Time Delays on the Identification of the Need for CPR for Limited English Proficient 9-1-1 Callers

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Abstract

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Background: A substantial percentage of the U.S. population does not speak English well (Limited English proficient [LEP]). When a LEP reporting person (RP) calls 9-1-1 for a cardiac arrest and receives Telephone-Assisted Cardiopulmonary Resuscitation (T-CPR) from the dispatch call receiver (CR), communication barriers may cause delays to initiating bystander T-CPR. This study investigates the causes of delays in CR recognition of the need for CPR and delivery of T-CPR to LEP and non-LEP reporting persons in cardiac arrest emergencies.

Methods: The cohort consisted of 76 LEP and 76 non-LEP confirmed out-of-hospital cardiac arrest calls in King County, WA in 2010-2012. CPR determination times and CPR introduction-to-instruction time intervals were analyzed for causes of delays using independent sample t-tests.

Results: The CPR determination time was 53% longer for LEP calls than non-LEP calls ($p < 0.001$). Three delay causes significantly lengthened determination time in LEP calls: due to RP language difficulties (48% longer, $p = 0.010$), RP not knowing answers to CR questions (54% longer, $p = 0.006$), and CR not initially recognizing CPR need (56% longer, $p = 0.015$). Three delay causes significantly lengthened determination time in non-LEP calls: delays due to RP leaving phone (69% longer, $p = 0.009$), due to unclear RP responses (77% longer, $p = 0.001$), and RP not knowing answers to CR questions (60% longer, $p < 0.001$). The CPR introduction-instruction time gap was 70% shorter for LEP calls than non-LEP calls ($p = 0.111$). Within the LEP group, the only significant delay was that due to the CR asking if the RP wanted to do CPR (81% longer, $p = 0.003$). Within the non-LEP group, the only significant delay was that due to the RP being confused about whether or not the patient was breathing (86% longer, $p = 0.002$).

Conclusion: Many of the significant causes of delays found in this study involved communication barriers between the RP and CR. Improvements to training dispatchers and the population served may address communication insufficiencies as well as the level of familiarity with emergency situations among the general population.

Tables

Table 1
Description of Study Variables

Variable	Description
TimeDeterminationCPR	Time (in seconds) at which sufficient information was received to provide the CR with a determination for the need for CPR
DelayedLeftPhone	Recognition of need for CPR delayed because RP left phone
DelayedNotatScene	Recognition of need for CPR delayed because RP was not at scene
DelayedEmotional	Recognition of need for CPR delayed because RP was emotional
DelayedRedundant	Recognition of need for CPR delayed because redundant questions were asked by CR
DelayedLang	Recognition of need for CPR delayed because of RP language difficulties
DelayedNoElab	Recognition of need for CPR delayed because CR kept repeating language that RP could not understand
DelayedAmbiguous	Recognition of need for CPR delayed because RP gave unclear responses
DelayedDoesnotknow	Recognition of need for CPR delayed because RP did not know answer to CR questioning
DelayedNotProtocol	Recognition of need for CPR delayed because CR did not follow protocol
DelayedMisdiagnosis	Recognition of need for CPR delayed because CR did not initially recognize need for CPR
DelayedMedHist	Recognition of need for CPR delayed because CR asked about medical history
DelayedIrrelevant	Recognition of need for CPR delayed because CR asked irrelevant questions
DelayedUnconscious	Recognition of need for CPR delayed because CR missed that patient was unconscious
DelayedBreath	Recognition of need for CPR delayed because CR missed that patient was not breathing normally
TimeGapCPR	Time interval (in seconds) elapsed between the CR introduction of CPR and start of first CPR instruction
GapWanttoCPR	Start of CPR delayed because CR asked if RP wanted to do CPR
GapDoesnotknowCPR	Start of CPR delayed because RP expressed concern that they do not know CPR
GapBreath	Start of CPR delayed because RP was confused about whether or not patient was breathing
GapEmotion	Start of CPR delayed because RP was emotional
GapConsc	Start of CPR delayed because RP was confused about whether or not patient was conscious
GapHelpNotComing	Start of CPR delayed because RP thought that help was not coming
GapLeftPhone	Start of CPR delayed because RP left phone
GapOtherRoom	Start of CPR delayed because patient was in a different room from RP

RP = reporting person.
CR= call receiver.

Table 2
Patient, location, and reporting person characteristics (N = 152)

Characteristic	N (%)
Gender	
Female	60 (39)
Male	92 (61)
Age	
< 2 years	6 (4)
20-29	4 (3)
30-39	6 (4)
40-49	10 (7)
50-59	18 (12)
60-69	22 (14)
70-79	46 (30)
80-89	31 (20)
90-99	9 (6)
Location	
Home	94 (62)
Nursing Home	50 (33)
Public	8 (5)
Multiple RPs	
No	120 (79)
Yes	32 (21)
Any RPs were a child	
No	144 (95)
Yes	8 (5)
Location of RP to patient	
Same room	124 (82)
Different room	21 (14)
Different building	7 (5)

Table 3a
Causes for delays associated with the CPR Determination Time

Delay Type	N	%Yes*
DelayedLeftPhone		
Combined	152	11%
LEP	76	16%
English	76	5%
DelayedNotatScene		
Combined	152	7%
LEP	76	9%
English	76	4%
DelayedEmotional		
Combined	152	10%
LEP	76	11%
English	76	9%
DelayedRedundant		
Combined	152	34%
LEP	76	38%
English	76	30%
DelayedLang		
Combined	152	15%
LEP	76	30%
English	76	0%
DelayedNoElab		
Combined	152	1%
LEP	76	0%
English	76	1%
DelayedAmbiguous		
Combined	152	13%
LEP	76	21%
English	76	5%
DelayedDoesnotknow		
Combined	152	11%
LEP	76	11%
English	76	12%
DelayedNotProtocol		
Combined	152	33%
LEP	76	36%
English	76	30%
DelayedMisdiagnosis		
Combined	152	8%
LEP	76	11%

English	76	5%
DelayedMedHist		
Combined	152	9%
LEP	76	13%
English	76	4%
DelayedIrrelevant		
Combined	152	24%
LEP	76	29%
English	76	18%
DelayedUnconscious		
Combined	152	9%
LEP	76	14%
English	76	3%
DelayedBreath		
Combined	152	18%
LEP	76	20%
English	76	16%

LEP = limited English proficiency.
* Corresponds to presence of delay among abstraction records.

Table 3b
Causes for delays associated with the CPR Introduction-Instruction Time Interval

Delay Type	N	%Yes*
GapWanttoCPR		
Combined	66	15%
LEP	37	19%
English	29	10%
GapDoesnotknowCPR		
Combined	65	6%
LEP	36	8%
English	29	3%
GapBreath		
Combined	65	15%
LEP	35	9%
English	30	23%
GapEmotion		
Combined	64	11%
LEP	35	9%
English	29	14%
GapConsc		
Combined	65	0%
LEP	36	0%
English	29	0%
GapHelpNotComing		
Combined	65	0%
LEP	35	0%
English	30	0%
GapLeftPhone		
Combined	67	4%
LEP	36	3%
English	31	6%
GapOtherRoom		
Combined	65	2%
LEP	35	0%
English	30	3%

LEP = limited English proficiency.
* Corresponds to presence of delay among abstraction records.

Table 4
9-1-1 call outcome time (in seconds) comparisons

Outcome Statistics	Median	N
TimeDeterminationCPR		
Combined*	58.5	130
LEP*	89.0	65
English*	39.0	65
TimeGapCPR		
Combined† ‡	4	95
LEP† ‡	4	52
English† ‡	7	43

LEP = limited English proficiency.
* Absent 14.5% overall (n = 22), 14.5% (n = 11) among limited English proficient cases and 14.5% (n = 11) among English fluent cases.
† Absent 37.5% overall (n = 57), 31.6% (n = 24) among limited English proficient cases and 43.4% (n = 33) among English fluent cases.
‡ Log_{10} transformation of time gaps equal to zero resulted in 32 (33.7%) overall dropped values, 17 (32.7%) from the LEP, and 15 (34.9%) from the English group.

Table 5a
9-1-1 call time for the need for CPR determination analysis

T-test for Log_{10}-Transformed Time that the need for CPR should have been determined by call receiver by *Variable*	Mean Difference	Percent Difference (%)	p-value	ANOVA p-value*
Language	0.32	53	0.000	
DelayedLeftPhone				0.024
Combined	0.14	27	0.391	
LEP	-0.11	-30	0.579	
English	0.51	69	0.009	
DelayedNotatScene				N/A
Combined	0.36	56	0.287	
LEP	0.19	36	0.542	
English	N/A	N/A	N/A	
DelayedEmotional				0.726
Combined	0.04	10	0.753	
LEP	-0.01	-2	0.968	
English	0.07	16	0.619	
DelayedRedundant				0.843
Combined	0.11	23	0.143	
LEP	0.05	12	0.623	
English	0.08	17	0.370	
DelayedLang				N/A
Combined	0.43	63	0.000	

LEP	0.29	48	0.010	
English	N/A	N/A	N/A	
DelayedNoElab				N/A
Combined	N/A	N/A	N/A	
LEP	N/A	N/A	N/A	
English	N/A	N/A	N/A	
DelayedAmbiguous				0.042
Combined	0.33	53	0.000	
LEP	0.11	23	0.224	
English	0.65	77	0.001	
DelayedDoesnotknow				0.790
Combined	0.40	60	0.000	
LEP	0.33	54	0.006	
English	0.40	60	0.000	
DelayedNotProtocol				0.179
Combined	0.13	26	0.122	
LEP	0.20	37	0.058	
English	-0.01	-3	0.903	
DelayedMisdiagnosis				0.250
Combined	0.32	52	0.027	
LEP	0.36	56	0.015	
English	0.03	7	0.720	
DelayedMedHist				0.499
Combined	0.17	32	0.134	
LEP	0.00	0	0.994	
English	N/A	N/A	N/A	
DelayedIrrelevant				0.510
Combined	0.18	35	0.035	
LEP	0.19	36	0.055	
English	0.08	17	0.554	
DelayedUnconscious				0.708
Combined	0.22	40	0.023	
LEP	0.10	21	0.306	
English	N/A	N/A	N/A	
DelayedBreath				0.575
Combined	0.07	14	0.485	
LEP	-0.02	-4	0.903	
English	0.09	18	0.460	

LEP = limited English proficiency.
*ANOVA values provided only for the interaction between language and delay type.
N/A due to low frequency of comparison groups within t-test and/or ANOVA.

Table 5b
9-1-1 call time gap between CPR introduction and instruction analysis

T-test for Log_{10}-Transformed Time gap between CPR introduction and start of instruction by *Variable*	Mean Difference	Percent Difference (%)	p-value	ANOVA p-value*
Language	-0.23	-70	0.111	
GapWanttoCPR				0.166
Combined	0.45	64	0.014	
LEP	0.72	81	0.003	
English	0.05	11	0.888	
GapDoesnotknowCPR				0.911
Combined	0.31	51	0.087	
LEP	0.37	57	0.161	
English	N/A	N/A	N/A	
GapBreath				0.373
Combined	0.72	81	0.001	
LEP	0.46	65	0.195	
English	0.85	86	0.002	
GapEmotion				0.194
Combined	0.42	62	0.238	
LEP	N/A	N/A	N/A	
English	0.22	40	0.563	
GapConsc				N/A
Combined	N/A	N/A	N/A	
LEP	N/A	N/A	N/A	
English	N/A	N/A	N/A	
GapHelpNotComing				N/A
Combined	N/A	N/A	N/A	
LEP	N/A	N/A	N/A	
English	N/A	N/A	N/A	
GapLeftPhone				0.126
Combined	0.16	31	0.746	
LEP	N/A	N/A	N/A	
English	0.53	70	0.380	
GapOtherRoom				N/A
Combined	N/A	N/A	N/A	
LEP	N/A	N/A	N/A	
English	N/A	N/A	N/A	

LEP = limited English proficiency.
*ANOVA values provided only for the interaction between language and delay type.
N/A due to low frequency of comparison groups within t-test and/or ANOVA.

Introduction

Every year approximately 300,000 cardiac arrests occur outside medical care facilities in the Unites States.[1] When 9-1-1 is dialed by a reporting person (RP), often times an arrest witness or bystander, an emergency response system activates to focus efforts on reviving the cardiac arrest victim. Commencing the response chain, emergency dispatcher call receivers (CRs) play a vital role by gathering patient information, identifying the emergency cardiac situation, and providing instructions for early cardiopulmonary resuscitation (CPR).[2] Bystanders at the scene may provide early CPR before dispatched emergency medical services (EMS) first responders arrive, which has been shown to improve the victim's chances of survival and subsequent related health outcomes.[3,4] In order to assist in the earliest delivery of CPR, CRs provide CPR instructions to reporting persons (RPs) via telephone communication in a process called Telephone-Assisted CPR (T-CPR). T-CPR relies on the bidirectional relay of information between the CR and the RP.[5] Barriers to the exchange of information between the two parties may cause delays in the delivery of T-CPR, resulting in poorer outcomes following the cardiac emergency.[6]

Furthermore, greater than 50 million people living in the US speak a language other than English at home.[7] Approximately 50% of the people living in the US whose primary language is not English speak English less than "very well," termed Limited English proficient (LEP).[8] Emergency 9-1-1 cardiac arrest calls from LEP RPs is associated with decreased provisions of bystander CPR as well as delays towards CR recognition of cardiac arrest and initiation of T-CPR compared to those from English fluent callers.[9,10] CRs report higher levels of difficulty and stress in determining the appropriate response when handling LEP calls, and believe language barriers lead to poorer victim outcomes when compared to English fluent calls.[11-13] Similarly, a

RP's perception of an emergency situation and their self-efficacy may affect their ability to manage an emergency crisis situation.[14] A previous study involving a cohort of LEP Cambodian adults indicated greater English proficiency and length of time spent in the US were strongly predictors of a person's willingness to utilize the 9-1-1 emergency system.[15] At present, substantial gaps remain in understanding the interaction between language communication barriers and EMS response.[16]

Delays that affect time to recognition of need for T-CPR and T-CPR instructions

There are many variables that affect the time it takes for the CR to recognize that the RP is reporting on a patient in need of T-CPR. Some of these delays are due to the CR's querying behaviors (like asking extra or irrelevant questions), some are due to the RP not providing clear or consistent answers to the CR's questions (like not understanding CRs questions, hanging up, or being too emotional to provide answers) and some are due to patient characteristics (such as a patient collapsing in a different room from the RP location).

This study investigates the causes of delays in CR recognition of the need for CPR and delivery of T-CPR to RP bystanders in cardiac arrest emergencies. It also analyzes the differences in the causes of these delays due to the level of RP English proficiency, comparing LEP and non-LEP calls. Due to the additional barriers in communication brought about by language differences, it is hypothesized that the causes of CPR delays will result in longer delays for calls from LEP callers relative to non-LEP callers.

Methods

Setting

This study took place in King County, Washington, in partnership with the Northwest Center for Public Health Practice and the Emergency Medical Services division of Public Health – Seattle & King County. This study was approved by the Institutional Review Board at the University of Washington.

Population

The study cohort consisted of 9-1-1 calls from bystander persons responding to victims of confirmed out-of-hospital cardiac arrests. Cases were confirmed by EMS providers at the scene of the cardiac arrest. A total of 152 cardiac arrest calls were included from the years 2010-2012, containing 76 LEP calls (as determined by the CR and noted on their Computer-Assisted Dispatch [CAD] report) and 76 matched non-LEP calls. Calls were matched based upon patient gender, arrest location, and whether multiple RP's communicated with the CR. The 9-1-1 Dispatch Centers fielding the calls involved North East King County Regional Public Safety Communication Agency ("NORCOM") and Valley Communications Center ("VALLEYCOM") for South King County, WA.

Data collection and Definitions

In this study, each cardiac arrest call was examined by a research coordinator and relevant data was abstracted into an abstraction form. Other data sources in addition to the dispatch audio recording included Medical Incidence Report Form (MIRF) which was used for case identification and Computer-Aided Dispatch (CAD) data which was used for identification of LEP cases. RP level of English proficiency was determined by the CR's subjective judgement and marked within the CAD. Patient demographic data included in the abstraction comprised of age, gender, etiology of cardiac arrest, and location of cardiac arrest. Classification of the "reporting person" abstracted from the call included whether multiple RPs spoke with the dispatcher, whether a child was an RP, and the RP's location relative to the patient at the time the emergency call was made.

Table 1 provides a detailed description of the variables included in this field study. The data set includes two time-based outcomes: the CPR determination time and the CPR introduction-instruction time gap. CPR determination time is the time in seconds at which sufficient information was received to provide the CR with a determination for the need for CPR (as determined by either the CR receiving clear information that the patient is not breathing or conscious, or the CR receiving at least two ambiguous responses to these questions) and the CPR introduction-instruction time gap is the time in seconds elapsed between the dispatcher's declaration of the need for the bystander to perform CPR and the initiation of delivering instructions over the phone to the bystander. The data set also includes variables for different causes of delay that may have contributed to these outcome times relating to dispatcher behaviors, caller characteristics, and patient characteristics (Table 1). For a subset of 30 calls a second abstractor recorded times and inter-rater reliability was calculated for all time variables and a small subset of nominal variables. Reliability for times was excellent, with 95% of times agreeing to within 5%. Kappa coefficients for two nominal variables were examined (did CR ask breathing question and did CR ask consciousness question) was calculated as 0.91 and 1, respectively. Reliability was not assessed for the variables relating to delays in CPR used in this analysis.

Statistical Analysis

Patient demographics, location of arrest, and reporting person characteristics were described using summary statistics. CPR outcome times between LEP and non-LEP callers were analyzed using independent samples t-tests as were the effects of specific delays types on CPR outcome times. Possible interaction effects between LEP status and the effects of specific delay types on times were examined using two-way analysis of variance (ANOVA) with an interaction term between LEP status and delay type. Outcome times were $\log_{10}$-transformed to reduce skewness due to multiplicative effects of absolute measurements. Results were presented as relative changes by exponentiating the estimates from the $\log_{10}$-transformed models. All statistical analyses were conducted with Stata/MP version 13.1 (StataCorp LP, College Station, TX).[17]

Three hypotheses of interest were examined:

1. LEP status will be associated with the CPR outcome times
2. The occurrence of some types of delays will be associated with CPR outcome times
3. The effect of some delay will differ based on LEP status.

Results

Patient and RP Characteristics

The 76 LEP and non-LEP 9-1-1 calls were balanced on patient demographic and location characteristics used for matching. The majority of cardiac arrests patients were men (61%) in the later decades of adulthood, suffering arrest in a place of residence (95%) (Table 2). Reporting person characteristics and their relative location to the patient exhibited minor differences between the LEP and English fluent groups with more child callers in the LEP group compared to the English fluent group (7% vs. 4% respectively).

Presence of Delays within 9-1-1 Call Abstraction

Out of the 14 delay types corresponding to the CPR determination, 12 types exhibited higher presence of delay percentages for the LEP group relative to the English fluent group (Table 3a). The remaining two delay categories, those due to CR repeating language RP could not understand and due to RP not knowing answers to CR questions, exhibited only minor (1%) differences between language groups.

In 4 of the 8 delay categories corresponding to the time gap between CPR introduction and start of instruction, the English fluent caller group exhibited higher percentages of call delays than the LEP group (Table 3b). In 2 categories of delays (those due to RP being confused about whether or not patient was conscious and due to RP thinking that help was not coming) there were no contributions to the overall time gap delay.

Association between CPR times and LEP status

Time to determination of the need for CPR and time difference between introduction of the need for CPR and start of CPR instructions are displayed in Table 4. The need for CPR was established by the CR in 85.5% (n = 130) of the calls. The overall median time for this outcome was 58.5 seconds, comprised of a median 89.0 seconds for the LEP group and 39.0 seconds for the English fluent group. Differences in CPR determination times among language groups were determined to be statistically significant, with LEP calls associated with a 53% longer CPR determination time than English calls ($p < 0.001$) (Table 5a).

For the second primary outcome measure, the time between CPR introduction and start of instruction, 37.5% (n = 57) of the records were unavailable for data analysis due to several reasons: 2 records were excluded due to data transcription errors, 15 records were excluded due to an absent CPR instruction start time, and 40 records were excluded due to absent CPR introduction and instruction start times. A greater proportion of time gap records were excluded for the English fluent group (43.4%, n = 33) than the LEP group (31.6%, n = 24). The overall median time gap outcome was 4 seconds, comprised of a 4 second median for the LEP group and 7 seconds for the English fluent group. The time between CPR introduction and the start of instruction was examined for calls where this time difference was bigger than zero. Consequently, 33.7% (n = 32) calls were dropped due to time intervals equal to zero. Differences in the CPR introduction-instruction time gap (following $\log_{10}$ transformation) among language groups were not seen to be statistically significant, with LEP calls associated with a 70% shorter time gap time than English calls ($p = 0.111$) (Table 5b).

Impact of Particular Delays on CPR Determination Delay and CPR Introduction/Instruction Time Gap

A statistically significant association between the occurrence of the delay and the time that the need for CPR was determined was observed for 6 delay types (Table 5a). Delays due to RP language difficulties (DelayedLang) were associated with a 63% longer CPR determination time ($p < 0.001$). Delays due to unclear responses given by RP (DelayedAmbiguous) were associated with a 53% longer CPR determination time ($p < 0.001$). Delays because RP did not know answers to CR questions (DelayedDoesnotknow) were associated with a 60% longer CPR determination time ($p < 0.001$). Delays because the CR did not initially recognize the need for

CPR (DelayedMisdiagnosis) were associated with a 52% longer CPR determination time ($p = 0.027$). Delays because the CR asked irrelevant questions (DelayedIrrelevant) were associated with a 35% longer CPR determination time ($p = 0.035$). Delays because the CR missed that the patient was unconscious (DelayedUnconscious) were associated with a 40% longer CPR determination time ($p = 0.023$). Within the LEP RP group alone, 3 delays were significant. Delays due to RP language difficulties (DelayedLang) were associated with a 48% longer CPR determination time ($p = 0.010$). Delays because RP did not know answer to CR questions (DelayedDoesnotknow) were associated with a 54% longer CPR determination time ($p = 0.006$). Delays because the CR did not initially recognize the need for CPR (DelayedMisdiagnosis) were associated with a 56% longer CPR determination time ($p = 0.015$). Within the English fluent group alone, 3 delays were statistically significant. Delays due to RP leaving phone (DelayedLeftPhone) were associated with a 69% longer CPR determination time ($p = 0.009$). Delays due to unclear responses given by RP (DelayedAmbiguous) were associated with a 77% longer CPR determination time ($p = 0.001$). Delays because RP did not know answer to CR questions (DelayedDoesnotknow) were associated with a 60% longer CPR determination time ($p < 0.001$). ANOVA revealed delays with statistically significant interactions between LEP status and delay type: due to the RP leaving phone (DelayedLeftPhone, $p = 0.024$) and due to unclear responses given by RP (DelayedAmbiguous, $p = 0.042$).

Among the 8 potential delays corresponding to the time gap between CPR introduction and start of instruction, 2 were found to have a statistically significant association with the time gap (Table 5b). Delays due to the CR asking if the RP wanted to do CPR (GapWanttoCPR) were associated with a 64% longer time gap ($p = 0.014$). Delays due to the RP being confused about whether or not the patient was breathing (GapBreath) were associated with an 81% longer time gap ($p = 0.001$). Within the LEP RP group, the only significant delay was that due to the CR asking if the RP wanted to do CPR (GapWanttoCPR), associated with an 81% longer time gap ($p = 0.003$). Within the English fluent group, the only significant delay was that due to the RP being confused about whether or not the patient was breathing (GapBreath), associated with an 86% longer time gap ($p = 0.002$). ANOVA analysis revealed no significant language-delay interactions contributed to the CPR introduction-instruction time gap.

Discussion

This study contributes to the research on the challenges with language barriers in prehospital emergency communications by quantifying the significance of various types of delays to receiving care in an emergency environment within LEP populations relative to English-fluent populations. In this matched-control study of 76 LEP and 76 non-LEP cardiac arrest 9-1-1 calls, it was found that among all levels of English proficiency, 6 delays significantly increased the time it took for the 9-1-1 dispatcher to determine that the patient required CPR. Differences in the level of English proficiency of the people calling 9-1-1 were seen to be significant for 2 types of delays towards the CPR determination time. Two types of delays significantly increased the time it took for the CR to commence CPR instructions once they told the RP that CPR would be required for the patient. Differences in the level of English proficiency of the people calling 9-1-1 were not seen to be significant towards increasing the CPR introduction-instruction time gap. Several of these significant delays directly involved barriers to communication between the RP and CR: language difficulties, unclear responses, not knowing an answer to a question, delayed recognition, and absent (unacknowledged) information. These findings correspond with previous 9-1-1 studies where LEP populations were seen to receive slower emergency response than English-speaking callers.[9,16]

Limitations

One of the limitations of this study was due to the inability to determine the amount each type of delay actually contributed to the overall outcome delays in CPR determination and CPR introduction-instruction time gap. Differences in the presence of delays among language groups were tested for significance, however much of the findings were limited by small sample sizes exhibiting absent data. Delay type data for the CPR introduction-instruction outcome were lacking, leading to a paucity of data within the LEP group. T-testing and ANOVA were rendered incapable of statistical analysis in cases where the English group did not experience certain delay types from which to compare to the LEP group. This may have contributed to a lack of power towards significance testing between language groups.

External validity concerns may reduce the generalizability of the results presented in this study. The population represented in King County, WA may not be representative of other counties throughout the U.S. in terms of population size, demographics, and diversity of languages spoken. More ethnically isolated regions of the Midwestern states may not experience the heterogeneity and its diverse implications upon emergency medical services' interactions. Likewise, the 9-1-1 dispatch centers (NORCOM, VALLEYCOM) may not be representative of other 9-1-1 call centers in terms of protocols followed, training, staffing, and familiarity with languages or dialects spoken within the serviced geographical region. As such, these findings exhibit the recent abilities of a particular trained workforce's ability to address emergency calls for a particular population within a particular timeframe.

The implications of the research study could assist 9-1-1 dispatchers distinguish between the constellation of potential issues that emerge when receiving calls from LEP reporting persons during cardiac arrest emergencies. As a result, EMS could improve the algorithm 9-1-1 dispatchers will follow to improve clarity and ensure as few barriers as possible prevent the efficient delivery of remote telephone assistance. Improvements to training dispatchers and/or the served population may address delays exhibited by all callers. For instance, the delay, “RP didn’t know answer to question” may reflect both communication inadequacies delivered by the dispatcher as well as the level of familiarity with emergency situations among the general population. Increased efforts aimed at educating the civilian population with CPR training seminars may help to reduce this and other related barriers illuminated in this study.

Future work could include conducting a similar study of 9-1-1 cardiac arrest calls with a larger sample size to ensure all statistical analyses are adequately powered. A number of comparative studies could follow. An evaluation could look for differences in time-based outcomes between counties with similar population language demographics but different 9-1-1 protocols or trainings. Since NORCOM and VALLEYCOM both contributed to this study, perhaps a comparative analysis study between the two systems within King County could serve as a natural experiment to test procedural improvements suggested by this study.

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