

# The Perception of Emergency Medical Staff on the Use of Electronic Patient Clinical Records Systems in Emergency Medical Service: A Systematic Review

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## ABSTRACT

**Background:** The electronic recording of patient information in ambulance services has provided healthcare professionals with the ability to send patient data to their GP or other relevant services electronically. It is critical to comprehend how paramedics view and adjust to electronic platforms as technology continues to advance. **Objective:** To identify the facilitators and barriers EMS staff encounter when using e-PCR. To explore the overall perception of EMS staff towards the utilization of e-PCR in EMS settings. **Method:** Four databases were searched including PubMed, Scopus, Medline and Science Direct. Result: All 11 publications were evaluated for qualitative data and the publication was found to be of fair or good quality. Studies investigating the perception of staff found mixed perceptions. The search generated a total of 1365 potential articles. After the initial screening process, 229 duplicate records were removed. Out of the remaining 1136 papers, 1079 were excluded as they did not meet the selection criteria (the title, abstract, and keywords). Of the remaining 57 papers, a full-text screening eliminated 46 for: the study design (quantitative studies) (n=22), no perception of staff documented (n=19) and no full text available (n=5). Thus, 11 papers that met the inclusion criteria were selected for final analysis. The risk of bias was quantified using CASP. A qualitative synthesis was conducted and three major themes emerged: Facilitators, Barriers and overall perception of staff. **Conclusion:** This systematic review found that EMS staff hold complex and diverse views on e-PCR systems. While several facilitators and barriers impact e-PCR adoption, it has been found that e-PCR has the potential to enhance documentation, communication, data-driven decision making and finally the ability to improve overall patient care quality. To ensure successful adoption, addressing technical issues, data security and training requirements and organisational barriers is important.

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**KEYWORDS:** *electronic health record, EHR, electronic patient care record, e-PCR, perception of paramedics, emergency medical staff, pre-hospital setting, ambulance service, EMS*

## 1. INTRODUCTION

The emergency medical services is a crucial component of the healthcare system. Emergency medical services (EMS) play a vital part in providing care to patients with both immediate and long-term medical conditions as well as for those who require assistance with social and mental health issues (Zorab et al., 2015).

An electronic patient care record (e-PCR) is largely used for planning patient care, establishing standards, recording the treatment provided, and evaluating the

results of that care. It contains details about the patients during phases of care given by various medical practitioners (Grimson, 2001; Van Ginneken, 2002). A medical professional's ability to provide quality health care depends greatly on the quantity and quality of data available. The patient's health data contained in the e-PCR is crucial not only for making patient treatment plans but also for making management and health policies (Häyrynen et al., 2008). It is imperative to note that the e-PCR is an

indispensable component of a patient's entire medical record and unequivocally represents EMS's version of an electronic health record (EHR) (Häyrynen et al., 2008).

In the past, EMS staff would communicate through direct conversations over the phone, or through paper clinical records (PCR) (England, 2014). Ambulance services have embraced information technology at work as a result of government-led schemes, allowing for the electronic recording and sharing of patient care data (England, 2014; Wachter, 2016). Ambulance services in the UK successfully introduced electronic devices like iPads with staff support, despite facing significant challenges (Porter et al., 2020).

The electronic recording of patient information in ambulance services has provided healthcare professionals with the ability to send patient data to their GP or other relevant services electronically (Barrett et al., 2021).

In the sphere of EMS, quick and precise documentation is essential because it ensures smooth communication and continuity of treatment among medical professionals (Greene, 2014). The e-PCR enables EMS staff to document crucial data, like patient demographics, medical history, and treatment done, which other health providers can use to make better treatment plans for the patients (Schooley & Hikmet, 2013). Accurate record-keeping also aids in the invoicing and reimbursement process, guaranteeing that the treatment provided is well documented and invoiced (Porter et al., 2020). Additionally, it is used evaluate or detect patterns, problem areas, and efficient procedures in EMS, thus helping in quality improvement (Wang et al., 2018).

An important factor to take into account in the development of healthcare technology is how EMS staff feel about using electronic patient care records as opposed to paper patient care records (Chau & Hu, 2002). It is critical to comprehend how EMS staff view and adjust to electronic platforms as technology continues to advance (Porter et al., 2020). Particularly in professional contexts, perception is a critical factor in determining an individual's attitudes and behaviours (Ammenwerth, 2019). Thus the aim of the present study is to identify the facilitators and barriers perceived by EMS staff regarding the use of e-PCR.

### 1.1. Aims and Objectives

#### Aims:

To investigate the perception of emergency medical service staff on the use of E-PCR in emergency medical service

#### Objectives:

1. To identify the facilitators and barriers EMS staff encounter when using e-PCR.
2. To explore the overall perception of EMS staff towards the utilization of e-PCR in EMS settings.

### 1.2. RESEARCH QUESTION:

What is the perception of emergency medical staff about the use of electronic patient clinical records systems in emergency medical service? A Systematic Review

### 1.3. RATIONALE:

The rationale for conducting this systematic review is to fill the gap in knowledge on the perception of EMS staff about e-PCR in emergency medical services. The transition to electronic patient care records has been a significant advancement for EMS staff (Chau & Hu, 2002). It is crucial to comprehend how EMS staff view the usability of this new system in order to evaluate the potential facilitators and barriers and overall patient care quality (Chau & Hu, 2002). While there is ample research on the perception of physicians and other healthcare professionals on the use of EHR in hospitals, there is very limited research done on e-PCR in EMS (Yoo et al., 2020). This study aims to identify important factors that can potentially help the implementers to develop appropriate rules and policies that can enhance the adoption of e-PCR by EMS staff.

### 2. METHODS

A systematic review approach was adopted to gather all relevant studies with respect to this topic. The Cochrane Collaboration defines "a systematic review as a comprehensive high-level summary of primary research on a specific research question that attempts to identify, select, synthesize, and appraise all high-quality evidence relevant to that question to answer it" (Harris et al., 2014; Van der Walt, 2019). In addition systematic reviews assemble all data relevant to predetermined qualifying criteria for addressing the particular research question (Harris et al., 2014).

A very broad research question may cover topics that may be too elaborate to pursue (Fandino, 2019). This study uses FINER criteria to frame the research question. Huley et al. (2001), recommended the use of FINER (feasible, interesting, novel, ethical and relevant) criteria in creating a good research question (Hulley et al., 2001). While the FINER criteria define the question in general, the SPIDER framework is a helpful method to build the specificity of the research question.

#### 2.1. Search strategy

The SPIDER framework was selected to guide and standardize the search strategy. SPIDER stands for

Sample, Phenomenon of Interest, Design, Evaluation, and Research type. In a study conducted by Methley et al, SPIDER was found to be more appropriate for searching for qualitative research (Fandino, 2019;

Methley et al., 2014). One reason for this is the 'Outcome' (O) in PICO is a more subjective element hence the term 'Evaluation' (E) is more suitable (Methley et al., 2014).

**Table1. SPIDER**

SAMPLE	Emergency medical staff (Paramedics, emergency medicine technician (EMT), emergency nurses and clinicians and emergency department (ED) staff)
PHENOMENON OF INTEREST	E-PCR/ EHR in EMS
DESIGN:	Qualitative study with thematic Analysis
EVALUATION:	Perception
RESEARCH TYPE	Qualitative researches

## 2.2. Information sources

Four scholarly databases (Pubmed, Scopus, Medline, Science Direct). The search strategy consisted of a combination of Medical Subject Headings (MeSH) and free-text keyword terms (Gandrup et al., 2020) as follows Emergency Medical Service staff OR EMS staff OR Paramedic OR EMTs And Electronic Patient Clinical Records System OR Electronic medical record OR Electronic Health Record OR EHR OR EPCR OR EMR OR Computerised patient records AND interview OR focus groups. No filter or additional search criteria were applied. Scopus was searched for grey literature using the same terms. An inspection of reference lists from retrieved articles identified relevant publications not obtained through the database search.

## 2.3. Eligibility criteria

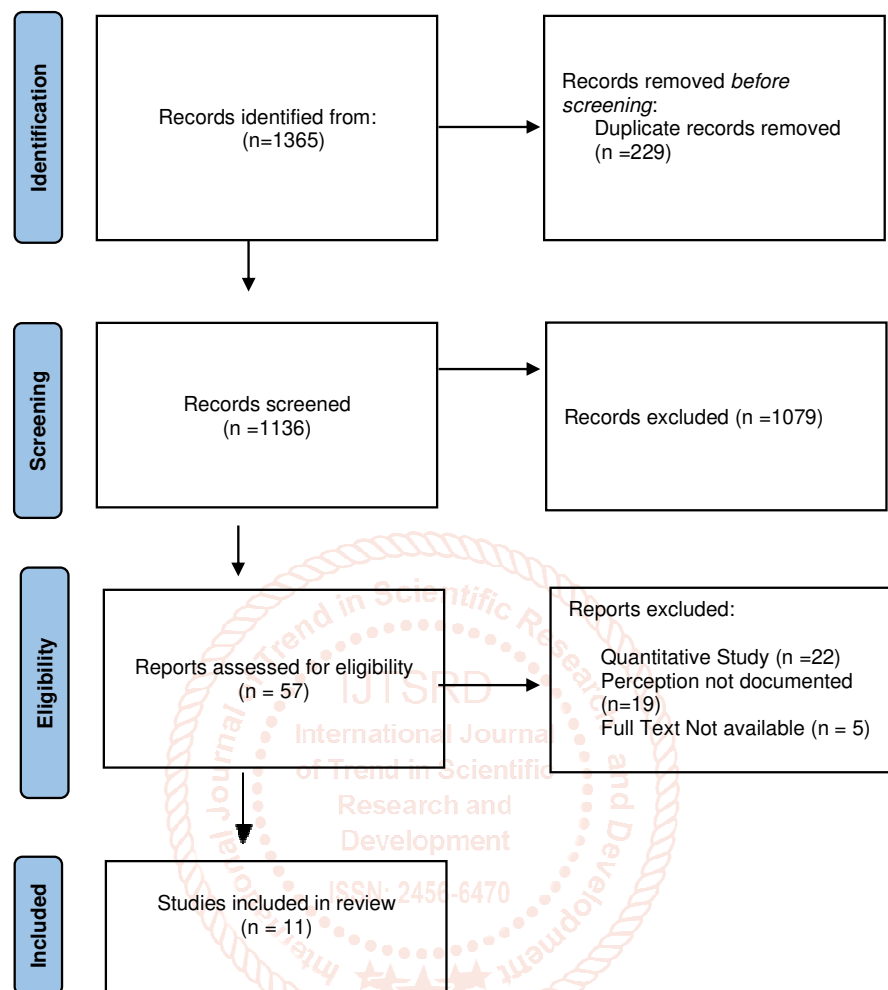
The eligible studies were those that qualitatively investigated perception of staff in an emergency medical service setting of using e-PCR/EHR or modification or enhancements to e-PCR. The topics searched for were the perceived factors that act as facilitators or barriers to the use of e-PCR or overall staff perception of using this. Quantitative methods were excluded. Mixed-method studies with relevant qualitative data were included. The review population included Paramedic, emergency medicine technician (EMT), emergency nurses and clinicians and emergency department (ED) staff. Studies involving any other hospital department were excluded. Conference abstracts and editorials were excluded. The inclusion and exclusion criteria are outlined in the following table

**TABLE 2. Eligibility criteria**

INCLUSION CRITERIA	EXCLUSION CRITERIA
Perception of emergency medical staff (Paramedics, emergency medicine technicians (EMT), emergency nurses and clinicians and emergency department (ED) staff)	Articles with perception of Healthcare providers from all other departments and patients perception
Intervention of interest: e-PCR and modification or enhancements to e-PCR	Papers that do not discuss this intervention
Research Methodology: qualitative study and qualitative data from mixed method study	Quantitative study
Published language: English	Any other language
Published after 2000	Published before 2000
Peer-reviewed articles and grey literature	Conference abstracts and editorials

## 2.4. PRISMA

This systematic review was designed and reported according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The PRISMA guidelines are made up of a 27-item checklist and a four-phase flow diagram (Selçuk, 2019). The flow diagram describes the selection process through four stages which are identification, screening, eligibility and inclusion criteria. The PRISMA was developed with the goal of improving standard systematic review reporting and offering specifics on the description of important study aspects (Hutton et al., 2016). Figure 1 shows the PRISMA Selection process.

**Figure1.Prsima flow chart**

## 2.5. Quality Assessment

The quality assessment of the evidence to be synthesized is a crucial step that all systematic reviews must go through (Long et al., 2020). The CASP(Critical Appraisal Skills Programme) tool was chosen for this study because it is the most widely used checklist/criteria-based tool for quality appraisal in qualitative evidence syntheses relating to health and social care (Dalton et al., 2017; Long et al., 2020). The CASP tool can be used to assess the benefits and shortcomings of any qualitative research approach (Dixon-Woods et al., 2007). Ten questions are included in the tool, and each one focuses on a unique methodological element of a qualitative study (Long et al., 2020). The CASP scores the paper into three categories of low, fair and high quality. Scores below 5 indicates low, 6 to 8 fair and 9 to 10 high quality. The total score obtained by the selected studies are mentioned in table 3.

**Table 3. CASP Assessment**

CASP	1	2	3	4	5	6	7	8	9	10	11
1. Did the article describe an important clinical problem addressed via a clearly formulated question?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2. Was a qualitative approach appropriate?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
3. Was the sampling strategy clearly defined and justified?	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	N
4. What methods did the researcher use for collecting data?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

5. What methods did the researcher use to analyse the data, and what quality control measures were implemented?	Y	Y	N	N	Y	Y	Y	Y	Y	Y	N
6. Was the relationship between the researcher(s) and participant(s) explicit	Y	Y	C	Y	Y	Y	Y	Y	Y	Y	Y
7. What are the results, and do they address the research question?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
8. Are the results credible?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9. What conclusions were drawn, and are they justified by the results? In particular, have alternative explanations for the results been explored?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
10. To what extent are the findings of the study transferable to other clinical settings?	Y	Y	N	C	N	Y	C	Y	C	Y	N
SCORE	10	10	7	7	9	10	9	10	9	10	7

1. Altuwaijri et al (2019)
2. Baird and Boak (2016)
3. Burley et al (2008)
4. Cuk (2017)
5. Jensen et al. (2021)
6. Landman et al.(2012)
7. Meisel et al.(2015)
8. Moy et al.(2023)
9. Niyonsaba et al.(2023)
10. Porter et al.(2020)
11. Rohrer (2017)

## 2.6. DATA EXTRACTION

In a systematic review, data extraction is the process of capturing key characteristics of studies in structured and standardised form based on information in journal articles and reports (Schmidt et al., 2021). Data extraction was completed independently by the author. This step entitles data collection from included full-texts in a structured extraction sheet made in Microsoft word. The form included details from the 11 selected articles. The extraction procedure includes a careful examination of all the contained literature. Following that, the major points and concepts of each individual article were determined, summarised, and noted. The table (table 4) included authors name and year of publication, article title, setting, focus of study, study methodology and sample population and key findings of the study. The key findings from each study showed the perception of emergency medical staff of using e-PCR. This approach was taken because the researcher wanted to employ materials that were important, relevant, and helped achieve the objectives of the study. The Table 4 below list the study characteristic.

**Table 4. Study characteristic Table**

Author	Title	Setting	Focus of Study	Type And No. of Participants	Key Findings
Altuwaijri et al. (2019)	Factors impeding the effective utilisation of an electronic patient report form during handover from an ambulance to an emergency department	North East England Emergency Department  UK	Factors effecting the utilisation on the electronic patient reports during handover	Qualitative (semi-structured interviews and observation )  Interviews (n=10) 7 paramedics and 3 ED staff  Observations (n=74)	The major factors identified as preventing ready utilisation of electronic records were the choice of system architecture, the design of user interfaces, and the procurement process used by the National Health Service.  20 out of 37 observations showed paramedics provided written information in



					addition to e-PCR.
Baird and Boak (2016)	Leading change: introducing an electronic medical record system to a paramedic service	Small private EMS  USA	Factors that aided in the adoption of e-PCR in a small emergency care	Mixed method study (Semi-structured interviews and quantitative survey)  Interview (n=4 Paramedics) Survey (n=34 Paramedics)	Ease of use and user interface were important factors affecting adoption  The findings indicate that allowing individual flexibility of use significantly aided the acceptance of the EMIR system in this company.
Burley et al (2008)	The Internal Value of Mobile Computing in Emergency Medical Services: an Australian Case Study	In branches of an EMS organisation  Australia	explores the value of the implementation of mobile computing in EMS	Case study research ( Semi-structured interview)  n = 45 (3 Information systems group, 2 Management, 2 Clinical Support Officers and 38 Paramedics)	Study found that the use of a mobile system enhances efficiency and effectiveness on various fronts and therefore delivers internal value for the organization.
Cuk (2017)	Investigating Problems Associated with Patient Care Reports and Transferring Data Between Ambulance and Hospitals from the Perspective of Emergency Medical Technicians	Purposive Sampling from Savannah region  USA (Savannah)	investigated problems with paper reports, computer-based patient care reports, and transferring patients and their information.	Qualitative  n= 6 Emergency Medical Technician	Preference for ePCR over paper records were found  Difficulty to write paper records in the back of an ambulance.  Desire to follow up transferred patients.
Jensen et al. (2021)	Understanding the Effect of Electronic Prehospital Medical Records in Ambulances: A Qualitative Observational Study in a Prehospital Setting	A single ambulance station  Denmark	To investigate the use of ePMR and whether it affected the ambulance professionals' clinical practice.	qualitative- an ethnographic study  26 ambulance professionals	facilitated data collection and a checklist for ED handover  Facilitated communication with patients  In severe cases, e-PCR alone couldn't suffice handover process

Landman et al.(2012)	Prehospital Electronic Patient Care Report Systems: Early Experiences from Emergency Medical Services Agency Leaders	EMS agency  USA and Canada	Motivation for adoption of e-PCR and their experiences	Qualitative study  n=23 EMS agency leaders. (Medical Director, EMS fellows and EMS agency directors)	reason for adoption of e-PCR was quality assurance.  Challenges found were fear of increase run time and reduce availability of ambulance, unfunded mandates, lack of integration with hospital  Strategies to improves e-PCR implementation: find good funding, build internal IT capacity, leverage regional health information organizations;
Meisel et al.(2015)	Optimizing the Patient Handoff Between Emergency Medical Services and the Emergency Department	EMS setting  USA	EMS providers perspective to improve handoffs.	Qualitative Study Focus groups  EMS Providers (n=48)	4 key potential ways to improve handoff: -direct communication with responsible ED provider -interdisciplinary feedback and transparency -standardize some aspects of handover - harness technology
Moy et al.(2023)	Understanding the perceived role of electronic health records and workflow fragmentation on clinician documentation burden in emergency departments	ED setting  USA	perceived role of electronic health records (EHR	Qualitative  n= 24 (Prescribing providers n=12 registered nurses n=12 )	Participants perceived EHRs positively, adding value to patient care.  -clinicians also expressed that many EHR features and functionalities were a source of frustration, and cognitive burden, and therefore, a threat to patient safety  The continued need to design EHRs that are harmonious with

					ED clinical workflow was recognised.
Niyonsaba et al.(2023)	Challenges and opportunities to improve efficiency and quality of prehospital emergency care using a mHealth platform: Qualitative study in Rwanda	Emergency medical service (SAMU)  Kigali (AFRICA)	The potential of a mHealth tool to address the challenges faced by EMS	Qualitative The semi-structured interview  n= 21 (Dispatch center n = 5 Ambulance staff n = 5 Receiving hospitals n = 8 Policymakers n = 3)	study highlights the challenges faced by the EMS and the potential of mHealth tools to address these problems.
Porter et al.(2020)	Electronic health records in ambulances: the ERA multiple-methods study	Freestanding ambulance services  UK	Effective implantation of E-PCR in prehospital context	Qualitative. Telephone survey and case study  n=17	Little evidence was found on if the introduction of EHR changed ambulance crews' perception of their role.  Some services had reverted back to paper records.  E-PCR was found as a legally sound documentation  The main advantage of E-PCR was data handling and auditing
(Rohrer, 2017)	Electronic Health Records in Prehospital Care	Pre-hospital setting  Austria	To analyze the special requirements for electronic documentation and support systems in prehospital care and to find if ELGA (Austrian Electronic Health Record) meets the requirement	exploratory research using mixed methods and a systematic review of findings  n= 7 (Paramedics n=4 and Physicians n=3)	The need for complete electronic documentation in prehospital settings was identified.  ELGA could improve documentation in prehospital settings improving the quality of care provided

## 2.7. DATA ANALYSIS

The data obtained from data extraction will be then thematically synthesised. Thematic analysis is a typical method used for analysis of primary qualitative data (Popay et al., 2006). Much like thematic analysis, synthesis



entails systematic coding of information from the articles selected followed by creation of descriptive and analytic themes (Thomas & Harden, 2008). It involves a inductive approach wherein the themes are created from the codes generated from the article without any preconceptions (Schmidt et al., 2021). Thematic synthesis involves three steps. In the first step detailed data from the selected materials will be coded word by word according to meaning and relevance (Thomas & Harden, 2008). This generated 331 codes. The second step entails grouping the codes into an organised structure depending on how are they similar to and different from one another which finally results in the formation of descriptive codes (Thomas & Harden, 2008). This study generated 135 descriptive codes. The third step involves development of analytical themes from the descriptive code which will help in determining the key findings (Thomas & Harden, 2008). Three analytical themes were derived which are facilitators to the use of e-PCR, barriers to the use of e-PCR and overall perception of staff on e-PCR. Table 5 contains the themes and codes derived. Table 6 contains the result of data analysis.

**Table 5. Themes and codes derived.**

Authors	BARRIERS	FACILITATORS	ATTITUDE
Altuwaijri et al.(2019)	<ul style="list-style-type: none"> <li>-E-PCR completion was time-consuming</li> <li>-Delay in submission</li> <li>-Restricted authorisation to access e-PCR through web tool</li> <li>-Lack of sufficient training</li> </ul>	<ul style="list-style-type: none"> <li>-Role as a legal medical document</li> <li>-Improved user interface</li> <li>-Transfer of patient information to ED before arrival</li> <li>-Increase the chance for informed decision-making</li> </ul>	-57% showed preference for e-PCR however some had mixed views about its benefits.
Baird and Boak (2015)	<ul style="list-style-type: none"> <li>-Initial struggle with the new system</li> <li>-Complexity in documenting</li> <li>-Lack of training</li> </ul>	<ul style="list-style-type: none"> <li>-Flexibility of hardware improved acceptance</li> <li>-Peer-to-peer training improved acceptance</li> <li>-User feedback leading to system improvement was appreciated</li> <li>-Quality of charting improved</li> </ul>	-Data obtained was considered priceless
3 Burley et al (2008)	<ul style="list-style-type: none"> <li>-Readability challenges and information overload</li> <li>-Instance of dual documentation as the system didn't allow jumping between pages</li> <li>-infrastructure cost and cost associated with training all paramedics</li> </ul>	<ul style="list-style-type: none"> <li>-Data quality</li> <li>-Standardization of records</li> <li>-Improved documentation and data analysis</li> <li>-Decreased paperwork.</li> <li>-Improved efficiency in capturing data</li> <li>-Compliance with clinical practice guidelines</li> <li>-Better patient outcome</li> <li>-Synchronisation of data and faster information processing</li> <li>-Data collection for evidence-based practice and dispatch code process.</li> <li>-Training</li> <li>-Time stamping of events produced valuable data for analysing the efficiency of</li> </ul>	<ul style="list-style-type: none"> <li>-User Satisfaction and Improved Productivity</li> <li>-Lack of uniqueness or individual character</li> <li>-Expectation of effective use of data for quality improvement was shown by participants</li> </ul>

		staff. -Hardware options	
Cuk (2017)	-Lack of time to complete the e-PCR. -lack of integration with other service providers	-Information sharing to ED before arrival and vis-versa -Improve patient care -Access to patient medical history -Ability to follow up with patients after transfer	E-PCR was more preferred than PCR
Jensen et al. (2021)	- Severe cases and short journey - interaction with patient are affected. - restricted access to certain features - Instance of double documentation because of technical issue	-Eminent tool for documentation -Standardised layout -Easy access to each page -Information sharing -real-time sharing of vital signs -collaboration with other providers -Patient-centered interaction -Ease of use and time saving -Mobility of e-PCR - Can function without server hence no problem of loss of data	-Good tool for actively collaborating in EMS setting
Landman et al. (2012)	-Financial Challenges -Organizational Challenges -Technical Challenges -Privacy Challenges -Difficulty in integration with hospital system - Fear of increased run time	-Quality assurance -Improved legibility and billing -Decrease in lost chart -Improved compliance with guidelines -State mandates for adoption -Funding sources -Internal IT support -Electronic interface with established organisations to improve sharing.	EMS agencies are highly motivated to adopt e-PCR systems to support quality assurance effort. Experienced frustration due to lack of integration resulting in handing over printed paper records to ED Frustration with mandates which did not come with any funds but with penalties
Meisel et al.(2015)	-Lax regulations delaying transfer of records -Lack of continuity of records with hospital records -standardisation limits options for adding essential information	Desire to know patient outcome	A mix of optimism and scepticism about the role of technology in bridging gaps in handoffs
Moy et al.(2023)	-lack of advanced design features - Inability to offload task - not user-friendly under critical	- encouraging design for more documentation -Smart data-capturing	- poor user experience was reported -widespread experience

	circumstances -unnecessary documentation instead of adapting to the need -INFORMAION OVERLOAD -Display fragmentation	methods - streamlined EHR displays and configurations	of burden and burnout among ED providers -EHR added value to patient care
Niyonsaba et al.(2023)	Connectivity concerns Software Maintenance and Updates Technical Challenges Data Security and Privacy Concerns	Potential Benefits of Geo-Location Enhanced Communication Efficiency Real-time Data Sharing Real-time Tracking of Ambulance Movement sound decision making and quality improvement	Viewed as a potential solution for EMS challenges
Porter et al, (2020)	-System design -lack of integration with other provider systems - inability to free text -Resistance to attend training - tendency to revert back to paper records seen - cost of training -time consuming -lose of connectivity - effect patient-clinician rapport - funding limitation	- Mandatory usage - local champions for training - feedback to staff can be encouraging -Software and hardware that can be easily updated without undue disruption -simple design for ease of use -evidence-based decision making - medico-legal documentation -information sharing -better security - structured data for documentation and auditing -Template for pathways and assessment tools - greater interoperability (map the patient along care pathways) -Real time data sharing Fewer missing records	-Described as awesome as it could receive data directly from devices Some reluctance to second generation system because of its former model. - data not entered directly to EHR instead first on a glove or notebook -EHR was found to be not used live but in different ways and timing. -EHR was seen as reliable and user friendly -vision and enthusiasm from senior managers -front-line staff who were willing and able to readily adapt to new systems Hospital clinicians found it beneficial to obtain live E-PCR available before patient arrival
Rohrer (2017)	-----	-Enhanced Workflow -Evidence-based decision making -Efficient handover -Better patient outcome -Cost saving -Information sharing	-----

**Table 6. Data Synthesis**

AUTHORS	FACILITATORS				BARRIERS				STAFF ATTITUDE	
	DOCUMENTATION	COMMUNICATION	QUALITY	ORGANISATIONAL	TECHNICAL	SECURITY	TRAINING	CULTURAL	POSITIVE	NEGATIVE
Altuwaijri et al.(2019)	✓	✓	✓	—	✓	—	✓	—	✓	—
Baird and Boak (2016)	✓	—	—	✓	✓	—	✓	—	✓	—
Burley et al (2008)	✓	✓	✓	✓	✓	—	✓	✓	✓	✓
Cuk (2017)	—	✓	✓	—	✓	—	—	—	✓	—
Jensen et al. (2021)	✓	✓	✓	—	✓	—	—	✓	✓	—
Landman et al. (2012)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Meisel et al.(2015)	—	—	✓	—	✓	—	—	✓	—	✓
Moy et al	✓	—	—	—	✓	—	—	—	✓	✓
Niyonsaba et al.(2023)	—	✓	✓	—	✓	✓	—	—	✓	—
Porter et al(2020)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Rother (2017)	✓	✓	✓	✓	—	—	—	—	—	—

### 3. RESULT

#### 3.1. Search Results

By using different database searching strategies a total of 1365 potential articles were retrieved from 4 databases. After the initial screening process 229 duplicate records were removed. Out of the remaining 1136 papers, 1079 were excluded as they did not meet the selection criteria (the title, abstract, and keywords); publication date before 2000 (n=346), not peer reviewed (n=250), not e-PCR/EHR (n=96), not in ambulance service setting/ emergency medical service/ ED setting (n=386) and not in English (n=1). Of the remaining 57 papers, a full text screening eliminated 46 for: the study design (quantitative studies) (n=22), no perception of staff documented (n=19) and no full text available (n=5). Thus, 11 papers that met the inclusion criteria were selected for final analysis. Figure 1 shows the PRISMA Selection process

#### 3.2. Risk of Bias

Quality assessment of 11 studies is summarised in table 3. Out of 11 paper 8 papers were found to be of high quality and remaining 3 of fair quality. Six studies lost point in the domain of - if the study was transferrable to other clinical setting and two paper in which sampling strategy was not clearly stated. The other domain in which three papers lost point was - methods used for data analysis and quality control was not clear.

#### 3.3. Characteristic of Included Study

The characteristic of 11 studies is summarised in table 4. Out of the 11 studies nine studies were Qualitative

studies and two were mixed method studies. Nine of the studies were on e-PCR and two were on modifications of e-PCR. Participants of the studies included paramedics, EMT, ED staff, EMS agency leaders, EMS support officers. Within each study the size of the sample frame varied considerably (n=4 to n= 74). Five out of the eleven studies were conducted in USA, two in UK, two in Austria, one in Denmark and one in Africa. The setting in which study was included five studies were in small EMS setting and four in large EMS setting and two studies in ED setting. Qualitative data collection was done from data obtained through semi-structured interview, open-ended questionnaires and focus groups.

#### 3.4. Qualitative Synthesis

From the overall data extracted three major themes (table 5) with 10 sub-themes emerged. (table 6) The three major themes that emerged are barriers, facilitators and overall perception of staff. Sub themes for factors acting as barriers to the use of e-PCR were technical issues and system usability concerns; data privacy and security considerations; training and education requirements for paramedics; and resistance to change and organizational culture. Facilitator Sub-themes addresses that emerged are improved documentation and record-keeping; communication and integration with other healthcare systems; data-driven decision-making and quality improvement; and user feedback leading to system improvement. The sub-themes that emerged under overall perception of staff are positive perception and negative perception. The result of data synthesis is

depicted in table 6. Sub-themes and the source of emerged codes are depicted in APPENDIX A

### 3.5. BARRIERS

#### 3.5.1. Technical issues and system usability concerns

Fear of losing records because of connectivity issues and this interpreting care delivery has been reported by four studies (Landman et al., 2012) (Niyonsaba, 2023) (Altuwaijri et al., 2019; Porter et al., 2020). Participants in four studies reported frustration because of having to do double documentation. Depending on paper documentation when the e-PCR system crashes or have technical issues was found to hinder the work environment (Altuwaijri et al., 2019; Burley et al., 2008; Jensen et al., 2021; Porter et al., 2020).

Most of the article also commented on the complexity of e-PCR system design which acted as barrier in many ways. Healthcare providers found it difficult to navigate through the system easily (Burley et al., 2008). It took more time to fill and complete documents which further caused delay in submission of e-PCR to the ED during handover (Altuwaijri et al., 2019).

The complexity of design made it difficult for first time users to utilise the system efficiently (Baird & Boak, 2016). The design of the e-PCR was found to cause information overload which was defeating its purpose of use. The participants felt that ED staff only briefly go through the e-PCR because they find it difficult to find the necessary information (Burley et al., 2008). Similarly the excessive data was found to affect the performance of healthcare providers as it was very difficult to obtain the necessary data required from the e-PCR (Moy et al., 2023). The fragmented display of screen was also reported as a barrier (Moy et al., 2023).

Problem to offload task was also mentioned by three papers as a source of frustration among users (Burley et al., 2008; Jensen et al., 2021; Moy et al., 2023). The inability of e-PCR to integrate with other service providers was reported as a barrier by four studies (Cuk, 2017; Landman et al., 2012; Meisel et al., 2015; Porter et al., 2020).

Distance from location of patient to the ED and severity of case were factors shown cause delay in completion of the complex e-PCR forms in two studies (Altuwaijri et al., 2019; Jensen et al., 2021). The e-PCR design was reported as not being user friendly under serious emergencies in one of the studies (Moy et al., 2023). Lack of time to complete the e-PCR in time for patient handover was noted by two other studies also (Cuk, 2017; Porter et al., 2020).

The standardised layout of the e-PCR though appreciated by many but was also seen to have drawbacks as it prevented addition of more essential information (Burley et al., 2008; Meisel et al., 2015). Lack of advance design features which adapted the e-PCR to user need was reported by the participants of a study (Moy et al., 2023). The need for frequent software updates and maintenance of e-PCR system was found to be one of the barriers to adoption in developing countries (Niyonsaba, 2023).

#### 3.5.2. Data privacy and security

With advancement electronic transfer of data in health care, data privacy and security concerns were reported by two studies (Landman et al., 2012; Niyonsaba et al., 2023). On the contrary one of the study's reported increased level of confidentiality with e-PCR as once it was completed it was saved into the system unlike paper records which will still be in the ambulance and for the fact that searches could be conducted without patient identifiers (Porter et al., 2020).

#### 3.5.3. Training for staff

Cost associated with training of staff and setting up of infrastructure was reported to be barriers in adoption of e-PCR system (Burley et al., 2008; Porter et al., 2020). Two studies reported that lack of training provided to staff was hindering the complete utilisation of e-PCR system (Altuwaijri et al., 2019; Baird & Boak, 2016). Resistance to dispatch staff for training by managers in busy areas was found as problem in one of the studies (Porter et al., 2020).

#### 3.5.4. Organisational Challenges

Lack of financial resources for the adoption and maintenance of the system was discussed in two studies (Landman et al., 2012) (Porter et al., 2020). Complex organisational structure was found to be a barrier to adoption of e-PCR (Landman et al., 2012). Lax regulation and lack of leadership was seen preventing proper utilisation of e-PCR in two studies (Landman et al., 2012; Meisel et al., 2015). Fear of increased ambulance run with the switch to e-PCR system was reported by participants (Landman et al., 2012).

Restricted access to the number of ED staff who can view e-PCR using the web tool was shown to affect the usefulness of e-PCR (Altuwaijri et al., 2019). Similarly, Jensen et al (2021) discussed how limited access to patients' medical history like medication details can affect quality of care provided (Jensen et al., 2021).



### 3.6. FACILITATORS

#### 3.6.1. Improved documentation and record-keeping

All of the studies reported that e-PCR improved the quality of documentation of patient care. Standardised layout of patient records were greatly appreciated by the participants (Burley et al., 2008) (Jensen et al., 2021) (Porter et al., 2020). Three out of 11 studies appreciated the role of e-PCR as a legal document (Altuwaijri et al., 2019; Burley et al., 2008; Porter et al., 2020). E-PCR was found to increase the compliance with clinical practice guidelines (Burley et al., 2008; Landman et al., 2012). Three studies reported e-PCR as a user friendly system. (Burley et al., 2008; Jensen et al., 2021; Moy et al., 2023).

A decrease in number of missing patient records were reported (Landman et al., 2012; Porter et al., 2020). Participants said the ability to follow up on patient outcomes on e-PCR will be beneficial to improve healthcare delivery (Cuk, 2017; Meisel et al., 2015) (Rohrer, 2017). In the study by Jensen et al (2021) the mobility of e-PCR that allows it to be carried by paramedics to the site and it can placed in a way that can improve conversation with patients (Jensen et al., 2021). Participants wanted a e-PCR that has the capability to function without a server so as to prevent loss of information during connectivity issues (Jensen et al, 2021).

#### 3.6.2. Communication and Interoperability

Seven out of eleven studies reported ability to transfer patient details electronically to the ED before arrival was considered as an important feature for efficient handover (Altuwaijri et al., 2019; Burley et al., 2008; Cuk, 2017; Jensen et al., 2021) (Niyonsaba, 2023) (Porter et al., 2020; Rohrer, 2017).

E-pcr was found improve collaboration with other healthcare providers (Jensen et al., 2021). Features of real time tracking of ambulance location, geo-location features to locate caller or patient and real time sharing of vital signs to ED were found to be feature that may improve adaption of e-PCR in developing country (Niyonsaba, 2023).

Shared interface with established organisations was shown to improve sharing capabilities of e-PCR (Landman et al., 2012; Porter et al., 2020).

#### 3.6.3. Data-driven decision-making and quality improvement

Participants from two studies reported data gathered through e-PCR was found to be important for evidence-based practice (Burley, 2008) (Porter, 2020). e-PCR was found to improve quality of health care delivery by increasing the availability of patient information along with keeping a automatic check on the quality measurements (Landman, 2012).

Participants found e-PCR to help in sound decision making and quality improvement (Rohrer, 2017) (Niyonsaba, 2023).

#### 3.6.4. Organisational improvements

Updating the system based in accordance with user feedback was seen as an essential factor in the successful implementation of e-PCR system (Baird, 2016). Providing hardware options and adaptation to an individual's needs were seen to promote usability of the system (Baird, 2016). Features like time-stamping of events within the e-PCR provided valuable data for analysing the efficiency of staff (Burley, 2008). Mandates for the adoption of the system was shown to be beneficial (Porter, 2020) (Landman, 2012). Participants reported providing feedback to staff and sending local champions to help the staff with system usage were seen improve adoption (Porter, 2020). In the study conducted by Landman et al, (2012) factors like having an internal IT support team and external funding sources were seen as facilitators for improving the usability of the system (Landman, 2012).

Participants in the study by porter et al identified software and hardware that can be easily updated without causing disruption to the work environment as a facilitator (Porter, 2020). Two studies suggested e-PCR to be a cost saving factor in healthcare delivery (Porter, 2020) (Rohrer, 2017).

### 3.7. OVERALL PERCEPTION OF STAFF

#### 3.7.1. Positive Perception

Most of studies found a preference for data collected through e-PCR to be important (Altuwaijri, 2019) (Baird & Boak, 2016) (Cuk, 2017) (Landman, 2012) (Moy, 2023) (Porter, 2020) (Niyonsaba, 2023). Participants reported user satisfaction and improved productivity with e-PCR in two studies (Burley, 2008) (Porter, 2020).

e-PCR was viewed as a good tool for collaboration with other services to provide quality healthcare delivery (Jensen, 2021). In a study conducted in a developing country, participants viewed e-PCR as a solution to all EMS challenges (Niyonsaba, 2023). Participants commented e-PCR to be 'awesome' as it could receive live data of vital sign from the machine and send it to the ED before arrival of patient (Porter, 2020).

#### 3.7.2. Negative Perception

Participants expressed frustration about e-PCR lacking integration with other providers which often causes staff to provide additional paper copies of the e-PCR (Landman, 2012). Participants in a study by Moy et al, 2023 reported poor user experience of using e-PCR (Moy, 2023).

Participants who has bad experience with the first generation system was reluctant to try the second generation (Landman et al, 2012). Participants were frustrated when proper funding was not available to establish the compulsory mandates (Landman, 2012). All participants reported experience of burden and burn out from the use of e-PCR (Moy, 2023).

#### 4. DISCUSSION

This systematic review provides an evaluation of 11 published studies, identifying the facilitators, barriers and overall perception of emergency medical staff on using e-PCR. This systematic study revealed that there was a mixed perception on the use of e-PCR despite of all the studies agreeing that it improved the quality and structure of the gathered data. Majority of studies evaluated the technical issues and usability concerns of the system along with organisational changes that can act as facilitators to improve the usability

##### Factors acting as facilitators to the use of e-PCR

The ability of e-PCR to improve storage and collection of patient health data was identified as one the primary facilitators. Participants in several studies have shown appreciation for standard layouts since this ensures important details are not missed (Burley et al., 2008; Jensen et al., 2021; Porter et al., 2020). Participants in one of the studies appreciated the role of e-PCR as a checklist for handover and a legal document which could offer legal protection (Porter et al., 2020).

Another key facilitator of e-PCR is its capacity to effortlessly integrate and transmit patient data with other service providers. This improves patient handoffs and promotes collaborative care. Seven out of eleven studies emphasis the significance of electronically transferring patient data to ED before arrival for facilitating an effective handover. (Altuwaijri et al., 2019; Burley et al., 2008; Cuk, 2017; Jensen et al., 2021; Niyonsaba et al., 2023; Porter et al., 2020; Rohrer, 2017). The adoption of e-PCR in developing countries can be encouraged by features like geo-location capabilities, tracking ambulance location and real time exchange of vital signs (Niyonsaba et al., 2023). Better recording of data allows emergency medical staff to make evidence-based decision that translates to delivery of quality patient care. (Burley et al., 2008) Data collected through e-PCR can be crucial for monitoring quality metric, staff efficiency and developing new policies (Landman et al., 2012).

User-feedback plays a crucial role in improving e-PCR system. It serves as an ongoing feedback loop for development of the system (Baird & Boak, 2016). Addition of hardware options were shown to enhance

adoption of the e-PCR. In addition to these factors like having internal IT support, external funding sources and mandates for adoption have all been acknowledged as potential facilitators to improve possibility of the system (Landman et al., 2012; Porter et al., 2020).

##### Factors acting as barriers to the use of e-PCR

Despite the benefits of e-PCR, the study identified few barriers that can limit its usability. One of the barriers that was mentioned in most of the paper was the technical issues and system usability concerns. Studie have reported the technical difficulties such as loss of connectivity resulting in the need for double documentation and also sometimes resulting in lost records (Burley et al., 2008; Jensen et al., 2021; Niyonsaba et al., 2023; Porter et al., 2020). The complexity of system design, including poor user interface and information overload poses significant challenge to usability.(Burley et al., 2008; Landman et al., 2012)

The incapability of e-PCR system to effectively integrate with other service providers and offload tasks was identified as a source of frustration among users (Burley et al., 2008; Moy et al., 2023). The lack of complete integration and coordination could lead to delays in patient care and hinder the overall effectiveness of EMS operation (Cuk, 2017; Landman et al., 2012; Meisel et al., 2015; Porter et al., 2020).

Data privacy and security concerns were discussed by two studies, highlighting the importance of protecting patient autonomy (Landman et al., 2012; Niyonsaba et al., 2023). While one study reported increased confidentiality with e-PCR due to security storage (Porter et al., 2020), the overall perception of data security remains a significant concern that needs to be addressed to ensure trust and compliance with regulatory standards.

Cost associated with staff training along with lack of training emerged as barriers to the adoption of e-PCR (Altuwaijri et al., 2019; Baird & Boak, 2016; Porter et al., 2020). Organizational barriers such as insufficient financial resources, complex organizational structures, lack of leadership were identified as barriers that could impede successful implementation and integration of e-PCR into EMS organisation.(Moy, 2023; Landman, 2012). Restricted access to ED staff to use e-PCR can act as a barrier to its complete usability (Altuwaijri, 2019).

##### Overall perception of staff on using e-PCR

Staffs were found to have a mixed perception about e-PCR (Meisel, 2015). E-PCR was found to improve quality of documentation (Landman, 2012) but was also said to cause information overload in users

(Burley, 2008). The data collected was said to be structured and clear by participants (Jensen, 2021) but few participants also reported that ED staff did not give sufficient attention to e-PCR because of difficulty to read information. (Burley, 2008) In a study conducted by Cuk (2017) e-PCR was more preferred than PCR (Cuk, 2017) but other study reported participants expressed frustration due to lack of integration resulting in handing over printed paper records to ED (Landman, 2012). User satisfaction and improved productivity was reported with e-PCR (Burley, 2008) but a study by Moy et al reported widespread experience of burden and burn out among ED clinicians (Moy, 2023).

## 5. LIMITATION

One limitation of this study is that it is based on the limited literature that is available on this topic, therefore may not represent the full spectrum of perception of EMS staff on e-PCR. The included studies may have sample population with different job role even though they all are emergency medical staff and a large variation in sample size therefore potentially introducing variation in perceptions. Finally, the study focuses primarily on perceptions and therefore may not capture objective measures of e-PCR system's effectiveness.

## 6. CONCLUSION

This systematic review found that EMS staff hold complex and diverse views on e-PCR systems. And this therefore highlights the need for a comprehensive understanding of their perspectives to ensure successful implementation and utilization of this system. While several facilitators and barriers impact e-PCR adoption, it has been found that e-PCR has the potential to enhance documentation, communication, data-driven decision making and finally the ability to improve overall patient care quality. To ensure successful adoption, addressing technical issues, data security and training requirements is important. Moreover, resolving the organisational barriers though challenging is very crucial. Ultimately, EMS staff's perspective towards e-PCR plays an important role in determining how effective it is in enhancing emergency medical services.

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