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Review

The regional resuscitation guidelines for pulseless electrical activity in emergency medical services in the United Kingdom: a systematic review

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Abstract

Background
Pulseless electrical activity (PEA) is managed in accordance with international and national guidelines. These guidelines are not fully evidenced, resulting in emergency medical services in the United Kingdom amending the guidelines to support paramedics when making resuscitation decisions. This review examined the local guidelines of services to identify the local clinical management of PEA, summarise the available evidence and prioritise future research.

Methods
The review was conducted according to the Joanna Briggs Institute systematic review of text and opinion. The review included locally amended guidelines and cited evidence for the management of PEA. A three-step search strategy was applied. Textual data was extracted to form conclusions which were categorised into similar meaning and developed into synthesised findings.

Results
Twenty-two documents met the inclusion criteria; Twenty-seven conclusions were extracted and analysed to generate 10 categories, forming three synthesised themes: the variability in the clinical management of PEA between ambulance services; the early identification of reversible causes and appropriate treatment options to increase survivability; and the consensus for further research.

Conclusion
This review identified variability in the clinical management of PEA; the autonomy of paramedics, which patients to transport to hospital and the factors applied to inform resuscitation decisions. A summary of the evidence in support of the local guidelines found that the early identification and treatment to reverse the cause of PEA was important to patient survival, however, this was acknowledged as complex and challenging to achieve. There was a consensus to improve patient outcomes using prognostic research.

Keywords:
ambulance services; emergency medical services; out-of-hospital cardiac arrest; paramedic; pre-hospital resuscitation; pulseless electrical activity; United Kingdom guidelines

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Introduction

In 2018, emergency medical services (EMS) in the United Kingdom attempted resuscitation in 22,631 patients in cardiac arrest. Despite considerable efforts to improve patient survival, outcomes following cardiac arrest remain poor. The UK out-of-hospital cardiac arrest (OHCA) registry reported an average survival to hospital discharge at 9.3% in 2018. Survival was highest among patients with a shockable rhythm (29.7%). The non-shockable rhythms, asystole had the poorest survival (1.6%) compared to pulseless electrical activity (PEA). The incidence of PEA has risen from 19.8% in 2015 with 3.8% of patients surviving to hospital discharge to 32.7% in 2018 with 5.3% of patient surviving (1). Despite this increase, the survival of cardiac arrest patients with PEA with good neurological function remains poor, with one study in Australia reporting no improvement to patient survival for over 10 years (2). For this reason, PEA is of interest and subject to an increasing research focus (3).

In the UK, EMS systems consist of 14 ambulance services that apply national guidelines published by the Joint Royal Colleges Ambulance Liaison Committee (JRCALC) and the Association of Ambulance Service Chief Executives (AACE). These guidelines follow the UK and European Resuscitation Councils, drafted from the Consensus of Science with Treatment Recommendations statements published by the International Liaison Committee on Resuscitation.

PEA is managed in accordance with basic and advanced life support (ALS) guidelines for the resuscitation of non-shockable OHCA patients (4). These guidelines highlight several prognostic factors to help identify those patients most likely to achieve return of spontaneous circulation (ROSC) or when resuscitation as a treatment is unlikely to succeed (5). The key factors to consider when making a resuscitation decision are the identification of reversible causes, no flow time, co-morbidities, end-tidal carbon dioxide (ETCO2) trend and QRS morphology (7). The JRCALC/AACE guidelines acknowledge the inherent challenges of managing OHCA patients with PEA and advocate senior clinical advice to support resuscitation decisions. However, the lack of evidence has resulted in EMS in the UK amending these national guidelines to support paramedics when making a resuscitation decision for PEA (8).

The purpose of this review was to analyse the clinical practice of EMS in the UK to see if or how local clinical guidelines have been developed, and to identify and summarise the cited reference sources for the management of PEA. As high-quality evidence in this area is limited, this systematic review will focus on evidence derived from text and opinion (9). A preliminary search of PROSPERO, MEDLINE, the Cochrane Database of Systematic Reviews and the JBI Evidence Synthesis was conducted and no current or underway systematic reviews on the topic were identified.

Methods

This review was conducted in accordance with the Joanna Briggs Institute (JBI) for systematic review of text and opinion (9) according to a priori published protocol (10). The review is registered on the international prospective register of systematic reviews (CRD42019138731). Ethical approval was not required as this review included secondary sources of evidence.

Review question

What is the resuscitation management of adult pulseless electrical activity out-of-hospital cardiac arrest by emergency medical services in the United Kingdom?

Inclusion criteria

This review considers text and opinion that includes guidelines for adult OHCA patients with PEA of presumed medical origin. Local clinical guidelines, narrative summaries of practice recommendations and cited reference sources were included. Cited evidence sources over 10 years were excluded. Only clinical practices from the UK were considered, as the EMS in other countries apply different clinical practices (11).

Search strategy

The search strategy aimed to locate published and unpublished local guidelines. A three-step search strategy was applied. First, an initial search of UK ambulance websites was undertaken to identify published local guidelines or associated guidelines. Website searches occurred between August 2020 and October 2020 and included:

- South Central Ambulance Service National Health Service (NHS) Trust
- South Western Ambulance Service NHS Foundation Trust
- East of England Ambulance Service NHS Foundation Trust
- London Ambulance Service NHS Trust
- Yorkshire Ambulance Service NHS Trust
- West Midlands Ambulance Service University NHS Foundation Trust
- Welsh Ambulance Service NHS Trust
- Isle of Wight Ambulance Service
- North West Ambulance Service NHS Trust
- Scottish Ambulance Service
- South East Coast Ambulance Service NHS Foundation Trust
- North East Ambulance Service NHS Foundation Trust
- East Midlands Ambulance Service NHS Trust
- Northern Island Ambulance Service Health and Social Care Trust.

If local guidelines could not be accessed using the ambulance website, a written request was submitted through contacts of the National Ambulance Research Steering Group. In the absence of guidelines, a narrative summary of practice recommendations were requested. Second, documents referenced within the local guidelines specific to PEA were identified as supporting literature. Third, documents referenced in the supporting literature with PEA in the title or abstract were identified.

Data collection

All identified documents were collected and uploaded into Mendeley 1.19.4 (12). Titles and abstracts were screened by two independent reviewers for assessment against the eligibility criteria. Documents that did not meet the eligibility criteria were excluded and reasons documented. Any disagreement that arose between reviewers were resolved through discussion or a third reviewer. This review was conducted under the systematic review registration number CRD42019138731.

Assessment of methodological quality

Eligible documents were critically appraised by two independent reviewers for methodological quality using the JBI critical appraisal checklist for text and opinion (9). The selected documents were appraised to establish trustworthiness by vetting opinions, credibility of the source, motives and context. Any disagreement that arose between the reviewers were resolved through discussion or by a third reviewer.

Data extraction

Textual data were extracted from the documents by two independent reviewers using the JBI data extraction fields comprising of: types of text, population represented, context, summary of the document, main findings, the reviewers conclusions and notes (9). The documents were read to ensure the extracted data included specific details on the resuscitative management of adult OHCA patients with PEA. The conclusions found were extracted from each document and tabulated to start the process of data extraction and synthesis. The validity of the conclusions was categorised during data extraction and assigned a level of credibility: 'unequivocal evidence' for conclusions that were beyond doubt; 'credible evidence' for conclusions that seemed reasonable opinion, albeit open to interpretation and 'not supported evidence' for conclusions not supported by data. Disagreement that arose between the reviewers were resolved through discussion or by a third reviewer.

Textual data synthesis

Documents were pooled using a meta-aggregation approach. This involved the synthesis of findings to generate a set of conclusions that were categorised according to their similarity of meaning. Conclusions with a similar meaning were categorised to create a comprehensive set of synthesised findings. Data were extracted and categorised by the lead author. The categories were checked by all reviewers to ensure appropriate placement of the synthesised findings. Any disagreements were resolved through discussion.

Assessing confidence in the findings

This review is an analysis of guidelines or narrative summary of practice recommendations (in the absence of guidelines) and cited evidence sources. Where possible the final synthesised findings were graded according to the ConQual approach for establishing confidence. The summary of findings table included the synthesised findings of the review, type of text, dependability, credibility and the overall ConQual score.

Results

Description of documents

A website search found three out of the 14 ambulance services had a local guideline for the resuscitation management for PEA. The remaining services were contacted and nine replied. Two of these services provided a local guideline for PEA, seven services had no local guideline, however, they provided a narrative summary of recommended clinical practice.

Table 1. Local ambulance service documents

Ambulance service documents	Q1 Source clearly identified	Q2 Source acknowledged as expert	Q3 Interest in relevant population	Q4 Analytical process of the opinion expressed	Q5 Reference to literature	Q6 Incongruence with the literature
AS1	Y	Y	Y	Y	Y	Y
AS2	Y	Y	Y	U	Y	Y
AS3	U	U	Y	U	N	Y
AS4	Y	Y	Y	U	N	Y
AS5	Y	Y	Y	U	Y	Y
AS6	Y	Y	Y	U	Y	Y
AS7	U	U	Y	U	Y	Y
AS8	Y	Y	Y	U	Y	U
AS9	Y	Y	Y	Y	Y	Y
AS10	Y	Y	Y	Y	Y	Y
AS11	Y	Y	Y	Y	Y	Y
AS12	Y	Y	Y	U	Y	Y
% of yes	83.3	83.3	100	33.3	83.3	91.6
AS = ambulance service; Y = yes; N = no; U = unsure						

In total, five services had a local clinical guideline for the management of PEA of which three included a termination of resuscitation checklist. All local guidelines were amended from JRCALC/AACE clinical guidelines.

The five local guidelines yielded 13 references. Nine references were excluded as they contained no information about PEA. The four remaining references were national guidelines (n=3) and a proposed teaching tool for the management of PEA (n=1). These four documents cumulatively cited 235 references of which six contained information about PEA in the title or abstract. A flow chart of search results is presented in Figure 1.

Methodological quality

The methodological quality of each document was assessed (9). The majority of documents were based on expert opinion and assessed as sufficient to be included in the review (Table 1).

The overall quality domains ranged from 100% for Q3 to 33.3% for Q4. Q4 refers to the analytical process and the logic in the opinion expressed and due to the limited rationale, this quality domain was assessed as low.

A total of 10 references were included in this review (Table 2).

The quality domain was low in Q5 (50%). Q5 referred to the reference to literature. This domain was assessed as low, having limited references to underpin the opinions expressed (Table 5).

Findings of the review

Twelve local ambulance documents and 10 references meant that 22 documents were included in this review. These documents produced 27 conclusions, supported by illustrative quotes. The conclusions were assembled by similar meaning and classified into 10 categories. The categories were aggregated to represent three synthesised findings and a level of credibility was assigned (Table 3).

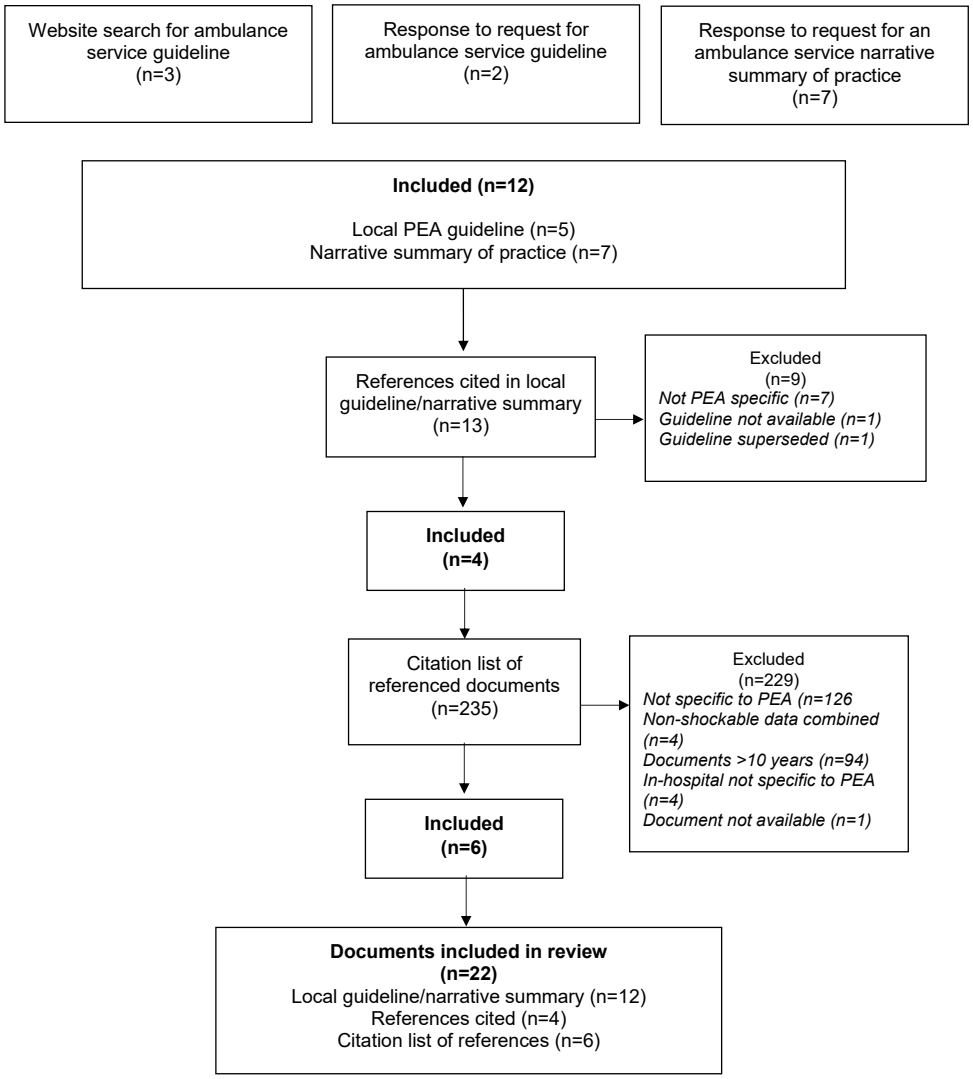

Figure 1. Search results, selection and inclusion process

Table 2. References cited in the local ambulance service documents

Reference	Q1 Source clearly identified	Q2 Source	Q3 Interest in relevant population	Q4 Analytical process of the opinion expressed	Q5 Reference to literature	Q6 Incongruence with the literature	Narrative summary
UK Resuscitation Council ALS guidelines, 2015 (2)	Y	Y	Y	Y	Y	Y	Guideline that informs UK paramedic practice
British Medical Association, 2016 (14)	Y	Y	Y	Y	Y	Y	Guideline
Association of Ambulance Chief Executives, 2019 (7)	Y	Y	Y	Y	Y	Y	Guideline that underpins UK paramedic practice
Littmann, Bustin, Haley, 2014 (15)	Y	Y	Y	Y	Y	Y	Training tool from expert opinion. Not validated in the pre-hospital or in-hospital setting
Myerburg, et al, 2013 (17)	Y	Y	Y	N	N	Y	Report by the National Heart, Lung and Blood Institute workshop. Expert opinion, identifying future research opportunities. Not specific to the pre-hospital setting
Mehta, Brady, 2012 (18)	Y	Y	Y	N	N	Y	Case study review from expert opinion. ECG clues can be determined for termination of resuscitation. Not validated
Saarinen, et al, 2012 (19)	Y	Y	Y	Y	N	Y	Retrospective cohort study of 104 adult patients. Norway, three sites. In-hospital and not externally valid
Arrich, et al, 2012 (20)	Y	Y	Y	Y	N	Y	Retrospective cohort. Vienna, single site. Limited internal validity as PEA and asystole data combined
Prosen, et al, 2010 (21)	Y	Y	Y	Y	U	Y	Pilot study of retrospective and prospective data. Belgium, two sites. Two groups not well balanced, some external validity, however, a range of different clinical skills identified
Nordseth, et al, 2012 (23)	Y	Y	Y	Y	Y	Y	Randomised control trial of 174 patients. Oslo, single site. Not blinded. Patients allocated to adrenaline vs. no adrenaline group, 59 patients excluded due to missing data
% of yes	100	100	100	80	50	100	
Y = yes; N = no; U = unsure							

Synthesis 1: National variation between emergency medical services in the clinical management of cardiac arrest patients with pulseless electrical activity in the United Kingdom

Thirteen conclusions were grouped into five categories and synthesised to form the national variation between EMS in the clinical management of PEA (Table 4). The categories in this synthesis related to the clinical autonomy of paramedics, the decision-making support from senior paramedics, transporting cardiac arrest patients with PEA to hospital, termination of resuscitation and decision-making factors.

A variation in the resuscitative management of PEA was identified between the local documents of ambulance services in the UK. This variation included the clinical autonomy of paramedics. The majority of services did not allow paramedics to terminate resuscitation without the support of a senior clinician (AS1-7,10-12). This enhanced support was available

Table 3. Summary of findings

UK ambulance service resuscitation management of pulseless electrical activity: a systematic review of text and opinion				
Synthesised finding	Type of research	Dependability	Credibility	ConQual score
There is national variation in the clinical management of cardiac arrest patients with PEA treated by emergency medical services in the UK	Text and opinion	Downgraded 2 levels**	Downgraded 2 levels**	Very low
Reversible causes of PEA when identified and treated early increase survivability. This is challenging to achieve out of hospital	Text and opinion	Downgraded 2 levels**	Downgraded 1 level*	Low
UK guidelines have a limited evidence base therefore PEA warrants further research to improve patient outcomes	Text and opinion	Downgraded 2 levels**	Downgraded 1 level*	Low
PEA = pulseless electrical activity *Downgraded 1 level as mostly credible findings from expert opinion and limited methodological evidence **Downgraded 2 levels as dependability issues across the documents, mostly based on expert opinion with no underpinning evidence or acknowledgement of influence				

Table 4. National variation between EMS in the clinical management of cardiac arrest patients with pulseless electrical activity in the UK

Conclusion	Category	Synthesised finding
Senior clinicians terminate resuscitation in most ambulance services (C)	Clinical autonomy of paramedics	There is national variation between EMS in the clinical management of cardiac arrest patients with pulseless electrical activity in the UK
Decision making support is provided by senior clinicians (C)	Senior clinicians providing decision-making support to paramedics	
Enhanced support from critical care is available in most ambulance services (C)		
Senior paramedics have a management plan for PEA (C)		
Due to the risk of low flow PEA is often transported to hospital (C)	Transporting cardiac arrest patients with PEA	
Best interest decisions are allowed (U)		
Patients are conveyed to hospital to eliminate reversible causes (C)		
Variation in local termination of resuscitation checklists (C)	Termination of resuscitation criteria	
Multiple factors are considered in local termination of resuscitation checklists (C)		
Factors to consider when making resuscitation decisions (C)	Decision-making factors	
The causes of PEA can be challenging to identify (C)		
No flow versus low flow (C)		
Stopping resuscitation is complex (C)		

throughout all participating services, of which, two provided the senior clinician with a PEA management plan or termination of resuscitation checklist (AS2,3). The checklists incorporated multiple factors, however, a number of variations between factors within the checklists were found. One checklist stated an ETCO2 below 1.5 kpa, resuscitation duration more than 30 minutes and no ROSC (AS7). These values differed from another checklist which stated an ETCO2 below 1.2 kpa and a resuscitation duration more than 20 minutes (AS8). The value of these factors to inform decision-making was not supported by the referenced literature (4,15,24).

The risks of terminating resuscitation were highlighted in three different local documents (AS1,3,9). The challenges of differentiating between the categories of PEA, a 'no flow' versus a 'low flow', were considered too great for one service who transported all patients to hospital to fully exclude cardiac output (AS1). The cited references suggested that multiple factors coupled with the correct identification and treatment of reversible causes, add to the complexities and challenges of managing PEA (14).

Synthesis 2: Reversible causes of pulseless electrical activity, when identified and treated early, increase survivability; however, this is challenging to achieve out of hospital

Eight conclusions were grouped into three categories and synthesised to find the challenges of identifying and treating the reversible causes of PEA, required to increase survivability (Table 5). The categories of this synthesis related to best interest decision-making, patient survivability and the challenges of appropriate treatment options.

Local service documents agreed that resuscitation should not be attempted in progressive or terminal illness or a natural death (AS1,2,9). How to identify a an end of life event resulting in PEA was not discuss beyond this. The local documents and reference lists did identify a number of factors known to increase the chance of patient survival. QRS morphology was factored into several local guidelines (AS1-3,9). One cited reference suggested that PEA should be managed according to the category, a wide or narrow QRS, however, this approach was not validated for clinical practice (15). PEA was also defined as true or pseudo (15), primary or secondary (13). There was no acknowledgment in the local service documents on how to manage these different categories.

The aim of specific treatments for PEA were to progress the patient into a shockable rhythm or to achieve ROSC. ROSC was more readily achieved by administering adrenaline, however, increased doses increased patient instability, poor neurological outcomes and in-hospital deaths (18). Identifying the cause and appropriate management of PEA was reported to increase patient survival (13). However, not all causes could be addressed with ALS and identifying this in the early stages of resuscitation was found to be complex and challenging (14).

Synthesis 3: United Kingdom guidelines have a limited evidence base and therefore, pulseless electrical activity warrants further research to improve patient outcomes

Table 5. Reversible causes of pulseless electrical activity, when identified and treated early, increase survivability

Conclusion	Category	Synthesised finding
Allowing a natural death (U)	Best interest decision-making	Reversible causes of PEA when identified and treated early increase survivability. This is challenging to achieve out of hospital
Identifying an end of life event (C)		
Identify and treat the reversible causes (C)	Patients can survive PEA	
Specific factors should be considered (C)		
Cause-specific treatment is more effective (C)		
Resuscitation cannot treat all causes of PEA (U)	Challenges of treatment	
Causes of PEA are challenging to identify (C)		
Appropriate clinical treatments are challenging (C)		

Table 6. Guidelines in the UK have a limited evidence base for the management of pulseless electrical activity

Conclusion	Category	Synthesised finding
Non-shockable rhythms are documented as unfavourable (C)	Current evidence base	UK guidelines have a limited evidence base and therefore, PEA warrants further research to improve patient outcomes
A limited evidence base (C)		
PEA warrants research (C)		
PEA outcomes could be improved (C)	Future research priorities	
Prognostic research is required due to the complexities of PEA (C)		
Pilot data on PEA is required (C)		

Six conclusions were grouped into two categories and synthesised to form the limited evidence base which underpin UK guidelines and the research focus required to improve patient outcomes (Table 6). The categories of this synthesis related to the current evidence base and future research priorities.

In the absence of a reversible cause, local service documents and cited references suggested that patient survival was unlikely (AS1,2,3,7,8) (4,14). The limited evidence base and the need for further research was congruent between the local ambulance documents and cited references. One approach suggested that the future management of PEA looked beyond the traditional 4Hs and 4Ts (13). Factors such as optimal adrenaline dose (14,16), electrocardiogram prognostication (17), the impact of co-morbidities (13) and QRS morphology (15) require a better understanding on the impact on patient outcomes. It was suggested that pilot research studies focussing on prognostic and therapeutic improvements were required to justify larger clinical trials (13).

Discussion

This is the first known review of EMS guidelines and recommended clinical practices when resuscitating cardiac arrest patients with PEA in the UK. The services included in this review adopted the national JRCLAC/ACCE clinical guidelines (7). Five services locally amended the guideline, however, most provided senior clinical support, with the majority not supporting termination of resuscitation without seeking this advice. For one service in the UK, a previous study identified senior clinicians were involved in the care of only 6% of PEA patients who died at the scene of the cardiac arrest. The reason for this limited involvement was unclear and should be considered in the development of future guidelines (25).

The local guidelines and recommended clinical practices introduced a variation in the clinical autonomy of paramedics, when to transport patients, the factors considered important to decision-making and when to terminate resuscitation. Variation in clinical practice when managing out of hospital cardiac arrest patients is not new and previous studies highlighted the difference in regional termination of resuscitation criteria (26). A previous systematic review and meta-analysis on termination of resuscitation also highlighted clinical variation in the diagnostic performance of criteria. For this reason, local criteria validation was recommended to prevent the termination of resuscitation in potential survivors (27).

The preparedness of EMS staff implementing such criteria was considered in a scoping review. The review found staff feeling inadequately prepared to terminate resuscitation, manage the patient death with more training and research required to support the challenges of decision-making (28). That said, a previous study looked at the impact of a new resuscitation guideline for non-shockable rhythms, to find patient outcomes improved (29). This study demonstrated the potential to improve outcomes for PEA, not by focussing on termination of resuscitation considered by the checklists included in this review, but by focussing on survivability.

When not to attempt resuscitation was agreed between the guidelines and cited references, although there was limited information on how to identify this. Identifying patients when resuscitation should not be attempted was previously examined within the ethical guidelines using the experiences of EMS clinicians (30). Multiple factors should be considered; severe neurological damage and age, mortal injury, unwitnessed cardiac arrest and no bystander resuscitation following 15 minutes of asystole or end stage of an irreversible condition with a life expectancy below six to 12 months. It was found acceptable to start resuscitation and subsequently withhold following a gathering of information to inform the patient's history. This finding suggests future guidelines should contain clear information on when not to attempt resuscitation for PEA.

In this review the risks of terminating resuscitation in a patient with a low cardiac output was considered a deciding factor, albeit referenced by a limited number of services. Identifying low cardiac output pre-hospital was previously acknowledged as challenging, with electrocardiogram, capnography and ultrasound collectively found to support diagnosis (31).

Ultrasound is not routinely supported in UK paramedic practice, however, it is vital low flow patients are correctly identified to ensure appropriate treatment (32). Although there is a lack of pre-hospital research, in-hospital studies found early diagnosis of low cardiac output, alternatively known as pseudo PEA may increase the rate of survival (33). In this review, one service felt the risk of terminating resuscitation in PEA with low output too great and therefore, transported all patients to hospital. This is one example of the challenges presented when managing PEA and why services in the UK, guided by the JRCALC provide senior clinicians to support resuscitation decisions.

Overall, patient outcomes following PEA, in the absence of a reversible cause were viewed as poor. The challenges of how to identify the cause and the appropriate treatment options have already been highlighted. However, the cited references stated that improvements to patient outcomes could be made through further research (13,17). In the literature, a number of factors were highlighted as future research priorities.

Prognostic research focussing on QRS morphology, end tidal carbon dioxide, resuscitation duration and the clinical management of different PEA categories may be helpful to inform pre-hospital resuscitation decisions. Further research was seen as vital to improve the survival of patients, as over recent years there has been little improvement, national clinical guidelines are mostly unchanged, yet the incidence of PEA has increased year on year (1)

Potential limitations

Relevant text may have been excluded as data was missing from two ambulance services. The vast majority of the documents contained limited information regarding PEA, and this is reflected by the number of conclusions extracted. Of the cited references in the supportive literature the title and abstracts were screened, however, this method may have missed relevant data on PEA in the main body of the text. Issues of validity concerning the analytical process of the opinion expressed and the extent of references cited in the supportive literature and narrative summaries were identified. The impact of guidelines on patient outcomes were not reported. Furthermore, there was no discernible evidence of patient involvement by ambulance services when developing the guidelines.

Conclusion

This review identified variability in the clinical management of PEA across ambulance services in the UK; the clinical autonomy of paramedics, which patients to transport to hospital and the factors applied to inform resuscitation decisions. There was also limited information on how to identify patients when resuscitation should not be attempted. A summary of the evidence cited in support of the local guidelines found that the early identification and treatment to reverse the cause of PEA was important to patient survival, however, this was acknowledged as complex and challenging to achieve. There was a consensus in the paucity of evidence and the potential for future prognostic research to improve patient outcomes.

Implications for practice
From the results of this review five implications for clinical practice may be considered and each were graded according to the JBI Grades of Recommendation (34).

1. In circumstances when guidelines are not applicable, the resuscitation team should consider all available factors associated with PEA, with early discussions between the paramedics on scene and/or senior clinician for shared decision-making (Grade B).

This relates to the multifactorial approach to making resuscitation decisions, however, due to the limited research, decision-making support is recommended to ensure those patients with a chance of survival are resuscitated and transported to hospital.

2. A low threshold for early transport to hospital should be considered as there is a risk of patients with a low cardiac output having resuscitation terminated at the scene of the cardiac arrest (Grade B).

This relates to the challenges of identifying the cause of PEA, the lack of clarity between the categories of PEA and appropriate specific clinical treatment options available in the pre-hospital environment.

3. Resuscitation should focus on the early identification of reversible causes, considering additional resources or transport to hospital if causes cannot be managed in the pre-hospital environment (Grade B).

This relates to the complexities and challenges of identifying the reversible causes of PEA.

4. Clarification on best interest decision-making for PEA is required in order to support EMS clinicians to not attempt resuscitation (Grade B).

This relates to the guidelines referring to a natural end of life with limited guidance on how to identify these patients.

5. The collection and analysis of data for PEA is required to help inform the future resuscitation management in the pre-hospital environment to reduce the variation in clinical practice (Grade B).

This relates to the limited evidence and subsequent variation in the local guidelines of ambulance services for the management of PEA.

Implications for research
There is an acknowledged paucity of research for the management of PEA, despite a growing rate of incidence. Research is challenging as identifying the cause of cardiac arrest in the pre-hospital environment and specific treatment options are limited. Previous research has analysed small sample sizes, merged non-shockable rhythm data and focussed on terminating resuscitation rather than patient survivability. A collaboration of services, to collect data, explore the qualitative aspects of PEA management and involve patients would be helpful to address the variation in clinical guidelines and practice found in this review.

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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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