion and exclusion criteria. Any conflicts that arose were discussed between the two investigators to meet consensus.

Results

Of the 2126 articles initially identified, nine studies were relevant and examined the ability of paramedics to identify STEMI on out-of-hospital ECGs. Results indicated that increased additional education provided to paramedics, and the implementation of protocols and/or tools demonstrated a higher degree of accuracy regarding STEMI recognition.

Conclusion

Seven of the nine articles had a strong general consensus that paramedics can independently interpret 12-lead ECGs in order to identify STEMI, however not all studies were of good quality. The importance of the pre-hospital ECG in the setting of STEMI is well established, however the ability of paramedics to independently interpret them requires further study.

Keywords:

paramedic, ECG, STEMI, interpretation, diagnosis

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Introduction

Over the past decade, the global number of deaths as the result of cardiovascular disease (CVD) has risen by 12.5%, and accounts for one-third of all deaths worldwide (1). Ischaemic heart disease (IHD) remains the largest contributor of CVD mortality (2). In 2015, CVD was the second leading cause of death in Australia, closely following all types of cancer (3). IHD was the most common form of CVD and was responsible for 12% of all Australian deaths during 2015. Acute myocardial infarction (AMI) comprised 43% of these IHD related deaths (3). Relatively few population-based studies examine the trends and types of AMI, however ST-segment myocardial infarction (STEMI) accounts for 25–40% of all AMI presentations (4). Given the impact of these diseases, there is a strong pre-hospital focus on early identification, treatment and transport of acute coronary syndromes (ACS). Assessment and identification of acute myocardial conditions is a key part of out-of-hospital care delivery for emergency medical services worldwide, including the use of a 12-lead electrocardiograph (ECG) (5). There are a range of different ways in which ECGs are interpreted in the out-of-hospital setting. These include paramedic based interpretation, the use of a computer algorithm, or transmission of the ECG to an on-call emergency physician or cardiologist for direct consultation (6,7).

Within Australia there are a number of emergency medical response services, with a government appointed provider of ambulance services for each state and territory. Each provider has a different set of guidelines and scope of practice to which paramedics must adhere. Within Victoria, Ambulance Victoria operates as the main emergency medical response service and plays a key role in delivery of care to STEMI patients. Before 2016, MICA paramedics were the only paramedics within Victoria with the ability and equipment to perform and interpret 12-lead ECGs. MICA paramedics have a higher skill set than advanced life support (ALS) paramedics and can perform more advanced procedures. They undertake additional training in order to make significant clinical decisions and provide further clinical support to ambulance crews with the management of more complex patient presentations. However, since that time Ambulance Victoria has seen the state-wide rollout of Zoll X-series monitors to all crews, including ALS. As part of this rollout, ALS paramedics completed a basic 12-lead ECG use and interpretation course. All ALS paramedics attended a training day, wherein approximately 4 hours were dedicated to the application, use and importance of 12-lead ECGs. This included a refresher module, revisiting the basic structure and function of the heart, the pathophysiology of IHD and ACS, the fundamental components of the 3-lead ECG, utilisation of a systematic approach to analyse a rhythm strip and basic arrhythmia recognition. Furthermore, 12-lead placement, acquisition and transmission, lead groupings, systematic interpretation of the ECG and STEMI criteria were all covered during the training provided. Paramedics were educated

on the management of these patients, and time was then allocated to practising interpreting 10 STEMI ECGs provided. Despite this, when identifying STEMI, ALS paramedics are currently instructed to rely on the Zoll interpretive statement that uses the Zoll Inovise 12L Interpretive Algorithm, a computerised interpretation of the tracing (6). If the monitor states ***STEMI*** or ***Acute MI*** ALS paramedics follow the STEMI Management Clinical Practice Guideline regardless of their individual capability to interpret an ECG (8). The STEMI management pathway asserts that MICA is called to continue the management of the patient, the ECG is transmitted to the receiving hospital via an emergency department and cardiology department notifications. However, if a MICA crew attend, they may use their clinical judgement to override the Zoll's automated STEMI interpretation. In the instance where MICA is unavailable, hospitals receive pre-notification based solely on the Zoll computer algorithm interpretation.

According to Zoll's published data, the Inovise 12L Interpretive Algorithm software has the ability to correctly classify an individual as having a STEMI in 89% of cases (sensitivity) (9,10). Furthermore, it reports the ability to correctly classify an individual as not having a STEMI in 100% of cases (specificity), and 98% of the time can detect patients with a positive STEMI ECG who are actually STEMI positive (positive predictive value, or PPV) (9,10). These statistics rely on the absence of confounders such as incorrect ECG dot placement and incorrect age and gender details entered into the monitor (9). There are multiple issues that occur when the choice is made to rely on a computer interpretation. There is a perceived issue with the current use of this technology. Anecdotally, there is a cohort of MICA paramedics that claim 'the Zoll is getting it wrong more often than it is getting it right...'. This results in a decreased level of trust by hospitals in Ambulance Victoria paramedics' ability to correctly identify STEMI, and decreased paramedic confidence in the Zoll monitor. Additionally, relying on a computer automated interpretation could be deskilling ALS paramedics due to a lack of skill utilisation. Consensus-based competency standards published by the American College of Cardiology and the American Heart Association suggest a minimum 500 of ECGs should be interpreted during initial training, with at least 100 ECGs yearly to maintain a certain level of competency (11). By using automated interpretation rather than clinical skills and decision making, paramedics could become entirely dependent on this technology, leading to a decline in clinical judgement and potentially even patient care. Assessment of the ACS patient requires extensive history taking, a good quality patient assessment and a 12-lead ECG. A computer interpretation alone may not account for an evolving myocardial infarction as the result of changing pathology and/or patient presentation. An ECG may have subtle changes that require serial ECGs, and these changes may indicate that the patient may require percutaneous coronary intervention (PCI) for an evolving infarct. These factors could all affect time to reperfusion and overall patient

outcomes. For these reasons, it is important to investigate current ECG recognition performance by paramedics, without the use of additional technology or external interpretation. The aim of this systematic literature review is to summarise the literature related to the ability of paramedics to interpret 12-lead ECGs in order to identify STEMI.

Methods

Formulation of the review

This systematic literature review was designed from the Preferred Reporting Items for Systematic Reviews and Meta-analysis Protocols (PRISMA) checklist (12). A modified Patient/Population, Intervention, Comparison, Outcome format was used to create the basis for the study design and search strategies (13). Paramedics were the population, ECG relating to STEMI was the intervention, there was no comparison and the outcome was the identification or interpretation of STEMI.

Eligibility criteria and screening

The chief investigator searched the electronic databases Ovid Medline, Ovid Emcare and CINAHL Plus using the search strategy provided in Table 1. The level of qualification that the paramedics held was not limited within this study, as there is no standardised degree or knowledge base worldwide. Publication

language was limited to English only, literature written before 2004 was not included for feasibility, and because these studies were unlikely to reflect current standards of practice for patients with suspected STEMI.

A two-stage process within the Covidence program was used for study selection. Covidence is an online based program that streamlines the production of systematic reviews by providing a platform for title, abstract and full text screening for multiple investigators (14). For this review, each article was blindly screened by two investigators. Initially the articles were screened by title and abstract only, and then the remaining using the full text against the inclusion and exclusion criteria (Table 2).

The literature had to be related to paramedics performing ECG interpretation to identify STEMI only, without any additional aids (eg. computer algorithm interpretation, telemedicine, transmission to physician for their interpretation). Any conflicts between the two parties during screening were resolved by discussion. To ensure all appropriate and available literature was captured, hand searching via Google Scholar and backward and forward reference searching of reviewed articles was completed. Reference management was performed using EndNote (version X8).

Table 1. Medline search strategy

P	PARAMEDICS	I	ECG + STEMI	O	DIAGNOSIS
1	Emergency medical technicians (MeSH)	12	ECG	26	Diagnos*
2	paramedic*	13	Electrocardiograph*	27	Recogni*
3	Emergency medical technician*	14	EKG	28	Interpret*
4	EMT	15	12 lead ECG	29	Read*
5	First responder*	16	12 – 15 Combined with OR 222,086		
6	Ambulance officer*	17	STEMI		
7	Medic*	18	ST elevation	30	26–29 combined with OR 5,464,553
8	Ambulance attendant*	19	ST elevation myocardial infarction		
9	EMS	20	Acute myocardial infarction		
10	Emergency Medical Services (MeSH)	21	AMI		
		22	Myocardial injury		
		23	Heart attack		
11	1 –10 Combined with OR 2,356,788				
		24	17–23 combined with OR 74,580		
		25	16 and 24 Combined with AND 15,568		
					Limit 2004 – current
				31	11, 25, 30 Combined with AND 1,713

Study quality assessment

Full text articles that met the inclusion criteria were then individually appraised by two investigators using the National Heart, Lung and Blood Institute; National Institutes of Health (NIH) tailored Study Quality Assessment Tools to determine the validity and potential flaws of each article (15). Some potential flaws include sources of bias, study power, methodology and strength of associated interventions and outcomes. This particular study quality assessment tool was chosen because it was simple to use and allowed two investigators to compare their results and discuss any variances. Articles were categorised as either 'good', 'fair' or 'poor' based on each reviewer's response to the items within the tool, and consensus was reached via discussion.

Table 2. Inclusion and exclusion criteria for title, abstract and full text screening

Inclusion criteria	Exclusion criteria
Articles that:	Articles that:
<ul style="list-style-type: none"> discussed paramedics related to ECGs in the setting of STEMI patient only occur in the out-of-hospital setting related to paramedic recognition and interpretation 	<ul style="list-style-type: none"> languages other than English published before 2004 related to how out-of-hospital ECGs affect hospital management related to how obtaining an ECG affects overall scene/treatment times related to either undergraduates/training/simulation based/survey based are unable to be accessed/located related to whether or not an ECG is simply obtained related to the transmission of ECGs/telemedicine for physician interpretation related to the use of automated ECG interpretation discusses physician's ECG interpretation related to the management of STEMI discusses in hospital/emergency department factors literature reviews only

Results

The initial search yielded 2621 results. Following the removal of 495 duplicates 2126 articles remained. After screening against the inclusion and exclusion criteria nine studies were included in the final review. The detailed screening process and article exclusion per stage has been presented as a PRISMA flow diagram (Figure 1), adapted from the PRISMA statement (12).

Study characteristics

The nine included articles are summarised in Table 3. Articles were conducted in the United States (n=4, 44%), Canada (n=4, 44%) and Australia (n=1, 11%), and study designs included observational studies (n=5, 55%), experimental studies (n=3, 33%) and retrospective studies (n=1, 11%). There were no randomised control trials. All literature included contained quantitative data.

Implementation of protocols and tools

A number of studies provided paramedics with additional STEMI based tools and/or protocols to assist with ECG interpretation and clinical decision making. Cantor et al performed a study with the County of Simcoe Paramedic Service in Canada, in which a protocol was implemented where paramedic identified STEMI patients were transported directly to PCI facilities (16). The results showed that 90% of primary care paramedics interpreted ECGs as STEMI positive where the patient did meet STEMI criteria (16). This study indicated that patients with suspected STEMI can be safely and effectively identified in the out-of-hospital setting and transported directly for primary PCI by paramedics. However, this study was categorised as poor quality according to the National Heart, Lung and Blood Institute NIH quality tool for a number of reasons (15). Over the study period, Cantor et al altered the population eligibility criteria and the protocol itself. The second eligibility criteria stated that STEMI interpretation could be undertaken by automated or paramedic interpretation. These two criteria are not dealt with or displayed independently in the results, so it is unknown how much of the success reported were 'paramedic interpreted'. This could have significantly altered the results and renders the overall study and results poor in quality, and at a high risk of bias (15). As such, the results from this study have minimal bearing on conclusions drawn about paramedic ECG interpretation for STEMI (15,16).

LeMay et al assessed the safety and feasibility of the Ottawa Paramedic Service's advanced care paramedics' interpretation of out-of-hospital ECGs and independently identify patients with STEMI (17). Before the commencement of the study, it was routine practice for paramedics to obtain a 12-lead ECG in the setting of chest pain that was considered potentially cardiac in nature. However, the study developed and implemented a protocol in which paramedics bypassed the nearest emergency department, opting for the PCI capable hospital, based on their ECG interpretation and criteria within the protocol. The study conducted by LeMay et al demonstrated that 83% of paramedic suspected STEMI were in fact confirmed STEMI by the cardiologist, and reports that paramedics can safely and independently triage patients with STEMI based on their interpretation of the out-of-hospital ECG (17). The study compared their data post implementation of the protocol against retrospective data and demonstrated a good quality rating according to the NIH quality assessment tool (15,17).

Figure 1. PRISMA flow diagram

In a separate study, LeMay et al assessed advanced care paramedics' accuracy in STEMI recognition using the implementation of a diagnostic tool (18). Paramedics would complete the tool based on their own interpretation in order to identify STEMI. This study indicated a sensitivity of 92% for STEMI recognition, specificity of 96% when STEMI was not suspected, a positive predictive value (PPV) of 82% and a negative predictive value (NPV) of 99%, concluding that paramedics can accurately interpret out-of-hospital ECGs to identify STEMI (18). This study was rated good quality according to the NIH quality assessment tool (15).

These three studies indicate that a set of criteria within a tool or protocol for paramedics to follow when identifying STEMI yields positive results. It works to strengthen paramedics' pre-existing clinical decision making by providing clear guidelines to indicate STEMI.

Provision of additional education

Of the nine studies included in the review, six provided

paramedics with some form of additional education. This included combinations of topics such as AMI, ECG use and electrode placement, 12-lead ECG interpretation and STEMI pattern identification, or a combination of the above.

Davis et al conducted a study to assess the PPV of the out-of-hospital 12-lead ECG when interpreted by paramedics versus emergency physicians (19). The study focused on a local emergency medical service (EMS) transporting STEMI patients to Palomar Medical Centre in California. Activation of a cardiac alert was based solely on the treating paramedic's interpretation of the 12-lead ECG. These paramedics received an additional 3 hours training on STEMI patterns. Confirmation of STEMI on the out-of-hospital 12-lead ECG demonstrated a sensitivity of 78% (19). Davis et al concluded that it is unclear whether a STEMI identification can be made based solely on the paramedic interpretation of the out-of-hospital 12-lead ECG.

Hutchison et al conducted a study through Ambulance Victoria, in which a full 12-lead ECG was performed by a MICA

paramedic in cases of suspected myocardial infarction (20). This would be interpreted by the MICA paramedic and wirelessly transmitted to a dedicated receiving hospital if STEMI was identified, where the ECG was assessed by the cardiologist or emergency physician. The 60 MICA paramedics involved received 4 hours of STEMI specific education before the commencement of the study. STEMI was confirmed in 58% of patients (20). This indicated that over 40% of patients with transmitted ECGs did not meet STEMI criteria. However, paramedics were not discouraged from sending ECGs that may be clinically helpful while not meeting STEMI criteria. This may have altered the data and statistics and could be one reason for the high percentage of seemingly incorrect interpretations.

Ducas et al describe a study in which ACPs provided the Canadian Winnipeg EMS personnel with 21 hours of additional training regarding STEMI management, ECG acquisition and interpretation (21). Patients' ECGs were assessed by paramedics alone and categorised as either indicative of STEMI or not indicative of STEMI. If STEMI was suspected, the ECG was wirelessly transmitted to the receiving hospital, or if deemed negative for STEMI by EMS, it was not transmitted. For suspected STEMI, paramedics demonstrated a sensitivity of 99%, a specificity of 68%, a PPV of 60% and an NPV of 99% (21). The study concluded that an EMS based out-of-hospital system of ECG interpretation and triage is safe and effective.

Feldman et al conducted a study to determine if paramedics can accurately identify STEMI on out-of-hospital 12-lead ECG. The authors compared paramedic ECG interpretation to that of blinded physicians (22). The Boston EMS paramedics completed a 6-hour training program regarding STEMI pattern recognition. Paramedics identified STEMI, and then two blinded readers (a cardiologist and emergency physician) independently categorised each out-of-hospital 12-lead to determine if it met STEMI criteria. Paramedics showed a sensitivity of 80%, specificity of 97%, PPV of 83% and NPV of 96%. This study concluded that paramedics can acquire out-of-hospital 12-lead ECGs and independently identify those patients with STEMI.

Both studies conducted by LeMay et al provided paramedics with an additional 8 hours of classroom training on the recognition of STEMI, followed by supervised training in the field (17,18). Both studies demonstrated that paramedics can identify STEMI on out-of-hospital ECGs. Conversely, the studies by Davis and Hutchinson both have the poorest results regarding paramedic 12-lead interpretation (19,20). Interestingly, both had the lowest number of additional training hours provided; 3 and 4 hours respectively. The remaining four studies have anywhere between 6 to 21 hours of additional training provided to paramedics. Results for the number of actual STEMIs correctly identified, or sensitivity, is much higher for the studies with higher training times. While not all studies outline complete and in-depth data, the specificity, or the

number of true negatives identified, is quite high for Feldman and LeMay; as is their PPV (the probability that patients with a positive screening test truly have a STEMI diagnosis) (18,22).

Assistance of computer automated interpretation

Lee et al undertook a study in the US with a regional EMS service in which STEMI criteria was met when there was a paramedic interpretation of STEMI, as well as a computer interpreted printout statement of STEMI (23). These two criteria are not dealt with or displayed independently in the results, so it is unknown how accurate paramedics are at solely identifying STEMI using out-of-hospital ECGs. In this way, while the study appears to meet the selection criteria, the results are not displayed appropriately to distinguish between a paramedic or computerised interpretation. Furthermore, the sample size of only 25 patients is much too small to achieve statistical significance and draw conclusive results. These factors render the overall study as poor in quality according to the NIH tool, and cannot be used within this review as reliable findings (15).

Zoll Inovise 12L Interpretive Software

The data within the nine studies included, compared with that of the Zoll published statistics of their Inovise 12L Interpretive Algorithm Statement of Validation and Accuracy, still shows results mostly in favour of the computerised interpretation (Table 4) (9). However, within the Zoll statement there is no description of research methods or study design, nor is there any report of their results making it difficult to assess their published statistics for validity and reliability. Furthermore, while it appears from the published statistics that the Zoll Interpretive Software would still identify STEMI with more accuracy than most paramedics, it does not account for confounding factors, eg. incorrect ECG dot placement, incorrect age and gender details entered, artefact, or any other errors (9). When these range of factors are present the Zoll statistics are shifted (as seen in Table 4). The out-of-hospital setting by nature can be riddled with confounding factors, such as vehicle movement causing artefact on ECG tracing, or poor environment related accessibility to patients that could affect lead placement. These factors could alter automated data and therefore ECG interpretation may lend itself more to a model in which paramedic ECG interpretation is preferred; especially when there are other factors besides ST-elevation which can indicate an infarct. Ultimately, paramedic ECG interpretation is a topic that requires further exploration, transparency and research.

Discussion

Nine relevant studies were identified that examined the ability of paramedics to identify STEMI on out-of-hospital ECGs. Three studies demonstrated the use of protocol implementation, which strengthened paramedics' pre-existing clinical decision making by providing clear guidelines to indicate STEMI. Six studies provided paramedics with advanced additional education regarding STEMI identification,

Table 3. Summary of included articles

Study Author/ year	Location	Study design	Population (n) and participation requirements	Method	NIH	Results
Cantor et al, 2012	Canada	Prospective observational study	Paramedics (advanced care) (134 patients) Mandatory	Quantitative	Poor	90% of paramedics interpreted STEMI identifications correctly Patients with suspected STEMI can be safely and effectively identified in the out-of-hospital setting and transported directly for primary PCI by paramedics
Davis et al, 2007	US	Prospective, observational study	Paramedics (54 patients) Mandatory	Quantitative	Fair	78% of paramedics interpreted STEMI identifications correctly Unclear whether STEMI identification can be made based solely on the paramedic interpretation of the out-of-hospital 12-lead ECG
Ducas et al, 2012	Canada	Observational cohort study	Paramedics (703 patients) Mandatory	Quantitative	Fair	99% of paramedics interpreted STEMI identifications correctly EMS-based out-of-hospital system of ECG interpretation and triage is safe and effective Sensitivity: 99.56 Specificity: 67.93 NPV: 99.69 PPV: 60.00
Feldman et al, 2005	US	Prospective observational study	Paramedics (151 patients) Mandatory	Quantitative	Good	80% of paramedics interpreted STEMI identifications correctly Paramedics can acquire out-of-hospital 12-lead ECGs and independently identify those patients with STEMI Sensitivity: 80% Specificity: 97% PPV: 83% NPV: 96%
	Australia	Prospective interventional study	Paramedics (intensive care) (204 patients) Voluntary elective	Quantitative	Good	58% of paramedics interpreted STEMI identifications correctly Unable to draw conclusions from data
LeMay et al, 2006	Canada	Experimental pilot study	Paramedics (130 patients) Mandatory	Quantitative	Good	83% of paramedics interpreted STEMI identifications correctly Concludes paramedics can independently triage patients with STEMI based on their interpretation of the out-of-hospital ECG
LeMay et al, 2006	Canada	Experimental	Paramedics (advanced care) (411 patients) Mandatory	Quantitative	Good	92% of paramedics interpreted STEMI identifications correctly Paramedics can accurately interpret out-of-hospital ECGs to identify STEMI Sensitivity: 92% Specificity: 96% PPV: 82% NPV: 99%
Lee et al, 2010	US	Prospective, observational study	Paramedics (12 patients)	Quantitative	Poor	92% of paramedics interpreted STEMI identifications correctly Paramedics in the field can detect STEMI using out-of-hospital ECGs
Young et al, 2011	US	Retrospective study	Paramedics (63 patients)	Quantitative	Good	75% of paramedics interpreted STEMI identifications correctly Paramedics with quality ECG interpretation training and education can identify patients with STEMI

Table 4. Key statistics from included studies and Zoll publications

Study (Author/year)	Sensitivity	Specificity	Positive predictive value
Cantor et al, 2012	90.00	N/A	N/A
Davis et al, 2007	78.00	N/A	N/A
Ducas et al, 2012	99.00	68.00	60.00
Feldman et al, 2005	80.00	97.00	83.00
Hutchison et al, 2009	58.00	N/A	N/A
LeMay et al, 2006	83.00	N/A	N/A
LeMay et al, 2006	92.00	96.00	82.00
Lee et al, 2010	92.00	N/A	N/A
Young et al, 2011	75.00	N/A	N/A
Zoll Inovise 12L Interpretive Algorithm (no confounders)	89.00	100.00	98.00
Zoll Inovise 12L Interpretive Algorithm (confounders)	77.00	99.00	97.00

and this resulted in a higher degree of accuracy regarding STEMI recognition. Not all studies included in the review were of high quality, and therefore hard conclusions cannot be drawn. However, trends across the studies remain in favour of safe and reliable paramedic identification of STEMI.

Proposals for future research

Moving forward, research regarding the accuracy of Ambulance Victoria paramedics' overall identification of myocardial infarction, including STEMI, would be an insightful project. Furthermore, investigation into how often the Zoll Inovise 12L software is actually identifying STEMI incorrectly or correctly in the field would prove extremely helpful. These results could be compared in order to demonstrate the accuracy of paramedics, as well as the Zoll software for STEMI interpretation.

Limitations

Despite undertaking a rigorous systematic approach to this review, all relevant literature may not have been identified. The exclusion of non-English publications and studies that were unable to be located or accessed could have excluded potentially relevant studies. Some articles were rated as 'poor' quality studies, somewhat limiting the strength of the overall conclusions. While reviewing the articles, it was noted that because of the lack of standardised training for paramedics, there is a range of qualification and knowledge level across the three countries. This difference does present a level of difficulty when comparing the studies to one another. Furthermore, specific detail of the training provided to paramedics was not reported within the studies, so this was unable to be compared accurately. As a selection of studies within this review have certain setbacks and limitations, the number of fair and good quality studies is quite small, intensifying the need for further research.

Conclusion

Seven of the nine articles have a strong general consensus that paramedics have the ability to independently interpret 12-lead

ECGs in order to identify STEMI. Furthermore, it seems that the more training and practice opportunity provided to paramedics, the greater their ability to accurately interpret STEMI on an ECG. Several studies implement STEMI specific protocols or tools for paramedics, and this also demonstrates an increased ability to identify STEMI in the out-of-hospital setting. While the computerised options for STEMI interpretation are increasing with advancing technology, paramedic or human-based ECG interpretation should not be cast aside. Clinical reasoning and decision making are a vital part of ACS and STEMI care, and should be maintained by paramedics as they are core concepts within the paramedic skillset. The paramedic interpretation of a 12-lead ECG should be informed by knowledge and clinical judgement, rather than complete reliance on an automated algorithm.

Competing interests

The authors declare no competing interests. Each author of this paper has completed the ICMJE conflict of interest statement.

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