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A standardized template for measuring and reporting telephone pre-arrival cardiopulmonary resuscitation instructions☆

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ABSTRACT

Background: Bystander cardiopulmonary resuscitation (CPR) improves out-of-hospital cardiac arrest (OHCA) survival. Telephone CPR (TCPR) comprises CPR instruction given by emergency dispatchers to bystanders responding to OHCA and the CPR performed as a result. TCPR instructions improve bystander CPR rates, but the quality of the instructions varies widely. No standardized system exists to critically evaluate the TCPR intervention.
Methods: Investigators analyzed audio recordings of suspected OHCA calls from a large regional 9-1-1 dispatch center and applied descriptive terms, a data collection tool and a six metric reporting template to describe TCPR. Data were obtained from October 2010 to November 2011. Dispatcher recognition of CPR need, delivery of TCPR instructions, and bystander CPR performance were documented.
Results: A total of 590 calls were analyzed. Call evaluators achieved "near perfect agreement" with 5/6 reporting metrics and "strong agreement" on the 6th metric: percentage of calls where need for CPR was recognized by dispatch. CPR was indicated in 317 calls and already in progress in 94. Dispatchers recognized the need for TCPR in 176 of the 223 (79%) remaining calls. CPR instructions were started in 65/223 (29%) and bystander CPR resulting from TCPR instructions was started in 31/223 (14%).
Conclusion: We developed and demonstrated successful implementation of a simple data collection and reporting system for critical evaluation of the TCPR intervention. A standardized methodology for measuring TCPR is necessary to perform on-going quality improvement, to establish performance standards, and for future research on how to optimize bystander CPR rates and OHCA survival.
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1. Introduction

Bystander initiated cardiopulmonary resuscitation (CPR) has been shown to increase survival,[1] however it is performed in less than half of all out-of-hospital cardiac arrests (OHCA).[2,3] Dispatch-assisted CPR, also known as Telephone CPR (TCPR), has been shown to double rates of bystander CPR[4] and provides an opportunity to systematically increase bystander CPR rates and survival on a large scale.[5] Previous work by Clawson et al. describing the development of pre-arrival instruction protocols for OHCA and subsequent quality improvement measures have improved bystander TCPR rates.[6] TCPR instruction is defined as real-time CPR guidance offered to callers by emergency dispatchers or other trained call takers. The goal is to provide bystanders with "just-in-time" instructions to (1) identify whether the victim is in cardiac arrest and (2) instruct the bystander to perform CPR prior to the arrival of trained rescuers. Many believe that one of the system factors responsible for the enormous variability in OHCA outcomes across communities is the quality and timeliness of the TCPR process.

The importance of collecting dispatch center characteristics, identifying barriers to bystander TCPR delivery, and standardized reporting of TCPR has been proposed by Castren et al. as a means

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to compare and improve bystander TCPR delivery among dispatch centers worldwide.[7] This work seeks to further standardize the method of recording and reporting TCPR by describing the application of descriptive terms, a codified measurement tool, and a standardized reporting format for assessing the quality of TCPR. The measurement tool and reporting template were applied to baseline data prior to a dedicated quality improvement initiative. The goal is to promote a reporting system which enables on-going provider and system-level feedback, system-to-system comparisons and to aid in answering important research questions in order to improve the critical intervention of TCPR.

2. Research methods

2.1. Study population and setting

Audio recordings of emergency dispatch calls were obtained from a large regional combined fire, EMS, and law enforcement dispatch center serving a population of approximately 712,000 people in Arizona.[8] The agency registered 40,118 medical calls in 2011. This center employs an automated medical computer aided dispatch (CAD) system [Incident Management, version 8.1.3, Intergraph, Huntsville, AL] and functions horizontally with both call takers and dispatchers working in parallel. Call takers at this center do not dispatch units. Once the call taker identifies the location and classification of a call the information is automatically and electronically sent to the dispatcher through the CAD. Dispatchers may choose to act temporarily as call takers while also dispatching calls during high call volume periods.

2.2. Data collection

All medical calls received by this dispatch center are assigned a "call type" when initially processed. Call types can either be assigned to "med" or "code." A "code" designation signified that the caller reports the victim as not breathing and not conscious. Call takers are also educated to triage as a "code" if there is any suspicion of an OHCA. If responding EMS units discover a "code" that was not reported by the caller or occurred after the call then the "call type" is amended retrospectively and applied to the call recording database. Calls are not always amended if the arrest occurs after leaving the scene during transport.

On duty dispatch center staff reviewed all medical calls recorded from October 1, 2010 to November 6, 2011 and searched the "call type" field for the term "code." The audio recordings corresponding to the resulting search were copied onto encrypted flash drives for analysis. Call date/time and unique response "run" numbers, corresponding to each call, were entered into an Excel spreadsheet [Excel v14.5, Microsoft, Redmond, WA]. This was accomplished during regular overnight shifts in addition to their usual responsibilities.

This agency participates in the Save Hearts in Arizona Registry and Education (SHARE) Program which has been previously described in detail and includes a voluntary Utstein-style OHCA EMS database linked with in-hospital post-arrest process and outcome data from hospitals.[9] SHARE collects data as part of a statewide cardiac arrest quality-improvement initiative sponsored by the Arizona Department of Health Services and the University of Arizona. The SHARE Program has created measurement tools modeled after the Utstein OHCA template to allow epidemiologic, clinical, and outcomes analyses of OHCA and TCPR.[10] These tools are available online at www.azshare.gov.

OHCA has been designated a major public health problem by the Arizona Department of Health Services. Thus, the SHARE Program initiatives and its data collection are exempt from the Health Insurance Portability and Accountability Act. By virtue of SHARE being a health department–sponsored public health initiative, the Arizona Department of Health Services' Human Subjects Review Board and the University of Arizona Institutional Review Board have determined that neither the interventions nor their evaluation constitutes human subjects research and have approved the publication of de-identified data.

Here we apply and report TCPR baseline data as a means to assess our measurement and reporting tool. Additionally, the baseline data serves as a benchmark from which to measure improvements in process metrics. The impact of such gains on patient outcomes can be subsequently gauged by linking process data with prehospital and hospital records.

2.3. Call processing

Investigators developed a standardized call-evaluation process and utilized an electronic web-based 21-element data collection tool (Appendix 7.1) to capture relevant dispatcher/caller interaction data in cases of suspected OHCA.[11] Evaluators independently processed 10 of the same 9-1-1 recordings and compared findings to assure consistency. Examples of data elements include: victim status assessment, dispatcher recognition of CPR need, delivery of TCPR instructions, and the verification of performance or non-performance of bystander CPR. Please refer to Appendix 7.2 for detailed descriptions and definitions of the 21 data elements.

The indication for performing CPR was defined as the bystander reporting that the victim was not conscious and was not breathing "normally." Not breathing normally was defined as the caller describing either complete absence of breathing, agonal breathing or a rapid or slow respiratory rate. Investigator identification of audible agonal breaths was also considered not breathing normally. Calls where CPR was in progress or initiated spontaneously by bystanders were excluded from key metric percentage and time analysis. Call taker recognition of the need for CPR is when they say any of the following in connection with a response to the patient's condition: "cardiopulmonary resuscitation," "CPR," "chest compressions," "compressions," "continuous chest compressions," "hands-only CPR," "CCR," "rescue breaths," "rescue breathing," "ventilations," or "rescue ventilations." TCPR instructions are defined as any portion of dispatcher-to-caller communication that detailed the delivery of either chest compressions and/or rescue breaths. Performance of bystander TCPR was defined as any chest compressions delivered to the victim in response to TCPR instructions (i.e., ventilations without chest compressions were not counted as TCPR performed) and the time is noted when the first compression is audible or the caller/rescuer indicates he or she has started compressions (i.e., by counting with dispatcher).

Audio recordings were analyzed using QuickTime [Version v.10, Apple Inc. Cupertino, CA]. Relevant data elements were recorded in the secure, web-based MySQL data collection system and stored in encrypted form on password-protected Windows 2008 servers only accessible to approved IP addresses. Six key performance metrics were derived from the current American Heart Association (AHA) dispatch CPR scientific statement and European Resuscitation Council (ERC) resuscitation guidelines[12,13]:

1) Median elapsed time interval from call receipt to dispatcher recognition of CPR need (time zero defined as the second at which the caller was acknowledged by the call taker on the recording).
2) Median elapsed time interval from time zero until start of CPR instructions.
3) Median elapsed time interval from time zero until first chest compression actually performed by bystander.

4) Percent of TCPR-indicated calls where need for CPR was recognized by dispatch.
5) Percent of TCPR-indicated calls where TCPR instructions were started.
6) Percent of TCPR-indicated calls where bystander TCPR was initiated.

A standardized reporting template was developed (Appendix 7.3) and was modeled after the Utstein template for reporting OHCA data.[14] This simple template was designed to (1) support efficient reporting of the six key metrics, (2) to serve as the basis for comparing performance among dispatch centers, (3) to provide the future bases for analyzing the association between the key metrics and patient outcomes and (4) utilizing these multi-system analyses to ultimately help develop benchmark targets and best-practices for dispatch centers.

2.4. Statistical analysis

To assess inter-rater reliability, a set of 25 randomly-selected calls from the recording database were analyzed by each member of the data collection team. The data collection team is comprised of 7 trained call evaluators who are part of the SHARE study group. Randomization was achieved through the arbitrary selection of a start point in the database and collection of 25 sequential calls from that start point for analysis. Statistical analysis [SAS, version 9.3, SAS, Cary, NC] was performed on the results to investigate the level of agreement of the cases and data elements as well as reproducibility between investigators. The agreement coefficient (AC1) and inter-class correlation coefficient (ICC) were calculated utilizing the definition "the probability of two raters agreeing for cause, based on all ratings except those associated with subjects that may produce an agreement by pure chance."[15–20]

3. Results

3.1. TCPR reporting template data

A total of 590 9-1-1 calls were analyzed (Fig. 1). From these, 367 were excluded: 139 due to barriers preventing CPR (dangerous environment, physically incapable, etc.), 94 for CPR already in progress, 90 for CPR not being indicated (e.g., conscious and/or breathing normally), 42 for victim status changes (e.g., awakens during call), and 2 for incomplete call recordings. This left 223 calls where CPR was indicated (study group).

3.2. Inter-rater reliability

Analysis of the level of agreement and reproducability of appraising TCPR between investigators is shown below (Table 1). All 7 members of the data collection team were able to achieve "near perfect agreement" with 5/6 key metrics. The team demonstrated "strong agreement" on the 6th metric: percentage of calls where need for CPR was recognized by dispatch.

3.3. Dispatcher performance data

Dispatchers recognized the need for CPR in 176 calls (79%) and failed to recognize the need in 47 calls (21%). TCPR instructions were given in 29% (65/223) of calls and bystander CPR was initiated in 14% (31/223) (Table 2). TCPR instructions were given in 37% (65/176) of calls in which CPR need was recognized by the dispatcher and 48% (31/65) of victims received CPR when the bystander received TCPR instruction.

The median time interval to dispatcher recognition of CPR need from the start of the call was 69 s [Q1 = 44 s, Q3 = 104.5 s]

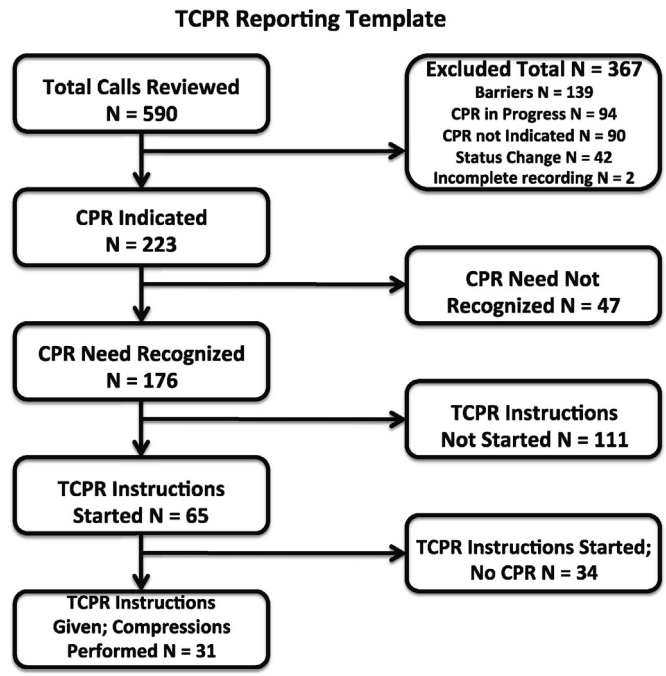

Fig. 1. TCPR reporting template.

(Table 2). The median time interval from start of call to initiation of CPR instructions was 175 s [Q1 = 139 s, Q3 = 207 s]. The median time from start of call to initiation of first compression was 251 s [Q1 = 189 s, Q3 = 306 s].

4. Discussion

Our objective was to develop a standardized method by which 9-1-1 call centers can collect and analyze data generated during TCPR calls. This method of data collection could be used for both provider and system-level quality improvement in such a way as to apply the concepts and recommendations given in the 2012 AHA Scientific Statement and 2010 ERC resuscitation guidelines.[12,13] To our knowledge this is the first attempt to report the application of such a standardized reporting template in the peer-reviewed literature. The method of reporting remains simple and manageable while expanding upon the work of Castren et al. by providing more detail than whether or not prearrival CPR instructions were provided.[7] The authors believe that both the quality and timeliness of prearrival instructions are of critical importance to maximizing the benefits of bystander CPR.

Bystander CPR has a powerful impact on survival from OHCA but public CPR training alone has not resulted in the majority of citizens being able and willing to perform CPR.[10] 9-1-1 emergency dispatchers and call takers frequently have the opportunity to help bystanders recognize cardiac arrest and perform CPR and are a vital link in the chain of survival.[4,21] The combination of both strategies likely offers the best chance of increasing overall bystander CPR rates. Additionally, because time to initiating CPR and defibrillation are closely related to survival after cardiac arrest, the times to recognition and initiating TCPR instructions are likely clinically important.[22] Thus the quality of TCPR instructions (% events recognized, time to initiation and time to first chest compression) are important data to accurately measure.

The current variability in the implementation and measurement of the TCPR intervention may be, in part, responsible for the large disparities which exist in outcomes.[5] Simply measuring the performance of TCPR (yes/no), without evaluating the time frames and quality of the instruction process, may not be an accurate measure

Table 1
Inter-rater reliability.

Metric	Correlation coefficient	*P*-value	Agreement degree
Median elapsed time before dispatcher recognition of CPR need	0.895	0.00	Near perfect agreement
Median elapsed time before start of TCPR instructions	0.917	0.00	Near perfect agreement
Median elapsed time before first chest compression	0.989	0.00	Near perfect agreement
	Agreement coefficient		
Percentage of TCPR indicated calls need for CPR recognized by dispatch	0.698	0.00	Strong agreement
Percentage of TCPR indicated calls TCPR instructions started	0.891	0.00	Near perfect agreement
Percentage of TCPR indicated calls bystander TCPR initiated	0.961	0.00	Near perfect agreement

Table 2
Key TCPR performance metrics.

Median elapsed time before dispatcher recognition of CPR need	69 s	[Q1 = 44, Q3 = 105]
Median elapsed time before start of TCPR instructions	175 s	[Q1 = 139, Q3 = 207]
Median elapsed time before first chest compression	251 s	[Q1 = 189, Q3 = 306]
Percentage of TCPR indicated calls need for CPR recognized by dispatch	79%	(176/223)
Percentage of TCPR indicated calls TCPR instructions started	29%	(65/223)
Percentage of TCPR indicated calls bystander TCPR initiated	14%	(31/223)

of the effectiveness of TCPR. For example, a dispatcher who helps get chest compressions started 7 min after receipt of an emergency call may have far less benefit on outcome compared to starting CPR 1 min after call receipt. Yet both callers received TCPR instructions.

An effective evaluation of TCPR entails listening to OHCA call recordings. The extreme variability in circumstances surrounding each call also requires clear definitions that are standardized and yet flexible enough to be adapted to unique events. While the large number of circumstances is a challenge to standardization, we created a data collection tool (Appendix 7.1) and data dictionary that specifically defined each element (Appendix 7.2). We realize that in very large dispatch centers and centers with very limited resources, analyzing every OHCA call recording may not be feasible. In such cases, it may be practical to analyze at least a representative and meaningful subset of suspected OHCA calls to allow ongoing assessment of dispatch center performance.

While some local measurement systems exist, currently there is no standardized methodology to record, report and evaluate these process measures, thus limiting intra-agency benchmarking and inter-agency comparisons, formation of performance standards, and future research. We believe that a standardized reporting template (similar to Utstein) is needed to enable the evaluation of each emergency CPR call and the performance of call centers longitudinally. Our proposed TCPR reporting template was not intended to be exhaustive, but rather concise and easily applied by a broad range of 9-1-1 call centers. It encompasses six definable, accessible, and reproducible "key" TCPR metrics: (1) elapsed time to recognition of need for CPR, (2) time to start of TCPR instructions, (3) time to first chest compression, (4) proportion of calls where need for CPR was identified, (5) proportion of calls where CPR instructions were given, and (6) proportion of calls where bystander CPR was performed (Appendix 7.3). Thus allowing thorough evaluation of the entire process and understanding of where lapses or delays in the TCPR process may be occurring.

We chose this particular 9-1-1 emergency call center because it did not previously have a structured TCPR measurement or quality improvement process, but was able and willing to help develop one. Barriers to TCPR delivery were identified in 24% (139/590) of all calls. There are significant language, cultural, and even physical challenges to getting lay rescuers to perform CPR with telephone instructions. These factors likely vary between communities. It is important to document the reasons TCPR is not possible and look for ways to improve the cardiac arrest identification and TCPR instruction process. Exclusion of barrier calls was important in order to avoid artificially lowering TCPR rates. Dispatchers failed to recognize the need for CPR in 47 (21%) of the 223 calls without identified barriers and in which CPR was both indicated and not already in progress. In calls that were recognized, identification of the need for CPR took a significant amount of time (median 69 s, IQR: 44, 104.5). TCPR instructions were initiated in 29% (65/223) of calls where instructions were indicated. Even though recognition typically occurred in just over a minute, the median time interval from the start of the call until the initiation of CPR instructions was nearly 3 min (median 175 s, IQR: 139, 207). Bystander TCPR was provided in 14% (31/223) of indicated cases and was typically initiated long after the start of the call (median 251 s, IQR: 189, 306). In response to the findings reported in this paper, these data were subsequently used in a comprehensive dispatch center TCPR protocol revision and training initiative.

5. Limitations

First, we acknowledge that using the search term "code" to identify suspected cardiac arrest calls using the dispatch center's CAD system is an imperfect method for identifying all cardiac arrest calls. Some cardiac arrests which occurred during transport and cases not properly labeled as a "code" in the CAD system were not included in the data analysis. Thus, our results could potentially be impacted by selection bias related to unidentified, excluded calls. Additionally, all CAD systems are not the same which could impact the way a community using a different CAD system identifies code calls.

Additionally, suspected OHCA calls are often complex and stressful events for both the dispatcher and the caller. This can make assessment of these calls challenging. While we attempted to standardize the TCPR process analysis, some aspects of evaluating TCPR are not an exact science and require personal judgment and interpretation.

A near perfect agreement was achieved among evaluators for 5 out of 6 key TCPR performance metrics with our tool. Evaluators achieved strong (but not perfect) agreement for identifying whether dispatchers recognized the need for CPR. This limitation may be the result of a non-optimal or difficult-to-apply definition for identifying the specific audio evidence that is required to confirm dispatcher recognition of CPR need. However, it may simply reflect the inherent complexity of TCPR calls and may remain at least somewhat ambiguous regardless of how rigorously the parameter is defined.

Finally, while we selected a large regional 9-1-1 center that we believed to be representative of other centers, the applicability of

this tool to other call centers remains unknown. The wide variation in size, structure, and administration of emergency call centers in the United States may present challenges to applying this tool. Future validation of the tool in various system types will be necessary to answer the questions related to the transportability of the tool.

6. Conclusion

We describe the development, application and assessment of inter-rater reliability of a standardized TCPR measurement tool that can be used to evaluate an EMS system's process for providing TCPR. Future study is required to evaluate whether this tool can be widely used at other centers and has the potential to aid systems in increasing the rate of bystander CPR and to improve OHCA outcomes.

Conflict of interest statement

Christian Dameff, Tyler Vadeboncoeur, Jeffrey Tully, Micah Panczyk, Aaron Dunham, Ryan Murphy, Uwe Stolz, Vatsal Chikani, Daniel Spaite, and Bentley Bobrow have no conflict of interest to declare.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.resuscitation.2014.02.023

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