RESEARCH ARTICLE

A systematic review of ePCR systems on reducing the response time of prehospital medical care [version 1; peer review: awaiting peer review]

ALI JASBI , Saravanan Muthaiyah , Thein Oak Kyaw Zaw

FOM, Multimedia University, Cyberjaya, Selangor, 63100, Malaysia

V1 First published: 26 Nov 2021, 10:1209
<https://doi.org/10.12688/f1000research.73718.1>
Latest published: 26 Nov 2021, 10:1209
<https://doi.org/10.12688/f1000research.73718.1>

Open Peer Review

Approval Status AWAITING PEER REVIEW

Any reports and responses or comments on the article can be found at the end of the article.

Abstract

Background

Poor communication at the time of patient handover is recognized as a root cause of a considerable proportion of preventable deaths. Despite several advantages, the Patient Care Report (PCR) implementation may include insufficient details for demonstrating the functional status of the patients during the actual response which can further prolong the response time. Healthcare entities have been emphasizing the need to implement e-PCR systems. This systematic review aimed to examine the impact of e-PCR systems on reducing response time of prehospital care.

Methods

Literature search was carried out using the relevant search terms and keywords with inclusion and exclusion criteria. N=6 researchers that focused on the impact of e-PCR systems on reducing response time of prehospital medical care were included within this review.

Results

The findings indicated that ePCR implementation led to prominent improvements in the quality of the care services provided by the healthcare organisation. Additionally, ePCR reduces the response rate by data standardization.

Conclusion

The implementation of e-PCR systems ensures the availability of records and automates reporting on given quality metrics. Moreover, the implementation of e-PCR systems also improved response time and increased the out of hospital rates of survival. However, fear of increasing the ambulance run time, compromise on the availability of ambulance, and challenges in integration with the existing information systems implemented within the hospitals, were some of the most common challenging situations associated with

implementing e-PCR systems.

Keywords

ePCR, EMS, pre-hospital medical care, emergency response time

Corresponding authors: ALI JASBI (1171402495@student.mmu.edu.my), Saravanan Muthaiyah (saravanan.muthaiyah@mmu.edu.my), Thein Oak Kyaw Zaw (rahman93.iu@gmail.com)

Author roles: **JASBI A:** Conceptualization, Formal Analysis, Funding Acquisition, Investigation, Methodology, Resources, Software, Supervision, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Muthaiyah S:** Investigation, Methodology, Project Administration, Supervision, Validation, Writing – Original Draft Preparation, Writing – Review & Editing; **Kyaw Zaw TO:** Validation, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

Grant information: The author(s) declared that no grants were involved in supporting this work.

Copyright: © 2021 JASBI A *et al.* This is an open access article distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

How to cite this article: JASBI A, Muthaiyah S and Kyaw Zaw TO. **A systematic review of ePCR systems on reducing the response time of prehospital medical care [version 1; peer review: awaiting peer review]** F1000Research 2021, 10:1209 <https://doi.org/10.12688/f1000research.73718.1>

First published: 26 Nov 2021, 10:1209 <https://doi.org/10.12688/f1000research.73718.1>

Introduction

Poor communication at the time of patient handover is considered as a root cause of substantial proportion of preventable deaths.¹ For this reason, efficient communication is one of the most significant priorities set by the World Health Organization (WHO) for improving the quality of healthcare services delivered to patients.¹ Despite introducing a substantial proportion of recommended strategies for reducing harm, the handover phase of care keeps a negative influence the clinical outcomes of the service users.² At the time of admission of patients into the healthcare setup, the Patient Care Report (PCR) includes an objective description of physical conditions of patients, including the mechanism related to injury, complaints, treatment provided to the patients, and other essential clinical information. However, PCR may include insufficient details for demonstrating the functional status of the patients at the time of transport, which prolong the response time. For this reason, healthcare organizations have been emphasizing the implementation of the Electronic Patient Care Report (e-PCR) systems. The utilization of the e-PCR systems facilitates digital recording; however, it also includes a drop-down list as well as checkboxes on the handheld devices by paramedics.³ The system has been reported to possess the potential for improving the availability of EMS record, as well as the legibility of the clinicians working in the ED.⁴

Implementation of e-PCR systems facilitates in making significant improvements within quality assurance, as well as billing for EMS agencies.⁴ Currently, e-PCR systems implemented within the healthcare organization have replicated the existing patient care reports based on paper with the electronic fields, for capturing history, assessment, physical exam, as well as treatment rendered. Despite several advantages of the e-PCR systems, a limited number of studies have explored the advantages of the e-PCR systems on prehospital clinical care. This systematic review is aimed to examine the impacts of the e-PCR systems on reducing prehospital medical care response time.

Methods

The structure utilized for gathering information was based on PICO, which included participants, interventions, comparators, and outcomes. Within this systematic review, the Participants 'P' were the patients requiring prehospital care, intervention 'I' was e-PCR systems; comparator 'C' was traditional PCR systems; and outcomes 'O' was the actual response time achieved. The PICO tool facilitated the formation of the following research question "what is the impact of e-PCR systems on reducing the response time of prehospital medical care?" The data collection for this systematic review was performed by considering an eligibility criterion, which is presented in the [Table 1](#) below.

Ethical approval was obtained from the research management center at the university. Researchers had to first submit the title of the project, what the author planned to do for the interviews and details of study objectives. The officer at the research management center after reviewing the documents will then issue a letter of clearance for the data collection to be carried out. The approval letter was then obtained, and the reference number of this letter is EA3222021.

Data sources

The published research articles from the online databases ([Table 2](#)) were considered as the sources of data for the present research. Literature search was performed by using keywords and search terms. Search terms included 'electronic patient care report', 'e-PCR', 'response time', 'prehospital care', and 'prehospital medical care'. The extraction of research articles was carried out by using the following online databases.

Table 1. Eligibility criteria.

	Inclusion criteria	Exclusion criteria
Language of Publication	English	Languages other than English
Date of Publication	2010 – 2021	Published before the year 2010
Journal	<ul style="list-style-type: none"> - Peer reviewed - Access to full-text versions 	Non peer reviewed
Research Design	<ul style="list-style-type: none"> - Randomised Controlled Trials - Qualitative Research - Mixed Method research 	<ul style="list-style-type: none"> - Observational research - Pilot research
Research Population	Patients requiring prehospital clinical care	Inpatients
Intervention	ePCR system	PCR systems, or manual reporting
Outcomes	Reduction in response time of prehospital care	Focus on the factors other than response time

Table 2. Databases.

i. PubMed
ii. CINAHL
iii. Science Direct
iv. Springer

Data collection process

The search terms and keywords relevant to the research topic were used for the extraction of studies from the online databases, as well as grey literature. The initial screening of the extracted studies were performed by searching for titles and abstracts of studies which then contributed to removing some of the studies. The abstract screening was then performed by analysis of the complete text of the research articles. The full-text analysis further led to removing certain studies, and only N = 6 most relevant studies were included in this research.

Quality appraisal

The critical appraisal of the research studies facilitates in distinguishing between the useful and flawed studies.⁵ The online databases contain substantial resources of peer-reviewed research articles; however, the flawed studies are most often intermixed with high quality and reliable studies. For this reason, it is essential to carry out a critical evaluation of the researches on particular topics for making informed decisions regarding the inclusion of studies within the present research. The quality scales, which represent the quality of studies in numerical form, can be used for assessing the quality of the research articles. The studies included in this systematic literature review were critically appraised by using the quality checklist recommended by Keele (2007),⁶ which assign scores against research aims, research design, data collection process, adequate presentation of data, and methods of analysis for assessing the quality of studies (refer to Data availability section).

Data analysis

The thematic analysis facilitates the evaluation of the outline of research and classification of information. Thematic analysis facilitates generating themes or codes from the data and analyzing the data in different categories.⁷ Thus, thematic analysis was an appropriate method of analysis for this systematic literature review. Based on the scoring, 6 articles were selected, and two key themes were derived from these selected journals namely impacts of ePCR on quality-of-care services and e-PCR systems and reduction in response time.

Results

Outcome of the screening of literature relevant to e-PCR is further illustrated in the following sections.

- Study selection
- Study characteristics
- Sample
- Risk of bias within studies
- Principle of findings

Study selection

Following the initial search, n = 220 studies were extracted from the electronic databases, whereas n = 20 studies were extracted by searching grey literature. The initial screening of the extracted studies was carried out by analyzing the titles of researches, such that the process of screening facilitated the removal of less relevant research articles. Moreover, research article abstracts were also assessed to extract the most relevant studies, which further contributed to the removing less relevant studies. The abstract screening was then followed by a complete scrutiny of the remaining studies; following the process of screening, this systematic literature review comprised of n = 6 studies (Table 3), which were most appropriate for this research (see Data availability section). The data screening process is presented in Figure 1.

Study characteristics

The research aim must present the research purpose and the researchers' intention behind conducting research.⁸ All of the N = 6 studies demonstrated the research aim and provided a clear insight into the research purpose. For instance, A study

Table 3. Summary table.

AUTHOR	Year	Sample size	Main findings
ANCKER <i>ET AL.</i>	2015	N = 65 healthcare providers	The intensive utilisation of the EHR was associated with the increased adherence to the recommended care with reference to the meaningful use of quality measures.
YOO HUANG AND GOO	2020	N = 171 individuals	The EMS organisations possessing a technology experience as well as capability with the track record of assimilation of new knowledge successfully have been found to improve the quality of information transferred within the healthcare organisation.
LANDMAN <i>ET AL.</i>	2012	N = 13 volunteers	The implementation of e-PCR systems ensures the availability of records and automate reporting on the quality metrics.
PORTER <i>ET AL.</i>	2020	Package 2 N = 22 middle and senior managers. Package 3 N = 30 middle and senior managers for interview sessions.	The perceived benefits of EHRs include significant improvement in the quality of charts, better legibility, fast data acquisition, reports standardization, and rapid retrieval of records.
BÜRGER <i>ET AL.</i>	2018	N = 10, 853 patients' data	The rapid ambulance response possesses a strong association with the higher rate of survival from the OCHA.
FITZPATRICK, MAXWELL, AND CRAIGIE	2018	N = 69 ambulance clinicians N = 99 nursing and physician staff	The ambulance clinicians highly accepted low-tech intervention, and significantly improved the processes of data recording and information exchange.

assessed the relationship between the utilization of EHR functions by physicians and the quality of healthcare services.⁹ Another study discussed that the adoption of EHRs by healthcare organizations also influence them to pay concentration on improving emergency medical services.⁴ The research aimed to identify the levels of motivation of the management of healthcare organizations behind the adoption of e-PCR systems and the challenges associated with the implementation of e-PCR.⁴

Moreover, Yoo *et al.*³ conducted research for investigating the antecedents of task support within the context of e-PCR within the emergency medical service (EMS). Another research considered in this systematic review assessed the manner in which electronic health records could be implemented more effectively within the prehospital context for supporting a safe as well as effective shifting from acute to community-based care.¹⁰ The research also analyzed the manner in which the potential benefits of e-PCR can be maximized.

A study assessed the feasibility, as well as acceptability of a novel, and low-tech intervention, which was aimed to provide support to the clinical information recording as well as the delivery during the pre-alert.¹ This research also analyzed the feasibility of the intervention for improving the quality of handover within the prehospital, as well as emergency department settings. Bürger *et al.*¹¹ analyzed the effect of the ambulance response time on the rate of survival after resuscitation of Out of Hospital Cardiac Arrest (OHCA).

Sample

The research mentioned that the sample size selection for any research is required to be carried out with reference to the research aims.¹² Out of all of the considered studies,^{1,3,9-11} considered a large sample population. Considering a large sample size within the research facilitates the generalization of research outcomes.¹² Another study researched by administrating an online survey via the National EMS Management Association (NEMSMA), having a total of N = 1500 members.³ However, out of the targeted members, N = 171 individuals were recruited for this research. Another study recruited a total of N = 65 healthcare providers who were eligible for *meaningful use*, an EHR incentive program introduced by the federal government of the United States (US).⁹ The *meaningful use* program was introduced to promote the adoption and the use of EHR among physicians and hospitals. The study abstracted data from the office visit records during the research timeframes and included 183 095 visits with 61,977 patients. Three of the EHR functions as potential predictors, including the acceptance towards the best practice alerts, the use of data sets, and viewing of the panel reports.

Figure 1. PRISMA flow chart.

The researchers extracted N = 18 quality measures from the *meaningful use* program. Moreover, another study recruited N = 69 ambulance clinicians who were based at one city center ambulance station.¹ The study also recruited all nursing and physician staff (N = 99) based in the emergency department of Glasgow based city hospital.

In addition, another study considered the data from N = 10, 853 patients determined the impacts of the ambulance response time on the rate of hospital discharge, and also carried out a comparison of faster as well as slower EMS systems, on the number of surviving patients.¹¹ Whereas another study conducted research by adopting multiple methods and comprised four work packages, one of the packages included within the research was based on semi-structured telephone interviews, which were performed by recruiting N = 22 middle and senior managers present across N = 13 free-standing ambulance services of the UK.¹⁰ In addition, another package (package 3) recruited N = 30 middle and senior managers for interview sessions. Moreover, package 3 also include N = 11 focus group sessions with paramedics and technicians. Only one of the research conducted recruited the sample population comprised of N = 13 volunteers recruited from the web-based survey and the didactic session.⁴ However, with reference to the aim of the research, the small sample population was appropriate for acquiring the desired outcomes.

Risk of bias within studies

Out of the N = 6 considered studies, N = 3 studies mentioned the risk of bias within their studies. One study mentioned that they assessed the respondents' bias to ensure no systematic differences between the respondents and non-respondents.³ Moreover, the study also ruled out the concern of the total method bias. In addition, another study highlighted that within their research, the risk of bias was resulted due to the low rate of response from the ambulance clinicians, such that only n = 25 (36%) of the ambulance clinicians participated in the research.¹ Lastly, another study mentioned the presence of social desirability response bias within their research, such that it was reported that the participants might have misinterpreted their improvement efforts for providing the desirable answers.⁴ This study also implemented a strategy for reducing the risk of bias and elicited the details, which would be difficult for the respondents to misinterpret. Thus, out of all N = 6 studies, Landman *et al.*⁴ research mentioned the initiative taken for reducing the risk of bias.

Principle findings in studies

Thematic analysis

Impacts of ePCR on quality-of-care services

The implementation of ePCR has been reported to cause significant improvements in the quality-of-care services delivered by the healthcare organisation. A study found that the condition-specific best practices alerts as well as order sets resulted in better scores on the measures related to clinical quality, and contributes to capture the processes in screening for cancerous conditions, tobacco cessation, diabetes, as well as pneumonia vaccination.⁹ The researchers also found that there were positive associations with healthcare processes; however, no positive associations were found with healthcare outcomes related measures. It was also reported that the intensive utilisation of the EHR increased adherence to the recommended care with reference to the meaningful use of quality measures.⁹

Another research found that similar to the other field service-oriented agencies, the organisations providing EMS are required to focus on the efficacy as well as effectiveness of operations.³ However, healthcare organisations have been experiencing uncertain situations while migrating towards the ePCR. The study stated that the EMS organisations possessing a substantial technology experience as well as the capability with a recognized track record of assimilation of new knowledge successfully had been found to improve the quality of information transferred within the healthcare organisation.³

e-PCR systems and reduction in response time

A study reported that the most significant reason for adopting the e-PCR systems by the healthcare organisations was its potential for providing support to the quality assurance efforts.⁴ The research also reported that the research participants perceived that the implementation of e-PCR systems ensures the availability of records and automates reporting on the quality metrics.⁴ Moreover, the implementation of e-PCR systems also improved the response time and increased the out of hospital survival rates.

In addition, another study stated that the perceived benefits of EHRs include significant improvement in the quality of charts, better legibility, fast data acquisition, reports standardisation, and rapid retrieval of records.¹⁰ The study also found that EHR implementation facilitates in performing clinical decision making. Another research found that the rapid ambulance response possesses a strong association to the higher rate of survival from the OCHA.¹¹ The shorter ambulance response time and the availability of ePCR facilitate delivering quality care services to the service users present within the emergency wards of the hospital. Lastly the research implemented the low-tech intervention, which comprised of a double-sided A6 card.¹

The card was with a high contrast colour, with the pre-alert, and hand over the requirements regarding the clinical information on the opposite sides. Within the intervention, the boxes for the clinical variables were accessible to be written by using a marker pen; however, the included variables, as well as the final mnemonic choices, were strongly centered on the synthesised data, as well as the ambulance clinicians' needs and the staff of ED. The research found that from the perceptions of ambulance clinicians, the pre-alert, as well as the components related to handing over of the card were useful, such that approximately 76% of the respondents reported recording clinical information by using a card, and proclaimed that it was extremely useful for supporting pre-alert.¹ Moreover, approximately 65% of the sample population proclaimed that they most often or always use the card for supporting handover. Thus, overall the low-tech intervention was extremely acceptable by the ambulance clinicians and significantly improved the processes of data recording and information exchange.

Another study discussed certain challenges which are likely to be experienced by the healthcare organisations in implementing the e-PCR systems and reported that fear of increasing the ambulance run time, compromise on the availability of ambulance, and challenges in integration with the existing information systems implemented within the hospitals, were some of the most common challenging situations associated to the implementation of e-PCR systems.⁴

Limitations

The PRISMA checklist was followed while conducting this systematic review; however, research articles within this systematic review were retrieved, extracted, as well as assessed by only two researchers. Four of the included studies assessed the influence of EHRs, and e-PCR on the quality-of-care services and response time to deliver EMS.^{3,4,9,10} However, one of the researchers assessed the feasibility of an e-PCR intervention on handover quality within prehospital care.¹ Whereas, another researcher analyzed the effect of the response time of ambulance on survival rate after resuscitation of OHCA.¹¹ For this reason, all of the considered studies cannot be directly compared due to differences in the aims of the research. Thus, the inclusion of heterogenous researchers hindered a direct comparison of the outcomes of studies.

Conclusion

The overall conclusion for this systematic review revealed that the EMS organizations possessing a substantial experience to deal with technology as well as capability with the proven track record of assimilation of new knowledge in a successful manner had been found to improve the quality of information transferred within the healthcare organization. Rather than sticking to the PCR systems, the organizations have been focusing on implementing e-PCR systems. The most significant reason healthcare organizations have been adopting the e-PCR systems by the healthcare organizations was its potential for providing support to the quality assurance efforts. The implementation of e-PCR systems ensures the availability of records, automates reporting on the quality metrics, improves the response time, and increases the out of hospital rates of survival.

Data availability

Figshare. Appendix. DOI: <https://doi.org/10.6084/m9.figshare.16620403>

Reporting guidelines

Figshare. Prisma Checklist. DOI: <https://doi.org/10.6084/m9.figshare.17032568>

Figshare. Prisma Flowchart. DOI: <https://doi.org/10.6084/m9.figshare.17032592>

Data are available under the terms of the [Creative Commons Zero “No rights reserved” data waiver](#) (CC0 1.0 Public domain dedication).

Author contribution

Main author: Conceptualization, Formal Analysis, Funding Acquisition, Investigation, Methodology, Resources, Software, Supervision, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing.

Co-author 1: Investigation, Methodology, Project Administration, Supervision, Validation, Writing – Original Draft Preparation, Writing – Review & Editing.

Co-author 2: Validation, Writing – Review & Editing.

References

1. Fitzpatrick D, Maxwell D, Craigie A: **The feasibility, acceptability and preliminary testing of a novel, low-tech intervention to improve prehospital data recording for pre-alert and handover to the Emergency Department.** *BMC Emergency Medicine*. 2018; **18**(1): 1–10. [Publisher Full Text](#)
2. Jensen SM, Lippert A, Østergaard D: **Handover of patients: a topical review of ambulance crew to emergency department handover.** *Acta Anaesthesiologica Scandinavica*. 2013; **57**(8): 964–970. [PubMed Abstract](#) | [Publisher Full Text](#)
3. Yoo CW, Huang CD, Goo J: **Task support of electronic patient care report (ePCR) systems in emergency medical services: An elaboration likelihood model lens.** *Information & Management*. 2020; **57**(6): 103336. [Publisher Full Text](#)
4. Landman AB, Lee CH, Sasson C, *et al.*: **Prehospital electronic patient care report systems: early experiences from emergency medical services agency leaders.** *PLoS One*. 2012; **7**(3): e32692. [PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
5. Umesh G, Karippacheril JG, Magazine R: **Critical appraisal of published literature.** *Indian Journal of Anaesthesia*. 2016; **60**(9):

- 670–673.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
6. Keele S: **Guidelines for performing systematic literature reviews in software engineering (Vol. 5).** Technical report, Ver. 2.3 EBSE Technical Report. EBSE. 2007.
 7. Roberts K, Dowell A, Nie JB: **Attempting rigour and replicability in thematic analysis of qualitative research data; a case study of codebook development.** *BMC Medical Research Methodology*. 2019; **19**(1): 1–8.
[Publisher Full Text](#)
 8. Doody O, Bailey ME: **Setting a research question, aim and objective.** *Nurse Researcher*. 2016; **23**(4): 19–23.
[PubMed Abstract](#) | [Publisher Full Text](#)
 9. Ancker JS, Kern LM, Edwards A, *et al.*: **Associations between healthcare quality and use of electronic health record functions in ambulatory care.** *Journal of the American Medical Informatics Association*. 2015; **22**(4): 864–871.
[PubMed Abstract](#) | [Publisher Full Text](#)
 10. Porter A, Badshah A, Black S, *et al.*: **Electronic health records in ambulances: the ERA multiple-methods study.** *Health Services and Delivery Research*. 2020; **8**(10): 1–140.
[Publisher Full Text](#)
 11. Bürger A, Wnent J, Bohn A, *et al.*: **The effect of ambulance response time on survival following out-of-hospital cardiac arrest: an analysis from the German resuscitation registry.** *Deutsches Ärzteblatt International*. 2018; **115**(33–34): 541–548.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
 12. Kaplan RM, Chambers DA, Glasgow RE: **Big data and large sample size: a cautionary note on the potential for bias.** *Clinical and Translational Science*. 2014; **7**(4): 342–346.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)

The benefits of publishing with F1000Research:

- Your article is published within days, with no editorial bias
- You can publish traditional articles, null/negative results, case reports, data notes and more
- The peer review process is transparent and collaborative
- Your article is indexed in PubMed after passing peer review
- Dedicated customer support at every stage

For pre-submission enquiries, contact research@f1000.com

F1000Research