THE HANDDS PROGRAM: DECREASING DISPARITIES IN CARDIAC ARREST SURVIVAL

by

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ABSTRACT

The current paradigm of bystander cardiopulmonary resuscitation (CPR) blankets a community with training. Research has shown high-risk neighborhoods can be identified and CPR training can be targeted in neighborhoods where it is most needed. The proposed research presents a novel conceptual framework, methodology and implementation of a community-based CPR training, the HANDDS (identifying High Arrest Neighborhoods to Decrease disparities in Survival) Program, and describes how the HANDDS Program was implemented in Denver, Colorado. The HANDDS Program is a systematic approach to implementing a community-based CPR training program and utilizes three simple steps: identify, implement and track. The conceptual framework first requires the long-term problem to be identified. As a result, the extent and distribution of racial disparities in cardiac arrest incidence, provision of bystander CPR and overall survival in Denver, Colorado, was identified using novel spatial analysis methods (Aim 1). Next, using qualitative methods, individual and neighborhood-level factors and strategies to overcome these issues were then identified (Aim 2). Finally, based on these findings, a targeted, culturally-sensitive CPR intervention was implemented and the impact on the provision of bystander CPR and OHCA survival at
the individual and neighborhood level was measured (Aim 3) using the RE-AIM framework.

The form and content of this abstract are approved. I recommend its publication.

Approved: David J. Magid
DEDICATION

I dedicate this work to my wonderful husband Eric Romine and dog Manny Roscoe Romine who have been an integral part of my life, both professionally and personally; my Mother Satwant, who has instilled in all of her daughters the dedication and determination to achieve any and all dreams; my sisters Neelu Nehls and Bobby Sasson, who support me through all of my crazy pursuits; my family and friends, who are always my cheering section; and to my mentor Dr. David Magid, who has been an amazing force in my life.
ACKNOWLEDGMENTS

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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>AHA</td>
<td>American Heart Association</td>
</tr>
<tr>
<td>ALS</td>
<td>Advanced Life Support</td>
</tr>
<tr>
<td>BLS</td>
<td>Basic Life Support</td>
</tr>
<tr>
<td>CARES</td>
<td>Cardiac Arrest Registry to Enhance Survival</td>
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<tr>
<td>CBPR</td>
<td>Community-Based Participatory Research</td>
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<td>CDC</td>
<td>Centers for Disease Control and Prevention</td>
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<tr>
<td>COMIRB</td>
<td>Colorado Multiple Institutional Review Board</td>
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<tr>
<td>CPR</td>
<td>Cardiopulmonary Resuscitation</td>
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<tr>
<td>DVD</td>
<td>Digital Video Disc</td>
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<tr>
<td>EB</td>
<td>Empirical Bayes</td>
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<tr>
<td>EMS</td>
<td>Emergency Medical Services</td>
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<tr>
<td>Gi*</td>
<td>Getis-Ord Gi* Statistic</td>
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<tr>
<td>HANDDS</td>
<td>High Arrest Neighborhoods to Decrease Disparities in Survival</td>
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<tr>
<td>HBM</td>
<td>Health Belief Model</td>
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<tr>
<td>HH</td>
<td>High-High</td>
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<tr>
<td>HL</td>
<td>High-Low</td>
</tr>
<tr>
<td>IRB</td>
<td>Institutional Review Board</td>
</tr>
<tr>
<td>LISA</td>
<td>Local Indicator of Spatial Autocorrelation</td>
</tr>
<tr>
<td>OHCA</td>
<td>Out-of-hospital Cardiac Arrest</td>
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<tr>
<td>U.S.</td>
<td>United States</td>
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CHAPTER I
INTRODUCTION

There are approximately 420,000 out-of-hospital cardiac arrests (OHCA) in the U.S. each year, accounting for 15% of all deaths. Striking geographic variation in OHCA outcomes has been observed with survival rates varying from 0.2% in Detroit to 16.0% in Seattle. This variation in survival rates can be partly explained by differing rates of bystander cardiopulmonary resuscitation (CPR). Provision of bystander CPR is a vital link in improving survival for victims of OHCA. For every 30 people who receive CPR, one additional life is saved. Communities in Seattle and Arizona that increased bystander CPR observed concurrent improvements in OHCA survival; therefore, a promising approach to increasing OHCA survival is to increase the provision of bystander CPR. CPR is a best practice for increasing OHCA survival rates and is promoted extensively by the American Heart Association (AHA) and the American Red Cross as a key component to increase OHCA survival.

As compared to whites, Latinos and African-Americans are more likely to sustain an OHCA and be found in asystole and pulseless electrical activity, both of which are poor prognosis rhythms. The neighborhood where a person arrests in can also dramatically affect his/her likelihood of receiving CPR and, ultimately, of surviving an OHCA. Residents who live in neighborhoods that are primarily Latino, African-American or poor are more likely to have an OHCA, are less likely to receive bystander CPR and, as such, are less likely to survive. Therefore, neighborhoods are an
important target for public health interventions to reduce disparities in bystander CPR and OHCA survival rates.

Traditional methods for increasing CPR use generic training programs that are employment, school or event-based,\textsuperscript{20-23} however, this approach to CPR training is not successful in communities of African-Americans, Latinos, those with limited English proficiency and the poor, all of which are groups with a high incidence of OHCA and low survival rates.\textsuperscript{9,15-19} Potential reasons for the low prevalence of CPR in these communities include poor accessibility to CPR training and training programs that are neither culturally-sensitive nor tailored to the cultural and socioeconomic characteristics of these groups. An alternative approach to increasing community CPR is to develop tailored CPR training programs and to target training to high-risk neighborhoods that have a high incidence of OHCA and low rates of bystander CPR.\textsuperscript{12,13} Before this targeted strategy can be implemented, community-based participatory research to understand the cultural and social barriers to CPR must be conducted and this knowledge applied to the design of neighborhood-based CPR interventions.

**Conceptual Framework**

Multiple frameworks have been used to describe how health disparities can be identified, interventions can be developed and implemented and the overall health impact on the community can be evaluated. The U.S. Department of Health and Human Services Office of Minority Health has built a logic model that can serve as a conceptual framework to move beyond merely identifying health disparities to actually addressing the health disparities.\textsuperscript{24} The model has five integral pieces: 1) identifying the long-term
health problem, 2) understanding factors that contribute to this problem, 3) mobilizing strategies and practices to address the problem and its contributing factors, 4) implementing these interventions and evaluating the outcomes and impacts, and 5) assessing the effect on long-term objectives and goals to impact the health problem (Figure I.1).

**Figure I.1 Office of Minority Health Conceptual Framework**

Conceptual framework for identifying, understanding, implementing and evaluating health disparities.

This framework serves as a model for systematically understanding the health disparity being addressed and then developing and implementing interventions that have measurable goals and objectives both in the short- and long-term.

There are some limitations to this conceptual framework. First, it is sometimes difficult to truly assess the impact of community-based interventions to address health disparities. It may be that measurable outcomes and impacts are outside the scope of the actual intervention. For example, a community-based intervention to decrease obesity rates in high school students from lower-income, minority neighborhoods may actually also increase the number of students who graduate from high school and go on to careers.
in healthcare. This measurable outcome may not be a primary outcome for the intervention, but all outcomes should be considered when measuring the impact on decreasing health disparities. Second, it can be challenging in public health to establish the real-world effectiveness of an intervention. For example, removing sugar-sweetened beverages from high school lunches and vending machines has been shown to be an efficacious way to reduce childhood obesity in students.\textsuperscript{25,26} However, it is difficult to show the effectiveness of this intervention on high school students’ overall health outside of a clinical trial. As a result, it may be necessary to still institute these best practices, even if the impact on health outcome may not be directly correlated at the population level.

**Problem Statement**

This model can be directly applied to the field of cardiac arrest and the provision of bystander CPR. There are two long-term problems that must be addressed in bystander CPR provision. At the individual level, African-Americans and Latinos are 30% less likely to have bystander CPR performed if they have an OHCA event. At the neighborhood level, residents who live in lower-income, African-American neighborhoods are 51% less likely to have CPR performed.\textsuperscript{19} However, there is a knowledge gap in defining the extent and distribution of racial disparities in OHCA incidence and provision of bystander CPR within a community. A second knowledge gap is the identification of contributing factors at the individual and neighborhood level that may affect this health disparity in OHCA incidence and bystander CPR provision. A third knowledge gap is in the strategies that can be employed to intervene and increase
cardiac arrest and CPR knowledge in the community setting. And finally, the last two knowledge gaps are in how these interventions can be measured and how they can be evaluated to assess the long-term impact on health outcomes in cardiac arrest.

**Purpose/Proposal**

The purpose of this research is to reduce disparities in OHCA care and outcome, and to move toward the Healthy People 2020 goal of “achieving health equity, eliminating disparities and improving the health of all groups.” Using the Office of Minority Health conceptual framework, three interrelated, complementary studies have been conducted to determine an effective CPR strategy designed to reduce disparities in OHCA survival in minority populations in Denver, Colorado. The conceptual framework first requires the long-term problem to be identified. As a result, the extent and distribution of racial disparities in OHCA incidence, provision of bystander CPR and overall survival in Denver, Colorado, was identified using novel spatial analysis methods. Next, using qualitative methods, individual and neighborhood-level factors and strategies to overcome these issues were identified. Finally, based on these findings, a targeted, culturally-sensitive CPR intervention was implemented and the impact on the provision of bystander CPR and OHCA survival at the individual and neighborhood level was measured.
CHAPTER II
BACKGROUND/LITERATURE REVIEW

In this era of healthcare reform, there is greater emphasis on public health interventions that are both efficacious and effective. Limited healthcare resources, such as public health education and promotional programs, will need to not only be efficacious in the clinical trial setting, but more importantly, scalable, reproducible and effective in the real world. Before developing any new community-based interventions, it is imperative to systematically review the literature to identify community-based interventions that have been used in prior research to reduce health disparities in minority populations.

Community-based interventions must rely on addressing not only the problem at hand, but also taking into consideration the social determinants of health that may contribute or exacerbate the problem.\textsuperscript{28} The World Health Organization defines the social determinants of health as “the circumstances in which people are born, grown up, live, work, and age, as well as the systems put into place to deal with illness. These circumstances are in turn shaped by a wider set of forces: economics, social policies and politics.”\textsuperscript{29} When developing and implementing cardiac arrest interventions, it is imperative to take into account not only the problem of low bystander CPR rates, but more importantly, the milieu of circumstances that may contribute to health inequities in cardiac arrest. For example, it may be that people living in higher-risk neighborhoods do not know their neighbors well, so they are less likely to intervene and help someone who


is having a cardiac arrest. Residents of higher-risk neighborhoods may have less access to health care and nutritious food, so they are more likely to have poorer health and ultimately sustain a cardiac arrest. Understanding how the social determinants of health integrate perceived barriers for high-risk neighborhood residents will be an integral part of activating a layperson to perform bystander CPR for a cardiac arrest victim.

**Background**

There are two major models that will be discussed prior to reviewing the literature. First, the Health Belief Model (HBM), which is generally used in the health prevention and promotion literature, will be described, as well as its applicability in teaching community members about CPR and activating them to action during a cardiac arrest event. Second, the role of cultural appropriateness versus targeting versus tailoring will also be discussed, as it relates to how these three strategies may enhance the effectiveness of a community-based CPR intervention.

**Health Belief Model**

The Health Belief Model was originally created in the 1950s and is used to describe and explain why people choose to do certain health activities. The model has been changed throughout the years, but it is used to help promote people’s readiness to act. It is one of the most widely used health promotion models. There are six core concepts in this model that affect a person’s readiness (Table II.1).
Table II.1 Six Core Concepts of Health Belief Model.

The table from the Glanz et. al. (2002) succinctly describes these core concepts.31

<table>
<thead>
<tr>
<th>Concept</th>
<th>Definition</th>
<th>Application</th>
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<tbody>
<tr>
<td>Perceived Susceptibility</td>
<td>One's opinion of chances of getting a condition</td>
<td>Define population(s) at risk, risk levels; personalize risk based on a person's features or behavior; heighten perceived susceptibility if too low.</td>
</tr>
<tr>
<td>Perceived Severity</td>
<td>One's opinion of how serious a condition and its consequences are</td>
<td>Specify consequences of the risk and the condition</td>
</tr>
<tr>
<td>Perceived Benefits</td>
<td>One's belief in the efficacy of the advised action to reduce risk or seriousness of impact</td>
<td>Define action to take; how, where, when; clarify the positive effects to be expected.</td>
</tr>
<tr>
<td>Perceived Barriers</td>
<td>One's opinion of the tangible and psychological costs of the advised action</td>
<td>Identify and reduce barriers through reassurance, incentives, assistance.</td>
</tr>
<tr>
<td>Cues to Action</td>
<td>Strategies to activate &quot;readiness&quot;</td>
<td>Provide how-to information, promote awareness, reminders.</td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>Confidence in one's ability to take action</td>
<td>Provide training, guidance in performing action.</td>
</tr>
</tbody>
</table>

These core concepts relate directly to activating community members to perform life-saving CPR when a cardiac arrest occurs. To affect the perceived susceptibility, it is important to provide community members with data on their own risk for having a cardiac arrest event. By identifying key individual factors (e.g. race/ethnicity, gender, age) and neighborhood-level factors (e.g. racial and economic composition of a neighborhood), we provided estimates of risk for our community members on their likelihood of having bystander CPR performed, and/or surviving a cardiac arrest event. Perceived severity was communicated to community members based on current data that shows 9 out of 10 people will not survive a cardiac arrest event, and that survival is even lower if a cardiac arrest victim does not receive CPR. Perceived benefit was described during an intervention to highlight the importance of prompt recognition of an event,
early activation of calling 911 and performing bystander CPR. This was strictly balanced with the perceived barriers that people may have about performing CPR. The cues to action were an integral part of any community-based CPR training intervention; these cues to action were accomplished by promoting awareness of cardiac arrest as well as instructing community members on how to perform CPR. Finally, the last part of the intervention was to reinforce educational efforts and increase a person’s confidence that he/she can perform CPR in the setting of a cardiac arrest.

The following HBM conceptual model (Figure II.1) was adapted to show how these concepts were addressed to increase the likelihood that community members would perform CPR. The action of performing CPR is a complex process, but specific parts of this model were used to design, implement and evaluate the CPR intervention.

**Figure II.1 Health Belief Model Adapted for Provision of CPR**

This figure showcases the core concepts of the health belief model that must be addressed in order to promote a person’s likelihood of performing CPR in a cardiac arrest event.
Cultural Appropriateness, Targeting and Tailoring

There are key differences in how the three concepts of cultural appropriateness, targeting and tailoring increase the utility of messaging to certain populations. First, cultural appropriateness may be accomplished through the use of five common strategies: peripheral, evidential, linguistic, constituent-involving and sociocultural. Peripheral strategies include designing materials that look, feel, or sound like the individuals (or cultural group) the material is being created for. This may be achieved by including a picture of an African-American family performing a specific health behavior, for example. This process of matching “surface” characteristics is described by Resnicow et al. Evidential strategies provide cultural groups with the health impact that a particular health condition may have on their specific group. Linguistic strategies are used to create health promotion materials which are in the person’s native language (e.g. translating a pamphlet into Spanish). Constituent-involving strategies utilize members of the target cultural group as liaisons to the project, helping with recruitment as well as the design and implementation phases. Finally, sociocultural strategies are used to discuss health behaviors in the context of the group’s morals, beliefs and values. Resnicow et al. describe this as the deep structures of cultural sensitivity that make the health behavior more pertinent to the target group.

Cultural targeting is done by focusing health promotion activities on the highest risk groups, and making these programs relevant to a specific cultural group. Inherent in targeting is the assumption that the group is relatively homogenous in that one strategy would assist all members of this group.
Finally, cultural tailoring is defined as “any combination of information or change strategies intended to reach one specific person, based on characteristics that are unique to that person, related to the outcome of interest, and have been derived from an individual assessment.” Tailoring, in contrast to targeting, is applied to the individual rather than the cultural group. For example, a CPR intervention could be targeted to a primarily African-American church; however, the intervention could be tailored to a person’s spirituality. In speaking with the individual who is engaging in the intervention, there may be more discussion about how the afterlife is associated with cardiac arrest. This is one example of how the messaging is tailored at the individual level based on the characteristics specific to that person.

Summary

This serves as a background to the HBM, as well as the differences between cultural appropriateness, targeting and tailoring. These key ideas have an integral role in the studies that will be highlighted in the literature review section.

Literature Review

The following is a critical review of the literature regarding public health interventions targeted toward minority populations. There are two main objectives of this literature review. First, what is the current state of evidence on the efficacy of “non-traditional” community-based controlled trials in reducing health disparities? Non-traditional is defined as interventions which may be considered outside of the normal educational interventions (e.g. faith-based, social media, barbershops). Second, what is
the best level of evidence available for community-based controlled trials that have been used in cardiac arrest to increase bystander CPR provision?

**Search Strategy and Methods**

A systematic review of the literature was conducted to identify controlled studies that evaluated a community-level intervention aimed at reducing health disparities. It was determined *a priori* that any studies on CPR and cardiac arrest would be identified and analyzed in a subgroup analysis. All studies published between January 1, 1950, through February 15, 2014, were considered. The PRISMA guidelines were followed to ensure the review met standard guidelines for conducting systematic reviews of the literature.34 Two electronic databases were searched using Boolean logic: PubMed and Cochrane Central Register of Controlled Trials. The root Boolean search in PubMed was the following: ((((((randomized controlled trial [pt] OR controlled clinical trial [pt] OR randomized controlled trials [mh] OR random allocation [mh] OR double-blind method [mh] OR single-blind method [mh]) NOT (animal [mh] NOT human [mh]))) AND ((("Minority Groups"[Mesh]) OR "Minority Health"[Mesh]) OR "Hispanic Americans"[Mesh]) OR ( "African Americans"[Mesh] OR "Urban Health"[Mesh] )) OR ( "Urban Population"[Mesh] OR "Ethnic Groups"[Mesh] OR "Urban Health Services"[Mesh] OR "Mexican Americans"[Mesh] ))) AND (((education) OR curriculum) OR training)) AND (((community) OR population health) OR population).

“Hand search” refers to those articles which were identified based on the author’s knowledge of the field and were not found in the literature searches.
Table II.2  Databases Searched.

This table includes all three databases searched and included in the final review.

<table>
<thead>
<tr>
<th>Database</th>
<th>References Identified</th>
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<tbody>
<tr>
<td>PubMed</td>
<td>1,684</td>
</tr>
<tr>
<td>Cochrane Central Register for Controlled Trials</td>
<td>344</td>
</tr>
<tr>
<td>Hand Search</td>
<td>3</td>
</tr>
</tbody>
</table>

Study Selection

One reviewer evaluated each full text article and determined exclusions based on *a priori* criteria. This excluded any study that: 1) did not occur in the U.S. (since the focus of literature review is specific to U.S.-based community interventions), 2) had duplicate studies from the same intervention, 3) had interventions carried out by a health care provider or in a clinic/hospital setting (rather than in the community), 4) was not a randomized or controlled clinical trial, and 5) did not have a primary health outcome (e.g. allergen exposure or bullying of students). In addition, the focus of this literature review is on novel or non-traditional methods for implementing community-based interventions. As a result, some studies were excluded from this literature review. These include studies that: 1) were conducted in locations that were well described in the literature, such as schools, 2) used telephone-based intervention, 3) used traditional group-based curriculum, 4) included motivational interviewing, 5) were tailored for pregnancy-based interventions, or 6) used self-management techniques. These topics are all thoroughly covered in public health literature.\(^{35-47}\)

The Jadad scale for randomized clinical trials was used to assess the quality of the studies included.\(^{48,49}\) Given that blinding is not possible in community-based trials, the Jadad criteria was slightly modified. A quality review was done for each study to ensure
the randomization was clear and consistent and that a clear explanation was given for withdrawals and dropouts. Figure II.2 describes the process for selecting the final 64 studies for inclusions.

**Figure II.2 Flow Diagram of Included Studies**

Flow diagram of studies excluded from the analysis and the final studies included in the literature review. Of note, 12 articles were included in two of the final categories.

In total, 2,031 titles and abstracts were identified using the search strategy in Pubmed, Cochrane and by hand search. Of these studies, 229 titles and abstracts were potentially relevant to community-based health interventions. An additional 109 articles
were excluded for using “traditional” methods for community-based interventions. As a result, 120 full text articles were reviewed that potentially met the inclusion criteria. Ultimately, 64 studies were included in the final literature review (Appendix A). These studies were grouped into six major categories: use of community health workers/promotoras (n=20), faith-based (n=19), media campaigns (n=15), non-traditional locations (n=16), web/computer-based (n=4) and CPR training (n=2). Of note, 12 studies were included in two of the final categories.

**Community Health Worker Studies**

There were 20 studies that used community health worker/promotoras to implement a community-based intervention. Eleven of the 20 studies were interventions to increase cancer screening in these minority populations,\(^{50-60}\) with a smaller number focusing on sexually transmitted diseases/teen pregnancy (n=5),\(^{61-65}\) obesity/healthy eating (n=3)\(^{66-68}\) and cardiovascular disease risk factor reduction (n=1).\(^{69}\) The primary racial/ethnic groups that were targeted for interventions were African-American (n=8), Latinos (n=8) and Asian (n=4). Nineteen of the 20 studies stated that their interventions were successful.

The community health worker model was used to promote health behaviors to community members that were similar in age, gender and/or race/ethnicity. These studies used multiple cultural appropriateness strategies to design and implement the interventions. Community health workers were part of the community that the studies were trying to reach, which utilized the constituent-involvement strategy. Community health workers would speak the same language (linguistic), use educational materials that
targeted the cultural group (peripheral), discuss statistics about health disparities (evidential) and use sociocultural beliefs that resonated with the target population. Two studies,\textsuperscript{61,63} for example, used African-American community health workers who were themselves teen mothers to promote a teenage pregnancy intervention for adolescent African-American women. As a whole, it appears this method for promoting health interventions was successful.

There were some major challenges noted by the study authors. For example, it was difficult to recruit and retain community health workers over the span of the studies. In addition, the majority of the community health workers were incentivized for the time they spent delivering the intervention in the community, which can be costly.

\textbf{Faith-Based}

There were 19 studies that utilized a faith-based approach to implement interventions.\textsuperscript{52,53,65,67,68,70-83} Eighteen of the 19 studies targeted African-American populations through church-based interventions, with one of these studies also including Latino parishioners. The topics for the interventions were highly variable. All studies stated that the pastor or church leader was the initial point of contact for allowing a church to participate in the intervention. One study specifically stated that having strong involvement of the pastors in the intervention (influenza vaccination rate) directly led to a more efficacious intervention.\textsuperscript{73} Faith-based interventions drew heavily from the targeting and tailoring literature. By focusing on cultural groups that attended specific churches, the faith-based interventions were able to target specific populations. The interventions also used tailoring to increase the spirituality and connection to health. The
level of tailoring varied by intervention. Some examples of tailoring included gospel music for a dance intervention, spiritually-based educational curriculum for colon cancer screening and physical activity and healthy eating activities tailored to parishioners.

Six of the 19 studies did not show a significant impact of the intervention. Study authors highlighted that in doing faith-based studies, randomization was best done at the level of the church due to problems with cross-contamination. Another challenge in implementing in the church was that pastors wanted to know the full scope of the study, which group they would be in (intervention versus control) prior to agreeing to participate in the study. Finally, another potential barrier to conducting faith-based initiatives was that many churches did not want to have any intervention, so many of the study designs included either a general health education curriculum or a delayed intervention. Overall, however, it did appear that faith-based interventions were a promising way to deliver targeted and tailored interventions, especially for African-Americans. The utility of faith-based interventions in other cultural groups is an area that warrants further research.

Media

Fifteen studies used a variety of media interventions to implement community-based health interventions. The 15 studies included interventions for cancer screening (n=5), sexually transmitted diseases (n=5), smoking cessation (n=2), organ donation (n=1), Hepatitis B vaccination (n=1) and CPR education (n=1). Video was also used as an alternative to print education, with five studies testing the
efficacy of video messaging interventions to increase organ donation, cancer screening and knowledge of hands-only CPR. Seven studies used large-scale media campaigns that were targeted and tailored for specific cultural groups. Two studies used social media sites (e.g. Facebook) to implement targeted sexually transmitted interventions based on friend groups. Additional unique communications strategies included radionovellas for Latino parents and children to promote Human Papilloma Virus vaccination and a bilingual comic book (for children) with two fotonovellas around smoking cessation (for adults).

Three of the 15 studies were not efficacious. There were major challenges identified in these studies. For example, one study cited the difficulty in saturating the market and how that prevented the messaging from being truly effective. The cost of radio and television advertising was also cited as a major barrier to implementation. However, overall the studies showed that tailoring and targeting culturally appropriate messages, especially in video format, to certain cultural groups was an efficacious method for promoting health behaviors.

Non-Traditional Locations

Sixteen studies used non-traditional locations for implementing community-based interventions. The major topics for these studies included healthy eating/physical activity/obesity (n=8), cancer screening (n=3), smoking cessation (n=1), vaccinations (n=1), depression awareness (n=1) and hypertension control (n=1). Non-traditional locations included beauty salons, barbershops, grocery stores, senior centers, Boy Scout troops, community adult schools, camps and urban housing.
developments. By utilizing non-traditional locations for implementation, these studies brought the interventions to the community, rather than requiring community members to come to traditional locations (e.g. hospitals, clinics, schools). These studies used a targeted approach to implementing. For example, one study tested a grocery store intervention to promote healthy eating in lower-income African-American neighborhoods.\(^9^9\) Two studies utilized cosmetologists and barbers to increase breast cancer and hypertension awareness.\(^1^0^6,1^0^9\) Another unique intervention used Boy Scout troops to teach lower-income African-American boys about healthy eating.\(^9^6\)

Four of the 16 studies were not efficacious. There were several major challenges to conducting implementation trials in non-traditional settings. For example, when conducting a grocery store intervention to increase the availability of nutritious foods, it was not feasible to require every grocery store to have all of the same foods or the same layout of the store. As a result, there was a loss in the reproducibility of the intervention and possibility of confounding due to factors outside the control of the study. Another challenge cited by authors was difficulty in recruiting, retaining and training non-healthcare workers in a non-traditional setting. In the barbershop and beauty salon studies, there was attrition in the barbers and cosmetologists who participated in the study (either by leaving the work place or choosing to no longer participate in the intervention).

**Web-Based**

There were four web-based studies included in this review. Studies addressed obesity (n=2),\(^1^1^0,1^1^1\) prostate cancer (n=1)\(^1^1^2\) and the sexually transmitted disease prevention (n=1).\(^1^1^3\) Three of the four web-based interventions were targeted to African-
Americans. The interventions appeared in the short-term to have a significant effect on promoting certain health behaviors (e.g. condom use, weight loss, prostate screening). The only study that did assess the longer-term effects of a web-based weight loss intervention found that there was significant decay in efficacy and exposure to the intervention over the 24-month time period.

Web-based interventions appear to show promise on changing behaviors in the short-term. More research will need to be conducted on the long term effectiveness of web-based interventions. In addition, connectivity to the web may be a challenge for older adults and people from lower-income neighborhoods.

CPR Training

Two studies described interventions to promote CPR training in the community. One study tested the efficacy of a video self-instruction in comparison to a four-hour traditional CPR training in African-Americans. At two months, there was no significant difference in CPR knowledge between the two groups. However, there was considerable degradation in knowledge for both groups, which highlights the importance of repeated messaging. The other study compared the efficacy of: 1) a brief, 60 second video training, 2) a 5 minute video training, 3) an 8 minute video training, and 4) an 8-minute video training plus hands-on practice versus untrained laypersons in performing hands-only CPR. All four groups performed hands-only CPR better than the untrained laypersons. The authors concluded that a 60 second video training was efficacious in educating laypersons about hands-only CPR. Although both studies were efficacious, the
major limitation was that CPR could only be assessed in simulated scenarios. It is unclear how these results will translate outside of the clinical trial setting.

**Summary of Reviewed Literature**

There is a growing body of evidence in the public health literature regarding the efficacy of community-based interventions. These studies provide the scientific foundation and rationale for the research conducted in Chapter III. The HANDDS Program builds upon the ideas presented in this literature review to implement and evaluate an intervention that targeted high-risk neighborhood residents, was tailored to the cultural groups that was being trained and utilized culturally-appropriate training materials.

**Overview of Research Methods**

The literature reviewed has shown that non-traditional methods for implementing community-based interventions can be efficacious and effective. By drawing from this research base, a multi-phased intervention was conducted using novel spatial analysis, community-based participatory research and program evaluation methods. An additional model, the Social Ecological Model, was also introduced during the conduct of this research. Briefly, we extended the model beyond the individual level, to increase understanding of how social and environmental factors could also impact bystander CPR provision. Further information regarding the Social Ecological Model will be discussed in Chapter IV.

There are multiple studies primarily in public health, cancer and infectious disease research areas\textsuperscript{114-121} that highlight the utilization of spatial analysis methods to identify
high-risk areas for disease. Spatial analysis has been used to identify geographical clusters or possible outbreaks of certain diseases. In contrast, there has been very little work done in the area of spatial analysis for identifying high-risk areas for cardiac arrest incidence and low bystander CPR prevalence.\textsuperscript{12,13,19,122-126}

Community-based participatory research is a well-established methodology for identifying the root cause of a health inequity, working with community members to identify solutions for addressing the problem, and then implementing a community-based intervention in conjunction with community members.\textsuperscript{127-129} The literature review highlights that this type of approach is likely to succeed in addressing health inequities in cardiac arrest and bystander CPR. We had a partial framework for why CPR was not being performed, however, we utilized the CBPR approach to further develop the social and environmental factors that also contributed to low bystander CPR rates in high-risk neighborhoods. Further details of the how the intervention was conducted will be addressed in Chapter III.

Finally, the RE-AIM framework is a well-vetted tool for evaluating the key components of a scalable, reproducible community-based intervention. Based on five key principles, the proposed research will be evaluated for its reach, effectiveness, adoption, implementation and maintenance. Prior studies have shown that this systematic approach to program evaluation is an effective method for understanding the scalability and reproducibility of a community-based intervention.\textsuperscript{130-135}
CHAPTER III
RESEARCH METHODS AND ANALYSES

Research Question and Hypothesis

Is a systematic, targeted approach to increasing bystander CPR training in high-risk neighborhoods a feasible method for decreasing health disparities in the provision of bystander CPR in Denver, Colorado?

My primary hypothesis is targeting culturally competent CPR training to high-risk neighborhoods is an effective strategy to boost bystander CPR—and ultimately OHCA survival. The rationale is that the neighborhood where an OHCA victim has his/her arrest can dramatically affect the likelihood of both receiving bystander CPR and surviving OHCA. This research will provide the essential scientific foundation to change the traditional paradigm of CPR training to a targeted, culturally-sensitive, tailored approach.

Specific Aims

Aim 1

Identify and quantify the socioeconomic and demographic characteristics of high-risk (high OHCA incidence and low bystander CPR) neighborhoods in Denver using innovative spatial statistics.

1This manuscript has been accepted for publication in *Academic Emergency Medicine*. 
Aim 2

Conduct community-based participatory research with qualitative methods (focus groups and key informant interviews) to interview residents from high-risk neighborhoods to identify barriers and facilitators to learning and performing CPR.

Aim 3

Informed by Aim 2, design and pilot a targeted, train-the-trainer community-based CPR intervention that is culturally-sensitive and easily accessible for residents of high-risk neighborhoods.

Knowledge Gaps and Correlation to Specific Aims

The research that was conducted outlines a systematic implementation of community-based CPR training programs in the neighborhoods in which it is most needed. Each specific aim described above fills a knowledge gap that currently exists in the study of health disparities in cardiac arrest and the provision of bystander CPR (Figure III.1). There are many more additional knowledge gaps in these areas, however the ones that will be addressed in this research have been included here. In addition, further explanation of how the aims correlate with the HANDDS Program and framework will be discussed in more detail. These three aims are derived from the systematic review of the literature and its application on how to reduce health disparities in the provision of bystander CPR and survival from OHCA.
Lack of Data on OHCA Survival Disparities in Denver

Relationship between the knowledge gaps in cardiac arrest literature and the specific aims.

Lack of Data on OHCA Survival Disparities in Denver

Neighborhoods are an important target to decrease health disparities in OHCA.\textsuperscript{14,18,136} Based on prior research, neighborhoods can be identified as “high-risk.”\textsuperscript{12,13} These high-risk neighborhoods are defined as having a high incidence of OHCA and low provision of bystander CPR as compared to their neighbors. Because there are new methods for identifying these high-risk neighborhoods, the implementation of a targeted, community-based intervention to increase bystander CPR and OHCA survival is now possible. Although this prior research used exploratory methods, more advanced spatial analysis\textsuperscript{137-139} can be used to identify high-risk neighborhoods. The
research conducted in Aim 1 is the first study to apply innovative spatial analytical tools in OHCA research. The Denver subset of the CARES\textsuperscript{140} dataset was analyzed to understand the extent of racial/ethnic disparities in the provision of CPR and OHCA survival and target areas for neighborhood-based CPR interventions were identified.

**High-Risk Neighborhood Residents Do Not Perform Bystander CPR**

Despite a strong evidence-base for CPR, the widespread translation of this practice into the community has not been accomplished.\textsuperscript{141} Historically, CPR training is based on convenience, occurring in workplaces,\textsuperscript{20,21} schools\textsuperscript{22,142,143} and at community events.\textsuperscript{23,144} This CPR training is not targeted based on needs or tailored to specific social or cultural groups that are less likely to do CPR, such as Latinos, those with limited English skills and the poor. This historical approach to CPR training fails to consider: 1) who is getting trained, 2) the setting in which the training occurs, and 3) how the training is delivered. No previous studies have been conducted to understand how these contributing factors, at the individual and neighborhood level, may impact a person’s likelihood of learning and performing CPR. The conducted research used community-based participatory research with qualitative methods (Aim 2) and was the first study to understand the underlying cause of health disparities in OHCA and provision of bystander CPR, and how a tailored, culturally-sensitive neighborhood-based intervention could be implemented in high-risk neighborhoods.

**Efficacy of a “Non-Traditional” Targeted CPR Training Program**

The uptake of CPR training and other health interventions has been limited in Latinos and African-Americans.\textsuperscript{9,15-18} Health disparities have been reduced in these
populations by: 1) understanding the social and cultural context of the target population, 2) identifying appropriate settings for the intervention, and 3) working with local community members to design and implement the intervention. Interventions that have adhered to the principles of community-based participatory research by using culturally-sensitive approaches, conducting interventions in non-traditional settings, such as churches and barbershops, and using local neighborhood residents as health promoters have been successful in promoting healthy behavior change. Aims 1 and 2, Aim 3 of the research used community-based participatory research methods and piloted a novel community-based culturally-sensitive intervention. The intervention was tailored to high-risk neighborhood residents and was conducted in local settings based on community preferences (at churches and schools) while using local resources (local bilingual residents as health educators) to implement and disseminate CPR trainings in Denver’s high-risk neighborhoods.

**Human Subjects Consideration**

All research conducted in this study was approved by the Colorado Multiple Institutional Review Board (COMIRB) (Appendix B). Aim 1 includes a secondary data analysis of CARES, which is a continuous quality improvement tool and surveillance registry designed to help local officials monitor and improve their provision of prehospital emergency cardiac care. To insure each patient’s confidentiality case reports were stripped of all individual identifiers before the data was permanently entered in the registry. Every patient received the standard care available in their community and no patient was subjected to an experimental intervention. In light of these safeguards, the
Institutional Review Boards (IRBs) of all participating sites has determined that CARES is exempt from the requirement to secure verbal or written consent. Aims 2 and 3 were considered expedited studies by the COMIRB. All participants signed written consents to participate in the studies.

**Research Aim 1**

Identify and quantify the socioeconomic and demographic characteristics of high-risk (high OHCA incidence and low bystander CPR) neighborhoods in Denver using innovative spatial statistics. My hypothesis is: the identified high-risk neighborhoods will be composed primarily of minorities with lower educational attainment and lower socioeconomic status.

The goal of this aim was to conduct a spatial analysis of the Denver subset of the CARES dataset to identify high-risk neighborhoods to target public health interventions to reduce disparities in OHCA survival. Although several spatial analysis methods have been used to identify clusters of disease (primarily in infectious disease, trauma and cancer), these methods had not been used in cardiac arrest. Future applications of this approach could be applied to other diseases (e.g. myocardial infarction and stroke). There are multiple methods for detecting clusters or areas that have statistically significant auto-correlation (e.g. spatial scan statistic and Kernel Density). Each method has its own unique advantages and limitations. Currently, however, there is no “gold standard” for identifying these high-risk neighborhoods. As a result, the primary objective of this Aim was a novel summary approach to identify census tracts using the
intersection of three separate spatial analysis methods: Empirical Bayes (EB), Local Moran’s I Local Indicator of Spatial Autocorrelation (LISA) and Getis-Ord Gi* (Gi*).

**Brief Overview of Analytical Techniques**

The three spatial statistical methods used in this study were designed to either: 1) visualize “hot spots” or spatial groupings of events (EB smoothing), or 2) detect spatially significant clusters of an event (LISA and Gi*). Rate smoothing is a technique used to stabilize rates based on small numbers and reduce noise in rates caused by different population sizes. The strength of the EB smoothing method is its ability to analyze data from smaller data sets that can have a great deal of variance. This is done by averaging each value with the overall mean of the data. Rate smoothing increases the ability to discern systematic patterns in the spatial variation of events by reducing noise and making trends and patterns more obvious. The drawback inherent in this method, however, is that significant data outliers could be lost by reducing variability or “smoothing” the dataset.

The LISA statistic was used to detect clusters in the dataset as well as statistically significant outliers. However, the LISA statistic could be affected on the edge of a locational dataset where there are less neighboring data values to use in the analysis thereby decreasing its effectiveness to identify outliers along border areas. The LISA did not take into account the incidence of OHCA in the census tract, only the neighboring census tracts.

The Gi* statistic identified clusters of statistically significant high value “hot spots” and low value “cold spots” by analyzing each data point in relation to its
surrounding data points.\textsuperscript{152,153} The advantage of this statistic is its ability to identify clusters of high incidence but also clusters of low incidence with the drawback of not identifying statistically significant outliers. The Gi* statistic did not include the OHCA rate for the census tract in question, in addition to the neighboring census tract values.

Both the LISA and the Gi* statistics are difficult to interpret at the edges of a geographic boundary, as those regions with few neighbors have a less robust statistic to identify outliers. Because each of these three approach has its advantages and limitations, no single method is considered the “criterion standard” for hot spot analysis.

\textbf{Study Population}

Denver has been collecting and analyzing its data on OHCA for more than 10 years.\textsuperscript{154-157} The city and county of Denver has a population of 600,158. Approximately 52\% of residents are classified as white, 32\% as Latino and 10\% as African-American.\textsuperscript{158} The City and County of Denver has contributed data to CARES since January 1st, 2009, and there are more than 2,000 OHCA events. Audits show that more than 99\% of this data is complete.

Denver utilizes a two-tiered 911 Emergency Medical Services (EMS) system, with the Denver Paramedics providing advanced life support (ALS) response and the Denver Fire Department providing basic life support (BLS) co-response. The Denver 911 call center uses Emergency Medical Dispatch software to provide pre-arrival instructions to the 911 caller. Denver Paramedics respond to 90,000 yearly 911 calls covering approximately 155 square miles with a population of 600,000. Cardiac arrest patients are transported to the closest of 11 receiving hospitals.
Denver has a consolidated city and county government comprised of 78 statistical neighborhoods defined by the Denver Regional Council of Governments made up of 144 census tracts. Census tracts are administrative units that have been used as proxies for neighborhoods in community and neighborhood-level analysis because they are designed to represent social and economically homogenous groups of approximately 2,500 to 8,000 people. Two census tracts (tracts 9800 and 9801) were removed entirely from the study area because of their designation as industrial areas by the U.S. Census Bureau with resultant population counts of zero. The resulting study area was comprised of 142 census tracts.

**Data Collection and Processing**

This study was a secondary analysis of the Denver subset of the CARES dataset. CARES is a secure, standardized, web-based data management system housed at Emory University that catalogues every out-of-hospital cardiac arrest of presumed cardiac etiology for which EMS provides care. As of 2014, 40 U.S. cities and five states contribute data to CARES. CARES collects a limited number of standardized data elements from the time of 911 call, event characteristics, demographics of the patient, emergency room and hospital outcomes. Further details on the CARES dataset can be found elsewhere.145

First, OHCA events were geocoded, which is the process of assigning geographic coordinates (e.g. latitude and longitude) based on address information from the CARES registry and each location assigned to a census tract using Centrus™. Census tract-level demographic and socio-economic data from the 2010 decennial census was used in
conjunction with Census 2010 geographic boundary shapefiles. The geocoded OHCA events were then joined with demographics for the corresponding census tract using ArcMap 10.1. The resulting geographic shapefile contained both CARES registry data (age, race, gender, witnessed arrest, arrest location) and census data (race, median household income, poverty status, and educational attainment).

Second, EB-smoothed OHCA incidence was calculated for each census tract. Third, using both the crude and EB-smoothed incidence, a LISA and Gi* statistic was calculated for each census tract with R software. Clusters of increased OHCA incidence were then determined based on whether the p-value resulting from non-parametric Monte Carlo simulations was $\leq 0.05$. Fourth, aggregate bystander CPR prevalence was calculated for each census tract over the three-year period. Finally, an overlay of the high OHCA incidence clusters with the low bystander CPR prevalence was conducted to find those high-risk tracts that had both statistically significant high rates of OHCA and low bystander CPR.

Results were stratified by a public (outside of the home/residence) versus private (home/residence) location of arrest, with 80% of all arrests occurring in a private location. The p-value was set at <0.05 for all analyses. The community-level structural, organizational, economic and demographic characteristics were then described to understand the composition of each high-risk neighborhood and to inform the census tracts to target for Aim 2.
Statistical Analysis for Identifying High-Risk Neighborhoods

Neighborhoods were defined as potentially high-risk if the census tract was identified in at least one of the three spatial analysis methods (EB-smoothed OHCA incidence, LISA, and Gi*) and the crude prevalence of bystander CPR fell into the lowest quintile for CPR prevalence. Each analysis was run separately. The results were combined to determine the census tracts that appeared in at least two out of the three methods for hot spot analysis and overlap with census tracts that fell into the lowest quintile for bystander CPR. Tier 1 census tracts were identified in all three spatial OHCA clustering methods and tier 2 were identified in two out of three spatial analysis methods.

Empirical Bayes-Smoothed OHCA Rates

First crude rates of OHCA were calculated for the three-year study periods using the number of OHCA events in each census tract divided by the tract population. Then, the EB-smoothed OHCA rates were calculated for the three-year study period using the smoothing tool in GeoDa 0.9.9.15, which is a freely available spatial statistics software package (http://geodacenter.asu.edu). The EB smoother adjusted values toward the mean of the observed data with the amount of shrinkage toward the mean being inversely proportional to the size of the overall at risk population. Census tracts with large populations experienced smaller amounts of adjustment toward the mean than census tracts with small populations. Smoothed data values were therefore stabilized in areas with small populations with unstable rates which in turn accounted for the geographic “small area” problem. The EB-smoothed OHCA rates were categorized into quintiles. Census tracts defined as high-risk if the EB-smoothed OHCA rates were in the top quintile.
Local Moran’s I LISA Statistic

The LISA statistic was used to detect clusters, and statistically significant outliers, in the data. However, the LISA statistic was subject to “edge effects”, meaning that influences from events outside the study area on events located on the edge of the study area were ignored. This meant there were less neighboring data values to use in the analysis, thereby decreasing the ability to identify outliers along the border. The LISA calculated local index values, z-scores, and p-values. Positive local index values indicated a census tract was surrounded by census tracts of similar values and was part of a cluster. Negative local index values represented outliers which were features surrounded by dissimilar values. The z-scores and p-values measured the statistical significance of each computed local index value. To properly interpret index values the z-scores and p-values were analyzed. Census tracts with high positive z-scores were statistically significant clusters surrounded by features of similar values—either similarly high or similarly low. Conversely, features with low negative z-scores were associated with statistically significant spatial outliers of clusters surrounded by dissimilar values.

The LISA was calculated using first order polygon contiguity in the ArcMap 10.1 Spatial Statistics toolbox. First order polygon contiguity designates that only neighboring census tracts that share a boundary will influence the calculation for each census tract. The LISA statistic was run on both the crude and the EB-smoothed OHCA rates calculated using Geoda in the prior analysis. Clusters with high OHCA incidence (areas that have incidence values of similar magnitude) for the aggregated study period were identified as “hot spots” while clusters of features with low incidence were referred to as
“cold spots.” Clusters of census tracts with high OHCA were those with significant p-value $\leq 0.5$ and either positive local index values designated as High-High (HH) or negative Local Index Values designated as High-Low (HL).

**Getis-Ord Gi* Statistic**

The Gi* statistic identified areas where incidents with either high or low values cluster spatially by looking at each census tract within the context of its neighboring census tract.\(^{152,153}\) Unlike LISA, the Gi* statistic did not identify the similarity of values to their surrounding neighbors. The Gi* was calculated using the Cluster and Outlier Analysis tool from the Mapping Clusters toolset of the ArcGIS 10 Spatial Statistics Tools toolbox. The crude and the EB-smoothed OHCA rates were analyzed using first order polygon contiguity which designates that only neighboring census tracts that share a boundary will influence the value calculation for each census tract. The z-scores and their associated p-values indicated the statistical significance with which the census tract is part of a spatial cluster of high or low values. The higher the z-score the more intense the clustering of high values (“hot spots”); the smaller the z-score the more intense the clustering of low values (“cold spots”). Census tracts with z-scores $>1.96$ were identified as hot spots for OHCA.

**Crude Bystander CPR Prevalence**

Based on prior research,\(^{123}\) it was likely that the majority of census tracts would have either zero instances or extremely low numbers of bystander CPR occurrence during the 3-year time periods. Therefore, only the crude aggregate bystander CPR rate for the 3-year time period was be used. The crude percentages of bystander CPR incidence was
calculated for each census tract by dividing the total number of OHCA victims who received bystander CPR in each census tract by the total number of OHCA incidents over the three-year time period.

Identification of High-Risk Census Tracts

A summary approach was used to determine if a census tract was high-risk. If the census tract was identified in at least one of the three spatial analysis methods for OHCA and had a low prevalence of bystander CPR, it was included. Tier 1 census tracts were identified in all three spatial OHCA clustering methods and tier 2 was identified in two out of three methods.

Considerations

Case ascertainment bias was possible, as CARES only includes EMS-treated arrests of presumed cardiac etiology. Cases due to trauma, respiratory causes, electrocution and drowning were outside the scope of this analysis. However, Denver EMS is the sole provider of services in the City and County of Denver and so all treated OHCA events should be uniformly captured. It was also possible that spatial clusters of OHCA incidence may not be found. Based on other research, this was unlikely to occur. Finally, census tracts were used as a proxy for neighborhood. Although this approach did not consider true neighborhoods, which rarely follow census tract boundaries, it did allow for the underlying demographics of the residents to be examined. Future research creating neighborhoods based on community land use and resident surveys may be used to identify more representative areas.
Research Aim 2

Conduct community-based participatory research with qualitative methods (focus groups and key informant interviews) to interview residents from high-risk neighborhoods to identify barriers and facilitators to learning and performing CPR. The research question is: what are the modifiable barriers at the individual, social and environmental level that are not currently discussed in the scientific and educational literature of CPR?

Background

The goal of this aim was to understand high-risk neighborhood residents’ experiences with OHCA, training in CPR, attitudes toward culturally-sensitive CPR training and ideas to improve cultural relevance of CPR training. Findings from this aim informed a tailored, culturally-sensitive neighborhood-based CPR intervention for minority populations who have been difficult to reach with traditional CPR training approaches.

Design

Using community-based participatory research with qualitative methods, both focus groups and in-depth semi-structured interviews were conducted. Qualitative methods were oriented toward understanding rather than simply measuring phenomena. Because data collection were open-ended, research participants were free to express themselves in their own words. Through detailed, in-depth analyses of the resulting data, these methods uncovered what may drive complex decisions like choosing to learn or perform bystander CPR at the individual, social and environmental levels. As such, they
were appropriate for exploring issues of disparities in bystander CPR provision in these high-risk neighborhoods.

Focus groups allowed residents who were Latino, both English- and Spanish-speaking and from Denver’s high-risk neighborhoods to discuss their understanding of cardiac arrest and CPR. In-depth interviews with community leaders provided a closer look at the barriers raised by the focus groups and how to incorporate existing resources to develop a neighborhood-based CPR intervention.

**Setting and Recruitment of Subjects**

Participants from Denver’s high-risk census tracts were purposefully sampled to participate in focus groups or semi-structured key informant interviews. Community-Based Participatory Research (CBPR) approaches were used to identify and partner with key community stakeholders and organizations who assisted with recruitment. The recruitment strategy was a purposive sample of residents who resided within the high-risk neighborhoods and were primarily English- or Spanish-speaking. Church leaders, medical professionals and community organizers were also recruited to participate in the in-depth interviews. “Snowball” sampling methods were used whereby participants also suggested the names of other people in their community who would want to participate. These participants were subsequently contacted and approached for potential study enrollment. Purposive sampling was conducted to ensure sample size and composition of groups.
Inclusion Criteria

All community members were 13-years or older, spoke either English or Spanish, and resided in the high-risk neighborhoods were eligible for participation in the focus groups/interviews.

Conduct of Focus Groups and In-Depth Interviews

An interview guide was developed in conjunction with the community liaisons and the research team (Appendix C). The guide was then used to conduct 6 focus groups and 9 key informant interviews; however, this was an iterative process. Data analysis began immediately after a focus group/interview was conducted. If a point of thematic saturation was reached, where no new information was being obtained, enrollment was stopped. A trained moderator who was fluent in both English and Spanish was used to conduct the focus groups and interviews. The moderator then introduced a CPR take-home kit that could be used to train family and friends. Focus groups allowed for a better understanding of barriers to CPR and how to design a community-based CPR intervention. Key informant interviews with community leaders provided a more in-depth look at the barriers raised by the focus groups.

Focus groups were stratified based on certain characteristics: 1) first generation and 2nd/3rd generation immigrants, and 2) language spoken at home, and 3) age. Each focus group lasted 30-120 minutes and had 6-10 participants. The focus group dynamics allowed participants to interact with each other. Interviews were approximately 30-60 minutes. All focus groups/interviews were conducted in the primary language spoken by the participant. Interested participants were asked to continue their involvement in the
research which included the development and implementation of a targeted, community-based CPR intervention (Aim 3).

Data Analysis

All transcripts from the focus groups/interviews were transcribed in English. The study team members, including the community liaisons, read all transcripts. A smaller group of study team members convened to code and identify preliminary themes. Data analysis started immediately to ensure adequate data capture and to ensure the aims of the research were being met. The study team members identified overriding themes and compared them across content areas. These themes were grouped together or assigned to subthemes. Any discrepancies among the study team members were discussed and final themes agreed upon. A thematic data analysis was performed using nVIVO qualitative data analysis package. The final data was presented to the community via printed materials and oral presentations.

Power

The sample size was determined by reaching a point of “saturation” where additional interviews were unlikely to identify new themes. Based on prior research, it was estimated that a maximum of 10 focus groups and 10 key informant interviews would allow for sufficient diversity and capture of key themes; however, saturation was reached and no new themes were emerging, so enrollment was ceased at 6 focus groups and 9 key informant interviews.
Considerations

Adequate recruitment of participants was extremely important in ensuring the views of the community were expressed in this research. The study team employed community liaisons and representatives from community-based organizations. There was a focus on partnerships with community-based organizations that served Latinos and African-Americans. Although this pilot study took place in Denver, these results may not generalize to minority populations living in other cities. Future research will need to be conducted in other cities to confirm that the findings from this study may apply elsewhere.

Research Aim 3

Informed by Aim 2, Aim 3 designed and piloted a targeted, train-the-trainer community-based CPR intervention that was culturally-sensitive and easily accessible for residents of high-risk neighborhoods. The first hypothesis is: targeted CPR interventions, aimed at the neighborhood level, will increase individuals’ awareness of CPR, increase their comfort in recognizing an OHCA and increase the number of people who are trained in CPR. The second hypothesis is: the proportion of people receiving CPR will increase in high-risk neighborhoods.

Background

The goal of this aim was to pilot a novel intervention designed to decrease disparities in CPR provision and OHCA outcomes for minority populations.
Design

Based on the findings from Aims 1 and 2, the proposed research tested the feasibility and efficacy of a targeted, culturally-sensitive, community-based CPR intervention designed specifically for residents of high-risk neighborhoods.

Setting and Recruitment of Subjects

The community liaisons and organizations identified in Aim 2 were utilized to recruit participants for this aim. Approximately 344 high-risk neighborhood residents were enrolled in the aim. Based on prior research, \(164,165\) it was conservatively estimated that each participant would teach an additional two to three people how to do CPR with the take-home CPR Anytime kit, which would benefit an additional 700-1,050 people.

There was an emphasis on family-centered recruitment because the immediate and extended family is very important in minority populations’ cultures.\(^5^4\) Because Latinos were oversampled in Aim 2, we chose to oversample Asians and African-American residents of high-risk neighborhoods.

All community members who were 13-years or older and spoke either English or Spanish were eligible for participation in the pilot intervention. It was feasible that study participants who did not reside in the high-risk neighborhoods may attend the trainings. Although there was a focus on high-risk neighborhood residents, anyone who attended a training was eligible to participate.

Tailored, Culturally-Sensitive Intervention

High-risk neighborhoods residents were educated how to: 1) appropriately use the 911 system, 2) perform CPR with an educational session combining a didactic session
with hands-on training, and 3) teach CPR to family and friends in their neighborhoods by providing each participant with a take-home CPR Anytime kit. By taking place in local community centers, churches and schools, and being conducted in the native language of participants, the intervention was tailored to high-risk neighborhood residents. The CPR intervention was further tailored based on the findings from Aim 2. Because health literacy among minority populations is below the national average, all intervention materials were adapted to a sixth grade reading level. The take-home CPR Anytime kits and all training materials were available in both English and Spanish and were also suitable for a person with a sixth grade reading level.

**Implementation of Intervention**

Informed by findings from Aim 2, this was a targeted, feasibility study of a community-based, culturally-sensitive CPR intervention to directly teach 350 participants how to do CPR and indirectly teach 700-1,050 friends and family of the original 350 participants how to do CPR using the “train-the-trainer” approach. Previous research shows that, on average, an additional 1.5 family members or friends are trained with each kit (total of 2.5 people per kit). Our research used the same kit because we wanted to make sure that the training was the same for all people that took part in the same. By using an evidence-based, validated video self-instruction method with the manikin, we could ensure that all participants would participate in the same type of training.
The educational intervention was approximately 1.5 hours in length and each session had no more than 40 participants. During the first part of the educational intervention, consent forms were administered and the study described. Then, the CPR Anytime kit digital video disc (DVD), which described in both English and Spanish how to perform hands-only CPR, was shown to the study participants. The group then practiced hands-only CPR. The participants took a pre- and post-intervention knowledge test to gauge how much information each participant retained (Appendix D). Finally, the participants were asked if they were interested in taking the kit home and teaching their family and friends. If they agreed to do so the participant was given a kit. The family or friend who the study participant chose to educate watched the video, practiced chest compressions on the manikin and received feedback (a clicking sound is emitted from the manikin when the correct chest compression depth is reached). The kits were specifically designed to be used in a train-the-trainer pyramid model program. The participants were asked to keep a record of those people who the participants trained and to give them a postcard consent to describe the program. Study participants were also asked to give five family and friends a pre- and post-test knowledge survey to test understanding of key concepts. Participants were asked to bring all materials back in two to four weeks and were incentivized with a gift of 10 dollars and a completion certificate, both of which were given out when the completed materials were returned. The data collection process is detailed in Figure III.2.
Workflow that outlines the data collected at each time interval of the targeted CPR intervention.

**Data Collection/Analysis**

Study participants completed a survey before the CPR educational intervention and were asked to fill out the post-test survey. The participants were instructed to return their data collection form and pre- and post-test surveys two to four weeks after the CPR education intervention. The follow-up survey for both the study participants and the family and friends was be an assessment of their knowledge and of their comfort with performing CPR and calling 911.

Survey data was collected and accumulated in aggregate in order to evaluate the issue as a whole. Individual participant information was stripped of names and personal
identifiers and assigned a random number. Conclusions were based upon pooled data from all participants. The deidentified data was entered into STATA 11.0 (College Station, Texas), which was used for data analysis. Descriptive statistics of the participants’ answers were determined and summary statistics, including frequency distributions, means and other descriptive analyses of variables, were computed to provide an overview of the characteristics of the group. Address-level data was captured so the distribution of the CPR Anytime training program into the community could be described. No addresses were shared and they only were used to identify the depth and breadth of the CPR Anytime intervention (e.g. distance of participants’ home from site used for training).

Changes in bystander CPR prevalence was also assessed six months prior and six months post the CPR educational intervention using the Denver CARES dataset. A difference in differences approach was utilized, with each census tract used as its own control. A linear regression model was used, adjusting for the pre- versus post-implementation period, proportion of private/public events, proportion of witnessed events, index of high-risk neighborhood residents trained, and whether the census tract was considered high-risk. An interaction term between pre- versus post-implementation period and number of people trained was also added to the model to assess the effect of the intervention over the time period.

**Outcome Measures**

Primary outcome measures were: 1) number of people directly trained in CPR, 2) participants’ satisfaction with the CPR intervention and knowledge acquisition (via pre-
and post-intervention knowledge test), and 3) number of people indirectly trained with the CPR take-home kits. Secondary outcome measures were: 1) bystander CPR prevalence and OHCA incidence in the target neighborhoods obtained from the Denver CARES dataset [as described in Aim 1], 2) knowledge acquisition and comfort of participants who were directly trained in CPR, and 3) knowledge acquisition and comfort of family and friends indirectly trained by the study participants.

**RE-AIM Framework for Program Evaluation**

The intervention also used the RE-AIM measures for evaluation. The RE-AIM framework has been used extensively for evaluating the effectiveness of community-based interventions and is well-vetted in the program implementation literature. In existence since 1999, this program evaluation framework has been designed to increase the speed in which promising, evidence-based community interventions are translated into the real world. This systematic evaluation framework concentrated on five major areas: 1) reach to the intended target population, 2) efficacy/effectiveness, 3) adoption by target populations, settings, or staff, 4) implementation consistency, as well as any costs and adaptations made during delivery, and 5) maintenance of the intervention over time for people and settings. The implementation of Aim 3 was also evaluated using this framework.

Specifically, the questions asked were derived directly from the RE-AIM website. Reach was measured by determining the number and demographic of people from the targeted high-risk neighborhoods that would participate in the CPR Anytime training program. The representativeness of the program participants as compared to the
underlying population demographics for the high-risk neighborhoods that were being targeted was also determined. The reach measured whether the HANDDS Program intervention reached the target populations that it was designed for. Effectiveness was measured based on the proportion of study participants who trained more than 1.5 family and friends, which was the previously validated multiplier for the CPR Anytime Kit.\textsuperscript{164,165} Participants reported outcomes (for both the study participants and the sample of family and friends) on knowledge gained through the intervention, comfort performing CPR and willingness to perform CPR was measured. Secondary measures of bystander CPR prevalence before and after was also calculated, although it was unlikely that a change would be seen given that this is a pilot which is not powered to show a difference in effect. Adoption was measured by the ratio of organizations that were contacted and those organizations that agreed to host the trainings. The representativeness of these organizations for recruiting the target populations was also measured. In addition, community liaisons were employed as intervention agents to identify sites for HANDDS Program implementation. Liaisons were asked to track the number of organizations that were contacted in order to get the desired number of study participants. Implementation was measured by determining the fidelity of the intervention (e.g. how consistent was the delivery of the CPR Anytime training), time needed to implement, and the associated costs of delivering the intervention. Process measures, such as how often the facilitator deviated from the recommended method for implementation and the types of training/re-education of staff that was needed to ensure the intervention is done consistently, was also measured. Finally, maintenance was measured at the programmatic level by
assessing whether the program became institutionalized within the participating organizations. At the conclusion of data analysis (approximately six months post intervention), the participating organizations were asked if they were continuing to do CPR training, if the organizations have any knowledge of study participants continuing to train others, and finally, if there is interest from the organizations for a repeat training event at one year.

**Considerations**

A power calculation was not conducted for this aim, as this was a pilot feasibility study. Based on the extensive review of the literature, it was determined that approximately 350 people would be the best sample size to test feasibility and to adequately evaluate the intervention. This research provided sample size estimates for a future multi-center trial that will be powered to assess the effectiveness of the intervention.

The top challenges anticipated prior to implementing this intervention were: 1) raising awareness of the significance of cardiac arrest, 2) overcoming two commonly cited barriers to CPR, fear of doing CPR incorrectly and fear of infection from doing mouth-to-mouth ventilations, 3) developing a program that was culturally relevant, and 4) developing a high quality program that was informative yet entertaining to maintain interest. Finally, the RE-AIM framework was used to evaluate the pilot intervention. One key component of the framework was the individual-level maintenance of the intervention (e.g. does the study participant remember how to perform hands-only CPR at six
months); however, given that this was a pilot study, this was outside the scope of the proposed research.
CHAPTER IV

DISCUSSION

Summary of Pertinent Findings

The HANDDS Program is a systematic approach to address health inequities in who receives bystander CPR. The HANDDS Program includes first identifying high-risk neighborhoods using novel spatial analytical methods, then understanding barriers to learning and performing CPR through qualitative methods, and finally implementing and evaluating a community-based train-the-trainer approach.

In Aim 1, we conducted a secondary analysis of prospectively collected Emergency Medical Services data of OHCA from January 1, 2009, to December 31, 2011, in the City and County of Denver, Colorado (Appendix E). EB smoothed incidence rates were calculated for OHCA, and LISA and Gi* statistics were used to identify hot spots. A total of 1,102 arrests in 142 census tracts occurred during the study period, with 887 arrests included in the final sample. Maps of clusters of high OHCA incidence were overlaid with maps identifying census tracts in the lowest quintile for bystander CPR prevalence. Five census tracts identified were designated as Tier 1 high-risk tracts, while an additional eight census tracts were designated as Tier 2 high-risk tracts. The neighborhoods were comprised primarily of Latino and African-American residents with a median household income ranging from $8,015 to $57,689.

In Aim 2, we conducted six focus groups and nine key informant interviews in five of the 13 identified high-risk neighborhoods, oversampling for Latinos and non-English, Spanish-speaking study participants (Appendix F). In total, there were 64
participants. The majority of the participants were ≥30 years (70%), female (75%), and Latino (88%). Forty-seven percent of the participants had not completed high school. Almost half (46%) of the participants had an annual household income <$30,000. Six key barriers were identified to calling 9-1-1: 1) fear of getting involved, 2) financial, 3) immigration status, 4) lack of recognition of cardiac arrest event, 5) language concerns, and 6) violence. Consistent with prior research, study participants cited similar barriers to performing CPR: fear of legal consequences (e.g. fear of lawsuit, misunderstanding of Good Samaritan laws, age of cardiac arrest victim), emotional disconnection from community (e.g. lack of community cohesion, questioning if other residents would stop to assist), knowledge (e.g. unsure of how and when to perform CPR, confusion from frequent CPR guideline changes, fear of doing it incorrectly), and risk to personal health (e.g. administering mouth to mouth to a stranger, unsafe setting). There were some additional cultural barriers that were identified including age, gender, immigration status, language concerns, racism, and fear of strangers or of touching someone.

Finally, in Aim 3, we implemented and evaluated a CPR train-the-trainer approach in high-risk neighborhoods. Based on the lessons learned from Aims 1 & 2, the training was both culturally-sensitive and tailored to the communities in which it was delivered. In total, 344 people participated in the training from 12 sites. Participants were Asian (50%), African-American (35.6%), female (68%), had completed high school (26.8%), and had an annual income <$30,000 (37.1%). Because Aim 2 had heavily represented Latinos, we targeted Asian and African-American residents living in high-
risk neighborhoods for the intervention. After the CPR training the number of questions answered correctly on a pre- and post-test increased from a mean of 1.71 (Standard Deviation [SD] 1.31) to 3.96 (SD 1.07) out of five questions and the majority of participants (84.6%) felt comfortable performing Hands-Only CPR. Study participants were then asked to train five family and friends. Of the 344 participants, 154 (44.8%) returned at two weeks to provide data on the people they had trained using the CPR Anytime Kits. An additional 886 family and friends were trained in CPR by the study participants. Of the 886 family and friends trained, 466 participants completed pre- and post-tests. Approximately 73% of the family and friends felt somewhat to very comfortable in performing Hands-Only CPR after learning it from their family or friend. Family and friends also increased the number of questions answered correctly from a mean of 2.78 [SD 1.49] to 4.11 [SD 0.69] out of five questions. A total of 1,230 people were trained in Hands-Only CPR (average: 3.6 people/kit); at $27 per CPR Anytime kit, this came to a cost of $7.56 for each person trained. A formal program evaluation was conducted using the RE-AIM framework (Appendix G).

**Addition of Social Ecological Model**

The Health Belief Model initially guided the development of the research aims, but was focused on how to promote bystander CPR in individuals. As the research progressed, it was apparent the likelihood of performing bystander CPR was influenced at multiple levels beyond just the individual, and should also include social and environmental factors (Figure IV.1). Therefore, the Social Ecological Model was added to guide the future development of behavioral change interventions to promote bystander
CPR. According to social ecological theory, the desired behavior (performing CPR) is influenced across multiple different levels, but leverage points can be found at each level to increase the likelihood of the desired behavior.\textsuperscript{170} The Social Ecological Model postulates that multi-level interventions should be the most effective manner to promote behavioral change.\textsuperscript{171}

![Social Ecological Model and Likelihood of Performing Bystander CPR](image)

**Figure IV.1 Social Ecological Model and Likelihood of Performing Bystander CPR**

Model that shows the different factors at the individual, social and environmental levels.

**Leverage Points Within the Social Ecological Model**

At the individual level, self-efficacy and cues to action were identified as factors affecting the likelihood of someone choosing to perform bystander CPR during a cardiac arrest.\textsuperscript{31} By identifying barriers to learning and performing CPR, a culturally-sensitive
and tailored train-the-trainer approach was implemented to teach high-risk neighborhood residents how to perform CPR. The goal to increase self-efficacy was achieved through both peer-to-peer interaction, as well as individualized, tailored education and CPR skills assessment. As a part of the CPR training, study participants were also educated about cues to action, such as the signs and symptoms of cardiac arrest, as well as when to perform CPR. They were informed that when they called 9-1-1 for a cardiac arrest, dispatchers would also be cueing them over the phone to perform CPR.

At the social level, the train-the-trainer approach leveraged an individual’s desire to go out and promote the skill within the high-risk neighborhood in which he/she lives. By providing neighborhood health inequality data to the study participants, it was postulated that high-risk neighborhood residents would be more motivated to go out and train as many family and friends as possible. The concept of bonding social capital by reaching out to family and friend social circles who were similar to the study participants was imperative to the success of the program. This was, in fact, what the research showed. For every one CPR Anytime Kit that was distributed, 3.6 people were trained in life-saving CPR.

The methods used by our study participants to reach out to others varied tremendously, but ultimately increased collective efficacy at the social level. They used civic engagement, both formal and informal, to affect change in their own neighborhoods. We obtained feedback from study participants at the second visit, when they were asked to return data on family and friends, including the number of people trained, knowledge retained and comfort performing CPR. The sites where family and
friends were trained were highly variable and included neighborhood association meetings, family reunions, poker parties hosted by the study participant, and even CPR skills night at the local senior living center. These formal and informal venues for civic engagement allowed for a multitude of people within the high-risk neighborhoods to be trained in CPR.

Again, through feedback from study participants, it appeared the act of empowering study participants to train others in their neighborhoods increased the level of neighborhood cohesion by aligning residents toward the same goal: decreasing health inequities. There appeared to be an increased interest in civic engagement, promoting neighborhood cohesion and bonding social capital among study participants. However, future research will need to be conducted to formally measure whether CPR training does in fact result in any impacts among these three areas and toward the ultimate goal of increasing collective efficacy.

At the physical environment level, certain key points were leveraged. Social determinants of health were addressed with study participants. Data was provided to participants on how their physical environment affected their community members’ risk of having cardiac arrest events and having bystander CPR performed. This information, coupled with the empowerment of knowing how to teach CPR, would ideally lead neighborhood residents to work on these specific social determinants of health, which may adversely affect their health. Future research could be conducted in the years after the HANDDS Program to assess how public courtesies, such as number of trash cans, public parks, lack of graffiti, neighborhood watch signs, etc., may change as more
community members become engaged within their neighborhoods, and the social level factors (civic engagement, neighborhood cohesion and bonding social capital) begin to affect the physical environment. It is unlikely the HANDDS Program alone would create this level of change; however, the interaction between this and other community-based programs may shift the tide toward impacting the physical environment.

Policy environment factors were also discussed with study participants; legislation to make CPR a mandatory requirement for all high schoolers was addressed. Making CPR a graduation requirement is a policy change that uses a collective approach to increase the number of people trained to respond to a cardiac emergency, rather than relying solely on an individual’s own sense of personal responsibility to learn and perform CPR. In the qualitative Aim 2, fear of being sued was cited as a barrier to performing bystander CPR. As a result, a discussion about Good Samaritan laws in Colorado was included in every training, and study participants were asked to communicate this information to their family and friends.

Current Colorado advocacy measures, such as CPR education as a high school requirement, as well as the protection afforded to bystanders through Colorado’s Good Samaritan law, may affect the likelihood that bystander CPR will be performed. Future research should be conducted to see how bystander CPR rates compare in states that do versus states that do not have CPR as a high school educational requirement. Additional research could also be conducted to assess the impact of discussing Good Samaritan laws during community CPR training on the willingness to act in an emergency situation.
Interaction of Factors Between the Levels

The three research aims that were conducted influenced the likelihood of performing CPR at the individual, social and environmental levels. In Aim 1, socioeconomic status and race/ethnicity were examined in relation to how they affected the likelihood a cardiac arrest victim would have bystander CPR performed. In Aim 2, physical and policy environmental, social and individual factors were identified that could affect whether a bystander chose to perform CPR. In Aim 3, a train-the-trainer approach was utilized to increase self-efficacy at the individual level. However, because study participants were asked to train their family and friends, this intervention also affected the social level to increase collective efficacy through neighborhood cohesion, increased civic engagement, and increased social capital. Study participants were empowered by learning a new skill (CPR), and then asked to share this knowledge as widely as possible. The unintended consequence of this sharing was the opportunity to engage others and increase the collective efficacy of that neighborhood and/or social group.

Although our specific intervention in Aim 3 did not directly affect the environmental and policy level, our qualitative research (Aim 2) showcased important changes that need to be made to decrease barriers to performing CPR. Physical and policy environment can provide a deeper, longer-lasting change than just individual-centered change. As a result, larger-scale initiatives at the policy-level are currently being undertaken by other organizations (e.g. American Heart Association) to require CPR training for every high school student and to change Good Samaritan laws so that
people are not be afraid of being sued if they try to assist a cardiac arrest victim. The largest proportion of people ultimately will be affected by working on the physical and policy environment; however, this is also the most challenging due to the amount of political will that must be changed to get this passed.\textsuperscript{177}

**Limitations of Social Ecological Model**

There are some limitations that must be addressed to the Social Ecological Model. Although it is important to look at the different levels as they relate to the desired behavioral change,\textsuperscript{177} it may be difficult to measure the effects of a given intervention on a specific level. As a result, testing specific hypotheses to test each of these levels can be challenging because there is likely an interaction between multiple levels. It may be difficult to disentangle the independent effect of the intervention on one level versus another level.\textsuperscript{178} However, the Social Ecological model does provide a framework in which the interplay of environmental, social and individual level factors on the decision to perform bystander CPR can be taken into account. It also highlights the important idea that a one-size-fits-all approach may not be feasible. Instead, tailoring the CPR training and using culturally-sensitive materials may help the individual achieve the appropriate cues to action.

**Next Steps**

The HANDDS Program was a pilot study to identify a novel method for identifying high-risk neighborhoods and working with community members to increase the provision of bystander CPR in their areas. Next steps for this research will include testing the scalability and reproducibility of this program in other geographic locations.
across the United States. As part of this multi-centered study, it will be imperative to examine differences across communities and cities and how social capital at the individual and community level impacts bystander CPR. This could be measured in a variety of ways to measure this including, but not limited to, the Social Capital Benchmark Survey, Social Capital Assessment Tool (full and adapted) and the Sampson method.\textsuperscript{179} These measures of social capital use a mix of questions that address social cohesion, informal social control, civic engagement, family and friend connections, trust and reciprocity and structural versus cognitive connectedness. These concepts can be measured at the individual and community level, and then factored into a multi-level analysis that examines the proportion of people within a neighborhood who receive bystander CPR. Although prior research has looked at measures of race/ethnicity and socioeconomic status as important predictors of receipt of bystander CPR, measures of social capital may in fact mediate or moderate this effect. Future research will need to be conducted to better assess the independent effect of these measure on both individual and neighborhood level CPR analyses.

Future research may also be conducted to test how the HANDDS Program functions in other disease states. Specifically, the lessons learned from developing this program may also be utilized in other diseases states in which health disparities are present and healthcare resources are scarce. For example, a similar program could be utilized for the targeted identification, implementation and evaluation of a culturally-sensitive intervention to reduce sexually transmitted diseases, teenage pregnancy and uncontrolled hypertension. The HANDDS Program provides a systematic approach to
both targeting resources where they are most needed and conducting the formative work that ensures that the public health intervention is successful and done in conjunction with the community which it is serving.
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APPENDIX A

TABLE OF INCLUDED STUDIES
<table>
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<tr>
<th>Author</th>
<th>Year</th>
<th>Category</th>
<th>Race/Ethnicity</th>
<th>Follow-up</th>
<th>Study Participants</th>
<th>Sites</th>
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<td>Category</td>
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APPENDIX B

INSTITUTIONAL REVIEW BOARD ACCEPTANCE LETTER
Certificate of Approval

19-Apr-2013

Investigator: Camilla Sisson
Sponsor(s): Colorado Clinical And Translational Sciences Institute
Subject: COMIRE Protocol 10-1572 Continuing Review
Effective Date: 19-Apr-2013
Expiration Date: 18-Apr-2014
Expedited Category: Title:
Description: Improving Survival from Out-of-Hospital Cardiac Arrest in High-Risk Neighborhoods: A Community-Based Participatory Research Study to Understand Barriers to CPR

All COMIRE-Approved Investigators must comply with the following:

- For the duration of your protocol, any change in the experimental design, consent, and/or consent form must be approved by the COMIRE before implementation of the changes.
- Use only a copy of the COMIRE signed and dated Consent and/or Assent Form. The investigator bears responsibility for obtaining from all subjects "Informed Consent" as approved by the COMIRE. The COMIRE requires that the subject be given a copy of the consent and/or assent form. Consent and/or assent forms must include the name and telephone number of the investigator.
- Provide non-English speaking subjects with a certified translation of the approved Consent and/or Assent Form in the subjects first language.
- The investigator also bears the responsibility for informing the COMIRE immediately of any unanticipated problems that are unexpected and related to the study, in accordance with COMIRE Policy and Procedures.
- Obtain COMIRE approval for all advertisements, questionnaires, and surveys before use.
- Federal regulations require a Continuing Review to renew approval of this project within a 12-month period from the last approval date unless otherwise indicated in the review cycle listed below. If you have a restricted high-risk protocol, specific details will be outlined in this letter. Noncompliance with Continuing Review will result in the termination of the study.

You will be sent a Continuing Review reminder 75 days prior to the expiration date. Any questions regarding this COMIRE action can be referred to the Coordinator at 303-724-8056 or UCHSC Box F-490.

Review Comments:

This electronic approval includes:
Continuing Review, CRV012
Application and Attachment F, H, M, 12/2012
Protocol, not dated
Please note that COMIRB will no longer be E-mailing approved documents. Stamped, approved documents can be retrieved in the eRA (InfoEd) system. Please click here to access instructions on finding these uploaded documents. Documents will be available within the next 48 hours.

Sincerely,

UCD Panel B

Please provide Feedback on Your Experience with the COMIRB Process.
APPENDIX C

FOCUS GROUP INTERVIEW GUIDE
INTERVIEW GUIDE

1. Opening
   a. Tell us your name, where you are from. (get demographic info from registration form given in beginning)

2. Introductory
   a. What would you do if someone suddenly falls down in front of you and appeared to be unconscious?
   b. Have you ever seen someone do this? What did you do? What did other people do?
   c. What is your understanding of the things that can cause someone to fall down? (probe: do they know the difference between a heart attack and heart arrest)

3. Transition
   a. What is your understanding of cardiopulmonary resuscitation (CPR) and what is it that CPR is doing?
   b. Have you ever seen someone do CPR? (probe: If so, who and what were the circumstances)?
   c. Have you done it yourself? (probe: If so, why did you decide to perform CPR? If you did not do CPR, why did you not perform CPR?)
   d. How many of you have taken a course in CPR? When and what type of training have you done?
   e. How and why did you decide to learn CPR?
   f. How did you hear about CPR training?
   g. If you are not trained in CPR, what are your thoughts about taking a CPR course?

4. Key
   a. What would you do if you were out on the street in your neighborhood and you and your neighbors saw someone fall down in your neighborhood? (Probe: What if you found out they weren't breathing and didn't seem to have a pulse)? (probe for reasons for answer) (probe for possible differences if somebody they knew or if a stranger)
   b. What would be the obstacles that would make people not do CPR? What might make it easier for people to do CPR?
   c. Generally speaking, how do you think people in your neighborhood would respond if you if you were in trouble? (probe for reasons)
   d. How do you think people in your neighborhood would respond if you fell down? (Probe: if you weren't breathing and didn't have a pulse)? (probe for reasons) (probe differences between known vs. stranger) (Could probe for differences between in own neighborhood and other places (what places?) and based on race or other characteristics)
   e. What would make people want to or not want to take a CPR class?
   f. What would be the best way to let people in your community know that a CPR training was going to occur? (i.e. email, news media, flyers, etc.)
   g. What kind of incentives would it take to get people to attend a training (i.e. food, CPR kit, magnet)?
h. What is your understanding of hands only CPR?
i. How did you hear about this?
j. If we were to teach you to do CPR only with your hands, without having to blow into someone's mouth, how might that affect your likelihood of doing CPR? Why or why not?
k. (Bring out CPR Anytime kit) Has anyone ever seen or used one of these?
l. (Play the first 8 minutes of the CPR Anytime kit) What do you make of this kit? (Probe: how do you feel about the people in the video? How does this training video make you feel? Would you feel comfortable performing CPR after this training?)
m. What would make you more likely to take this home and teach your family members?
n. What would make people in your community decide to take CPR training?
o. How can we best work together to get the message and trainings out to your communities (write things down on a flipchart)?
p. What do you see as the priority areas for your neighborhood right now? Do you see CPR training as being a high enough priority for this to be implemented in your area? Why and why not?
q. What kind of role would you be interested in playing in this promoting CPR in your community?

5. Ending
   a. What else have we not covered? Have we missed anything?

Pre-focus group questions:

Now I'm going to ask you how many times you've done certain things in the past 12 months, if at all. For all of these, I want you just to give me your best guess, and don't worry that you might be off a little. About how many times in the past 12 months have you (ACTIVITY):

Note: for all questions 6a-6k, interviewer probes for an actual number and if respondent can not provide an actual number, the interviewer follows up with: 'Would you say you never did this, did it once, a few times, about once a month on average, twice a month, about once a week on average, or more often than that? (IF RESPONDENT ANSWERS "A FEW TIMES", PROBE WITH.) Would that be closer to 2-4 times or 5-9 times?

a. (How many times in the past 12 months have you) Had friends over to your home?
b. Been in the home of someone of a different neighborhood or had them in your home?
c. Been in the home of someone of a different race or had them in your home?
d. Worked on a community project?

e. Donated blood?

f. Attended any public meeting in which there was discussion of town or school affairs?

g. Attended a political meeting or rally?

h. Attended any club or organizational meeting (not including meetings for work)?

i. Been in the home of someone you consider to be a community leader or had one in your home?

j. Volunteered?

k. Served as an officer or served on a committee of any local club or organization?
APPENDIX D

PRE- AND POST-TESTS FOR STUDY PARTICIPANTS
PRE-TEST

Name ____________________________ Date __________________

Phone Number ____________________ Email _________________

Address ____________________________________________

City, Zip Code _______________________

Demographic Information of Participants
Thank you for agreeing to participate in this study. Before we get started, we are
going to ask a few questions. All of this information will be kept confidential and
will not be shared with anyone. We are only collecting this information to get a
better sense of who is participating in the study and will not share names or
addresses or any personal information with anyone. Thank you for your time.

Age (years) ___________ Gender: □ Female  □ Male

1) Which of the group best describes your Race/Ethnicity:
(Choose All That Apply)
□ Asian □ Black/African American □ Latino/Spanish/Hispanic □ Native American/Alaskan Native
□ Pacific Islander □ White □ Other ___________________________

2) Have you ever taken a formal CPR course before? □ Yes □ No
   a) If so, how many years ago was it? _______________________

3) What is the highest level of education you have achieved? (Choose ONE)
□ Middle school □ Completed College
□ Some High school □ Master's Degree
□ Completed High school □ Doctorate Degree
□ Some college

4) Which best describes your annual household income? (Choose ONE)
□ Less than $10,000 per year
□ $10,001- $20,000 per year
□ $20,001-$30,000 per year
□ $30,001-$50,000 per year
□ $50,001-100,000 per year
□ $100,001-200,000 per year
□ Greater than $200,001 per year
5) What is your profession? 

6) Were you familiar with CPR before you came here today?  
☐ Yes  
☐ No

7) How did you hear about this? (pick as many as apply)  
☐ Newspaper  
☐ Television  
☐ Flyer  
☐ Friend/Word of mouth  
☐ Internet  
☐ Other (please specify) 

General Knowledge Questions: Please answer the below questions to the best of your ability.

8) What does CPR stand for?  
☐ Cardiac Push Response  
☐ Cardiopulmonary Resuscitation  
☐ Care Prior to Response  
☐ I don't know.

9) How many times should you push in the center of the chest during Hands-Only CPR during a one minute period?  
☐ 50  
☐ 150  
☐ 100  
☐ I don't know.

10) What are the correct steps for providing Hands-Only CPR?  
☐ Dial 911 and push hard and fast in the center of the chest  
☐ Push hard and fast in the center of the chest then dial 911  
☐ Give two breaths than dial 911  
☐ I don't know.
11) Which of the following situations can you use Hands-Only CPR?
- A drowning victim
- An unconscious child
- An adult you witness go into cardiac arrest
- All of the above
- I don't know.

12) How deep should you push on the chest of an adult when doing Hands-Only CPR?
- 1 inch
- 2 inches
- 3 inches
- I don't know.
POST-TEST

Name ___________________________ Date ____________

Follow-up Survey

Hello. Thank you once again for participating in the CPR training! Please fill out the following questions.

1) What does CPR stand for?
   ☐ Cardiac Push Response
   ☐ Cardiopulmonary Resuscitation
   ☐ Care Prior to Response
   ☐ I don’t know.

2) How many times should you push in the center of the chest during Hands-Only CPR during a one minute period?
   ☐ 50
   ☐ 150
   ☐ 100
   ☐ I don’t know.

3) What are the correct steps for providing Hands-Only CPR?
   ☐ Dial 911 and push hard and fast in the center of the chest
   ☐ Push hard and fast in the center of the chest then dial 911
   ☐ Give two breaths then dial 911
   ☐ I don’t know.

4) Which of the following situations can you use Hands-Only CPR?
   ☐ A drowning victim
   ☐ An unconscious child
   ☐ An adult you witness go into cardiac arrest
   ☐ All of the above
   ☐ I don’t know.

5) How deep should you push on the chest of an adult when doing Hands-Only CPR?
   ☐ 1 inch
   ☐ 2 inches
   ☐ 3 inches
   ☐ I don’t know.

HANDDS Protocol, v 1.0

Page 4 of 4
Multiple Cluster Analysis for the Identification of High-Risk Census Tracts for Out of Hospital Cardiac Arrest (OHCA) in Denver, Colorado

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Abstract

Background: Prior research has shown that high-risk census tracts for out-of-hospital cardiac arrest (OHCA) can be identified. High-risk neighborhoods are defined as having a high incidence of OHCA and a low prevalence of bystander cardiopulmonary resuscitation (CPR). However, there is no consensus on which approach is best for this process.

Objective: We propose a novel summary approach to identify high-risk neighborhoods through three separate spatial analysis methods: Empirical Bayes (EB), Local Moran’s I (LISA), and Getis Ord Gi* (Gi*) in Denver, Colorado.

Methods: We conducted a secondary analysis of prospectively collected Emergency Medical Services data of OHCA from January 1, 2009 to December 31, 2011 from the City and County of Denver, Colorado. OHCA incidents were restricted to those of cardiac etiology in adults ≥18 years. The OHCA incident locations were geocoded using Centrus. EB smoothed incidence rates were calculated for OHCA using Geoda and LISA and Gi* calculated using ArcGIS 10.

Results: A total of 1102 arrests in 142 census tracts occurred during the study period, with 887 arrests included in the final sample. Maps of clusters of high OHCA incidence were overlaid with maps identifying census tracts in the lowest quintile for bystander CPR prevalence. Five census tracts identified were designated as Tier 1 high-risk tracts, while an additional 8 census tracts were designated as Tier 2 high-risk tracts.

Conclusion: This is the first study to use these three spatial cluster analysis methods for the detection of high-risk census tracts. These census tracts are possible sites for targeted community-based interventions to improve both cardiovascular health education and CPR training.
Introduction

Approximately 420,000 out-of-hospital cardiac arrests (OHCA) occur each year in the United States. Research has found that survival rates from OHCA vary widely based on the location where the event occurs. An important variable in the survival of an OHCA is the victim’s timely receipt of bystander cardiopulmonary resuscitation (CPR), yet only a minority of all OHCA patients receive bystander CPR. Bystander CPR is an important link in the American Heart Association’s chain of survival for OHCA. For every 30 people who receive bystander CPR, one additional life will be saved. However, recent research has shown that the chance of receiving bystander CPR and surviving after an OHCA can vary drastically from city to city, (e.g. 0.2% in Detroit to 16% in Seattle).

Although there is geographic variation in OHCA survival between cities, there is also variation at the neighborhood (census tract) level. Bystander CPR rates also appear to cluster within cities. Using geographic information systems (GIS) and spatial cluster analysis, neighborhoods can be identified as “high-risk,” defined as having higher than expected incidence of OHCA, with corresponding low prevalence of bystander CPR. The utility of identifying these neighborhoods is the ability to maximize public health resources by tailoring CPR training and cardiac arrest educational programs to neighborhoods that are most in need.

There are multiple methods for detecting clusters or areas that have statistically significant autocorrelation (e.g., spatial scan statistic and Kernel Density). Each method has its own unique advantages and limitations. Currently, however, there is no “gold standard” for identifying these high-risk neighborhoods. As a result, the primary objective of this study was to propose a novel
summary approach to identify census tracts using the intersection of three separate spatial analysis methods: Empirical Bayes (EB), Local Moran’s I (LISA) and Getis Ord Gi* (Gi*).

Methods

Data

This study is a secondary analysis of the Cardiac Arrest Registry to Enhance Survival (CARES) dataset for Denver City and County, Colorado. CARES is a secure, standardized, web-based data management system housed at Emory University, funded by the Centers for Disease Control and Prevention (CDC) and the American Heart Association that catalogues every out-of-hospital cardiac arrest of presumed cardiac etiology for which Emergency Medical Services (EMS) provides care. As of 2011, 40 U.S. cities from 25 US states contribute data to CARES. CARES collects a limited number of standardized data elements from the time of 911 call, event characteristics, demographics of the patient, emergency room and hospital outcomes. Further details on the CARES dataset can be found elsewhere.4

All OHCA events were geocoded, (the process of assigning geographic coordinates, e.g., latitude and longitude) based on address information from the CARES registry and each location assigned to a census tract using ArcMap 10.1 (ESRI, Redlands, CA). Census tract level demographic and socio-economic data from the 2010 decennial census were used in conjunction with Census 2010 geographic boundary shapefiles.20 The geocoded OHCA events were joined with demographics for its corresponding census tract. The resulting geographic shapefile contained both CARES registry data (age, race, gender, witnessed arrest, arrest location) and census data (race, median household income, poverty status, and educational attainment).
Study Population

All adult (≥18 years old) OHCA patients that had a resuscitation attempted by EMS between January 1, 2009 through December 31, 2011 were eligible for inclusion. During the study period 1102 arrests occurred in 142 census tracts in the City and County of Denver, with the final sample including 887 arrests. Arrests were excluded from the final dataset if the address occurred outside of the study area (City and County of Denver; n=66) or the event occurred in a jail (n=3), a hospital or health facility (n=18), or nursing home or "other" location (n=128), as these locations would presumably have rapid access to bystander CPR.

Study Area

The city and county of Denver has a population of 600,158. It has a consolidated city and county government comprised of 78 statistical neighborhoods defined by the Denver Regional Council of Governments (DRCOG) made up of 144 Census Tracts. Census Tracts are administrative units that have been used as "proxies" for neighborhoods in community and neighborhood level analysis because they are designed to represent social and economically homogeneous groups of approximately 2,500 to 8000 persons. Two Census tracts (Tract 9800 and Tract 9801) were removed entirely from the study area because of their designation as industrial areas by the Census with resultant population counts of zero. The resulting study area is comprised of 142 census tracts.

Statistical Analysis

Three Statistical Methods for High-Risk Neighborhood Identification

Neighborhoods were defined as potentially high-risk if the census tract was identified in at least 1 of the 3 spatial analysis methods (EB smoothed OHCA incidence, LISA, and Gi*), and the
crude prevalence of bystander CPR fell into the lowest quintile for CPR prevalence. Each analysis was run separately, and then the results combined to determine the census tracts that appeared in at least two out of the three methods for hot spot analysis and overlapped with census tracts that fell into the lowest quintile of those receiving bystander CPR. Tier 1 census tracts were identified in all three spatial OHCA clustering methods and tier 2 were identified in 2 out of 3 spatial analysis methods.

Calculation of Crude OHCA Incidence for 2009-2011
The incidence of OHCA was determined by dividing the total number of OHCA events in a census tract by the total number of adults 18 years and older that lived in a specific census tract. Because the data incorporated three years, the denominator (population of adults 18 years and older) was multiplied by three.

Crude Bystander CPR Prevalence
The majority of census tracts had either zero instances or extremely low numbers of bystander CPR occurrence, during the 3-year time period. Based on prior research, we used only the crude aggregate bystander CPR rate for the 3-year time period. The crude percentages of bystander CPR incidence were calculated for each census tract by dividing the total number of OHCA victims who received bystander CPR in each census tract by the total number of OHCA incidents over the 3-year time period.

Empirical Bayes Smoothed OHCA Rates
The EB smoothed OHCA rates were calculated for the three-year study period using the number of OHCA events in each census tract divided by the tract population using the smoothing tool in
GeoDa 0.9.9.15, a freely available spatial statistics software package (http://geodacenter.asu.edu). The EB smoother adjusted values toward the mean of the observed data with the amount of shrinkage toward the mean being inversely proportional to the size of the overall at risk population. Census tracts with large populations experienced smaller amounts of adjustment toward the mean than census tracts with small populations. Smoothed data values are therefore stabilized in areas with small populations with unstable rates which in turn accounts for the geographic “small area” problem. The EB smoothed OHCA rates were categorized into quintiles. Census tracts were defined as high-risk if the EB smoothed OHCA rates were in the top quintile.

**Local Moran’s I Statistic**

The LISA measured the similarity between census tracts and calculated values both within and across geographic boundaries while additionally identifying spatial outliers. The LISA calculates local index values, z-scores, and p-values. The z-scores and p-values measure the computed local index value and provide a measure of statistical significance. Census tracts with statistically significant positive z-scores indicate areas surrounded by areas with similar OHCA rates - either similarly high or similarly low (positive spatial autocorrelation). These are designated “High-High” (HH) or “Low-Low” in the maps. Conversely, census tracts with statistically significant negative z-scores indicate areas surrounded by dissimilar values (negative spatial autocorrelation). These are designated as “High-Low” (HL) or “Low-High” (LH) in the maps.

The LISA was calculated using first order polygon contiguity in the ArcMap 10.1 Spatial Statistics toolbox. First order polygon contiguity designated that only neighboring census tracts
that shared a boundary would influence the calculation for each census tract. The LISA statistics were run on the crude OHCA incidence by census tract. Clusters with high OHCA incidence (areas that have incidence values of similar magnitude) for the aggregated study period were identified as “Hot Spots” while clusters of features with low incidence are referred to as “Cold Spots.” Clusters of census tracts with high OHCA were those with significant p-value ≤ 0.5.

Getis-Ord Gi* Statistic

The Gi* statistic identified areas where incidents with either high or low values cluster spatially by looking at each census tract within the context of its neighboring census tract. Unlike LISA, the Gi* statistic did not identify the similarity of values to their surrounding neighbors. We calculated Gi* using the Cluster and Outlier Analysis tool from the Mapping Clusters toolset of the ArcGIS 10.1 Spatial Statistics Tools toolbox. The crude OHCA incidence by census tracts were analyzed using first order polygon contiguity which designated that only neighboring census tracts that shared a boundary would influence the value calculation for each census tract. The z-scores and their associated p-values indicated the statistical significance with which the census tract was part of a spatial cluster of high or low values. The higher the z-score the more intense the clustering of high values (hot spot); the smaller the z-score the more intense the clustering of low values (cold spots). Census tracts with z-scores greater than 1.96 were chosen as high OHCA clusters.

RESULTS

A total of 1,102 arrests in 142 census tracts occurred during the study period, with 887 arrests included in final sample. Of the 887 arrests, 17.5% (n=155) of the cardiac arrest victims received bystander CPR. The mean crude OHCA incidence for Denver County was 0.67 per 1000 people
and the mean CPR prevalence was 19.0%. Figure 1 shows the distribution of crude OHCA incidence during the three-year study period. Table 1 describes the baseline demographics and characteristics of the 887 OHCA events.

OHCA Results

EB Smoothed OHCA Incidence Analysis

The EB smoothed OHCA rates ranged from 0.20 to 1.60/1,000 people. There were 9 census tracts that fell into the highest quintile (1.02 to 1.60/1,000) and were considered high OHCA incidence census tracts (Figure 2a).

Local Moran’s I Analysis

LISA analysis identified 17 census tracts with high rates of OHCA incidence. The majority of the 17 census tracts identified by LISA as clusters of high OHCA incidence (16 out of 17) were categorized by ArcGIS as HH (high clusters neighboring with other census tracts with high clusters). The remaining 1 census tract designated as having a cluster of high OHCA incidence was categorized as HL (high clusters neighboring with census tracts with clusters of low incidence of OHCA). All 16 of these LISA designated HH census tracts were located in the northeastern to northwestern part of the City and County of Denver. The HL designated tract was located in the southern portion of Denver County (Figure 2b).

Gi* Analysis

The Gi* analysis identified 48 clusters of census tracts with a high rate of OHCA incidence. Eleven census tracts were in the 90% significance level, 16 were in the 95% significance level
and 21 were identified in the 99% significance level. Fourteen out of the 48 census tracts were the same tracts identified by LISA in northern Denver (Figure 2c).

**Bystander CPR Results**

*Crude Bystander CPR Prevalence*

Crude Bystander CPR rates ranged from 0 to 1. Rates in that fell below the mean for Denver County (0.19) were used to identify census tracts with the lowest bystander CPR prevalence (Figure 2d). Seventy-two census tracts where identified as having low rates of bystander CPR using this method.

**High-Risk Census Tracts**

Using three spatial analysis techniques, we identified tier 1 and tier 2 areas with relatively high rates of cardiac arrest, and relatively low prevalence of bystander CPR. Tier 1 neighborhoods were identified in all three spatial analysis methods, while tier 2 neighborhoods were identified in two out of three spatial analysis methods. Figure 3 shows the thirteen high-risk neighborhoods that were identified using this approach. Table 2 lists the socio-economic demographic data for each neighborhood as compared to the median household income ranging from $8.015 to $57,689.

**Discussion**

This is the first study to utilize a novel summary approach to identify high-risk OFICA neighborhoods. This combination approach uses the strengths of three separate analytical spatial clustering methods in order to identify areas which were hot spots for cardiac arrest, and were in
the lowest quintile for bystander CPR prevalence. Consistent with prior research, these neighborhoods were comprised of lower-income, primarily African-American and Latino residents.

This type of spatial analysis may change how public health resources are targeted throughout the country. Rather than blanketing a city with CPR training, our research shows that neighborhoods can be identified where the need is greatest, and the potential impact of targeted CPR training could be most effective. Prior research has shown that neighborhoods comprised of lower-income, African-American residents are most at risk for not receiving bystander CPR. Our research takes this one step further by identifying specific neighborhoods within Denver County that should be targeted for community-based CPR training interventions. We found that the Lincoln Park neighborhood was considered high-risk. This area has a high proportion of white residents, and would not have been identified by us as a target for CPR training if we had only focused on lower-income, African-American neighborhoods. This highlights the importance of using data to drive systematic, targeted training in the highest-risk neighborhoods.

Our work has significant policy implications. There is a growing body of evidence for targeting training when resources are limited (e.g. CPR training), including a recent Science Advisory from the American Heart Association. We believe that this novel, systematic spatial analytical approach may be a new manner in which high-risk neighborhoods can be identified. This type of hot spot analysis could also be important in identifying high-risk neighborhoods for other acute, time-sensitive conditions such as myocardial infarction and stroke. Although the majority of research identifies disease-specific conditions, we could presumably integrate these maps in order to fully understand the health and wellness of our neighborhoods. This more complete
picture of health, driven by GIS-based analyses, would allow us to design and implement targeted neighborhood-based interventions that would improve both morbidity and mortality in these areas.

There are some limitations to this study. We used census tract as a proxy for neighborhood. This allowed us to examine the underlying demographics and composition of these areas. Future research could use community-based land use surveys to identify true neighborhoods within an area. We also chose to use three common spatial analysis methods. Each of these methods has its own strengths and weaknesses. Therefore, we decided to use a summary approach that would allow us to draw conclusions based on triangulating these three methodologies, rather than just picking one. Finally, we did not separate OHCA events by public or private events. However, prior data has shown that more than 80% of events occur at home. It is possible that certain areas could be high-risk given that they have larger daytime populations (e.g., busy downtown district). However, the majority of the high-risk neighborhoods that we identified were in fact residential primarily.

Conclusion

Using a novel summary approach, we have identified high-risk neighborhoods in the City and County of Denver. This research allows us to triangulate areas based on multiple spatial analytical approaches, with the idea that a truly high-risk neighborhood will be identified using all three methods. Future research will need to be conducted to test the effectiveness of a community-based CPR intervention targeted to the highest-risk neighborhoods we have identified. Ultimately, this type of targeted approach to CPR training focused on the areas where the impact can be greatest may be a model for other public health conditions.
Acknowledgements

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References


Table 1: Characteristics of Study Sample

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<tr>
<th>2009-2011 OHCA Descriptive Statistics (n=887)</th>
<th>n (%)</th>
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<tbody>
<tr>
<td><strong>Race</strong></td>
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<tr>
<td>Hispanic</td>
<td>99 (11.2)</td>
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<td>White</td>
<td>276 (31.1)</td>
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<tr>
<td>Black</td>
<td>117 (13.2)</td>
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<tr>
<td>Asian</td>
<td>10 (1.2)</td>
</tr>
<tr>
<td>American Indian</td>
<td>10 (1.2)</td>
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<td>Native Hawaiian</td>
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<tr>
<td>Unknown</td>
<td>372 (42.0)</td>
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<td><strong>Bystander CPR</strong></td>
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<tr>
<td>Lay Person Medical Provider</td>
<td>15 (1.7)</td>
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<td>Lay Person Family Member</td>
<td>78 (8.8)</td>
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<td>Layperson</td>
<td>62 (7.0)</td>
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<td>EMS Personnel</td>
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<td>First Responder</td>
<td>558 (63.0)</td>
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<td>Responding EMS Personnel</td>
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<td>Arrest after EMS arrived</td>
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<td><strong>AED Used</strong></td>
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<tr>
<td>Yes</td>
<td>256 (26.6)</td>
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<tr>
<td>No</td>
<td>80 (9.0)</td>
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<tr>
<td>Present but not used</td>
<td>264 (29.8)</td>
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<tr>
<td>Unknown</td>
<td>307 (34.6)</td>
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<tr>
<td><strong>Survival to Discharge</strong></td>
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<tr>
<td>Discharged Alive</td>
<td>94 (10.6)</td>
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<td>Died in Hospital</td>
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<td>Good Cerebral Performance</td>
<td>71 (8.0)</td>
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<td>Moderate Cerebral Disability</td>
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<td>2 (0.1)</td>
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<tr>
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### Table 2: Characteristics of High-Risk Neighborhoods

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<tr>
<th>Neighborhood</th>
<th>Tract ID</th>
<th>Total Arrest Crime Rate per 1000</th>
<th>Total FB Rate per 1000</th>
<th>Bystander STP Crime Rate</th>
<th>% White</th>
<th>% African American</th>
<th>% Hispanic</th>
<th>Median Age, years</th>
<th>Median Household Income ($)</th>
<th>% of High School Grad or higher</th>
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<td>1.89</td>
<td>0.12</td>
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<td>72.9</td>
<td>31.4</td>
<td>32,769</td>
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<td>Five Points</td>
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<td>1.00</td>
<td>1.08</td>
<td>0.09</td>
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<td>31.5</td>
<td>27.8</td>
<td>32.5</td>
<td>31,195</td>
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<td>Sth S narc</td>
<td>5</td>
<td>1.75</td>
<td>2.50</td>
<td>0.93</td>
<td>21.0</td>
<td>28.0</td>
<td>30.0</td>
<td>16.1</td>
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<td>West Coollie</td>
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<td>1.50</td>
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<td>18.1</td>
<td>7.5</td>
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<td>27.7</td>
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<td>Elyria</td>
<td>35</td>
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<td>33.7</td>
<td>40,091</td>
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Barriers to Calling 911 and Learning and Performing Cardiopulmonary Resuscitation (CPR) for Latino High-Risk Neighborhood Residents in Denver, Colorado

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Abstract

Background: Latino cardiac arrest victims are 30% less likely than whites to have bystander CPR performed. Neighborhoods comprised of minority and lower socioeconomic status populations are more likely to have an out-of-hospital cardiac arrest (OHCA) event, less likely to have bystander cardiopulmonary resuscitation (CPR) performed, and less likely to survive. The goal of this study was to identify barriers and facilitators to calling 9-1-1, learning and performing CPR in five low-income, Latino neighborhoods in Denver, Colorado.

Methods: Six focus groups and 9 key informant interviews were conducted in Denver, Colorado during the summer of 2012. Convenience, purposeful and snowball sampling, done by community liaisons, was used to recruit participants. Two reviewers analyzed the data in an iterative process to identify recurrent and unifying themes. A qualitative content analysis was used with a five stage iterative process to analyze each transcript.

Results: Six key barriers to calling 9-1-1 were identified: (1) fear of getting involved, (2) financial, (3) immigration status, (4) lack of recognition of cardiac arrest event, (5) language, and (6) violence. Seven cultural barriers were identified that may preclude performance of bystander CPR. (1) age, (2) gender, (3) immigration status, (4) language, (5) racism, (6) strangers, and (7) fear of touching someone. Participants suggested that increasing availability of tailored education in Spanish, increasing the number of bilingual 9-1-1 dispatchers, and policy level changes including CPR as a requirement for graduation and strengthening Good Samaritan laws may serve as potential facilitators in increasing the provision of bystander CPR.

Conclusion: Distrust of law enforcement, language concerns, lack of recognition of cardiac arrest, and financial issues must be addressed when implementing community-based CPR educational programs for Latinos. Using data from the community can facilitate improved design and implementation of CPR programs.

Key words: heart arrest, CPR, sudden death
Provision of bystander CPR is an important link in the chain of survival.[1] Research has shown that CPR can double or even triple a person’s chance of surviving a cardiac arrest event.[2, 3] However, health inequities exist. African-American and Latino cardiac arrest victims are 30% less likely than whites to have bystander CPR performed.[4] Neighborhoods comprised of minority and lower socioeconomic status populations are more likely to have an out-of-hospital cardiac arrest (OHCA) event, less likely to have bystander cardiopulmonary resuscitation (CPR) performed, and less likely to survive.[5-10] Prior research has shown that these neighborhoods can be identified and targeted for potential OHCA interventions designed to address these issues.[3, 11-13]

In order to increase bystander CPR rates, it is important to understand the barriers to learning and performing CPR. Our prior research in lower income, primarily African-American neighborhoods in Columbus, Ohio,[14] identified three major barriers to learning CPR which included financial, informational, and motivational factors. We also identified barriers to performing CPR which included fear of legal consequences, emotional issues, knowledge, and situational concerns. Participants suggested that family/self-preservation, emotional, and economic factors may serve as potential facilitators in increasing the provision of bystander CPR.

Although this was the first study to identify barriers in African-Americans, little is known about how these barriers and facilitators differ for other racial/ethnic groups. As a result we wanted to specifically study whether the results from Columbus, Ohio were applicable to high-risk neighborhood residents in Denver, Colorado. Based on prior research [11, 12, 15], we identified
five neighborhoods in Denver, Colorado in which the incidence of OHCA was 2-5 times higher than the median for the County, and rates of bystander CPR were below average. These high-risk neighborhoods were comprised of primarily Latinos and lower socioeconomic status residents.

Before we implemented a targeted CPR intervention in these high-risk neighborhoods, we wanted to understand the underlying barriers and facilitators to calling 9-1-1, learning and performing CPR for the residents of these high-risk neighborhoods. Therefore, the goal of this research was to use qualitative methods to understand common barriers that may decrease utilization of the 9-1-1, and learning/performing bystander CPR for OHCA victims in primarily lower-income, Latino neighborhoods in Denver, Colorado.

METHODS

Setting

The city and county of Denver has a population of 634,256 individuals and covers approximately 153 square miles, with 52.7% of residents classified as white, 31.7% as Hispanic or Latino and 10.4% as black by the 2010 US Census Bureau. It has a consolidated city and county government comprised of 78 statistical neighborhoods defined by the Denver Regional Council of Governments (DRCOG) made up of 144 Census Tracts. Census Tracts are administrative units that have been used as “proxies” for neighborhoods in community and neighborhood level analysis because they are designed to represent social and economically homogeneous groups of approximately 2,500 to 8,000 persons.
Denver utilizes a two-tiered 911 EMS system with the Denver Paramedics providing ALS response and the Denver Fire Department providing BLS co-response. The Denver 911 call center uses Emergency Medical Dispatch software to provide pre-arrival instructions to the 911 caller. The Denver Paramedics respond to approximately 90,000 9-1-1 calls annually, with about 1% of these calls related to cardiac arrest. Cardiac arrest patients are transported to the closest of 11 receiving hospitals.

Identification of High-Risk Neighborhoods

Three spatial analytical methods were used to identify high-risk neighborhoods (defined as having a high OHCA incidence and low prevalence of bystander CPR). The analytic approach that was used to identify these census tracts was based on prior research using geographic information systems. [15] Briefly, data from the Denver subset of the Cardiac Arrest Registry to Enhance Survival (CARES) dataset, an ongoing OHCA surveillance registry that collects data from EMS systems throughout the United States, [20] were used to identify high-risk neighborhoods (defined by census tracts) in Denver, Colorado. Consecutive adults (≥18 years of age) who experienced OHCA of cardiac etiology and were treated by EMS were studied during January 1, 2009 to December 31, 2011. Data were geocoded using ArcGIS 9.3 (Environmental Systems Research Institute [ESRI] Inc., Redlands, CA) and Geoda software (http://geodacenter.asu.edu), and spatial analysis methods were used to identify high-risk census tracts. [16]

Thirteen census tracts were identified as being high-risk. Maps of clusters of high OHCA incidence were overlaid with maps identifying census tracts in the lowest quintile for bystander
CPR prevalence. Five census tracts identified were designated as Tier 1 high-risk tracts, while an additional eight census tracts were designated as Tier 2 high-risk tracts.

Five of the thirteen neighborhoods were chosen as target areas for the study based on existing community partnerships, consultation with community liaisons and emphasis on cultural barriers primarily in Latinos. The neighborhoods had a crude annual incidence of OHCA that ranged from 1.06-1.33 per 1,000 people (Denver County mean 0.67 per 1,000 people). During the 3-year study period, bystander CPR prevalence ranged from 0% to 15% (Denver County mean 19%).

These five neighborhoods were comprised of residents who were primarily Hispanic/Latino (range: 16.3%-83.9%; Denver County average 31.5%), African-American (range: 0% to 40.2%; Denver County average: 10.4%) and/or had a lower median household income (range: $24,907 to $39,432; Denver County average: $49,041).[17]

Study Design and Sample
We were guided by the philosophy of community-based participatory research, particularly the consideration that soliciting perspectives from diverse community members who have a stake in the outcome is critical to ensure success of any future intervention.[21] We chose to use qualitative methods with both focus groups and in-depth semi-structured interviews. Focus groups allowed residents who were both English and Spanish-speaking, from Denver’s high-risk neighborhoods to discuss their understanding of cardiac arrest and CPR. In-depth interviews with community leaders provided a closer look at the barriers raised by the focus groups and how to incorporate existing resources to develop a neighborhood-based CPR intervention.
Recruitment of Subjects: Community liaisons, who were leaders from the target neighborhoods, recruited focus group participants and key informants using a mixture of convenience, purposeful and snowball sampling techniques during the spring/summer of 2012. Because we were targeting a population that traditionally is difficult to reach for participation in research studies, we chose to use three common types of qualitative sampling techniques to ensure the composition of our focus groups/interviews and that the views of target neighborhood residents were well-represented. Flyers advertising the focus groups were placed in businesses located in the targeted neighborhoods. Based on prior successful recruitment techniques, community liaisons conducted on-site recruitment at a local businesses located in the target neighborhoods (convenience sample), as well as at Servicios de la Raza, a 501c3 non-profit community-based organization which serves Latino residents from all across Denver. Our research team had worked in these neighborhoods for more than 5 years, and was well established in the high-risk neighborhoods and had strong working relationships with the residents of these areas.[22-25]

We recruited residents of the five target neighborhoods so that we could have a focus group comprised of residents from the same neighborhood (purposeful sample). One to two focus groups were conducted in each of the five neighborhoods (total of 6 focus groups).[26] From the respondents who agreed to attend the focus groups, we asked them to recommend others who also live in the target neighborhoods, and assist us in recruiting for future focus groups (snowball sample). Snowball sampling is a commonly used qualitative sampling technique that identifies study participants, who then recruit other potential focus group members to participate in the study. We continued to recruit participants in the focus groups and key informant interviews until our target sample size and saturation of themes was reached.[27] A priori, we divided
groups based on the neighborhood in which the participant lived, as well as the primary language
spoken at home (English versus Spanish). Focus groups were stratified by neighborhood because
we were interested in neighborhood level factors that may affect the likelihood of performing
CPR. Participants could also choose which language they felt most comfortable speaking. We
had postulated that concerns may be different for non-primary English speakers. Written
informed consent was obtained from each participant for the audiotaping of the focus groups and
interviews. Each study participant was given a ten-dollar gift card for their participation. The
research protocol was approved by The Colorado Multiple Institutional Review Board.

Inclusion Criteria: All community members who were 13 years or older, spoke either English or
Spanish, and resided in the high-risk neighborhoods were eligible for participation in the focus
groups/interviews.

Conduct of Focus Groups and In-Depth Interviews:
We employed two trained moderators who were fluent in both English and Spanish to conduct
the focus groups and interviews. In total, we had 55 focus group participants (in 6 focus groups)
and 9 key informant interviews. Each focus group lasted approximately 60-120 minutes in
duration- engaging 6-15 participants in each group. Focus groups allowed for a better
understanding of barriers to calling 9-1-1, learning and performing CPR and how to design a
community-based CPR intervention. Key informant interviews with Latino community leaders
provide a more in-depth look at the barriers raised by the focus groups. Interviews lasted
approximately 30-90 minutes. All focus groups/interviews were conducted in the primary
language spoken by the participant. Interested participants were also asked to continue their
involvement in this research, which was to include the development and implementation of a targeted, community-based CPR intervention.

The same Interview Guide was used for both the focus groups and interviews (Appendix A) and included questions on barriers to calling 9-1-1, learning and performing CPR and how to design a culturally-sensitive, tailored CPR training program for Latinos. Consent for participation in the study was done in the participant’s primary language. For children 13 and older, we required a parental signature on the consent form to be signed so that we knew that parents were comfortable with their child participating in a focus group.

Data analysis began immediately after a focus group/interview was conducted. When the study team determined that no new information was being obtained from the focus groups/interviews, we determined that we had reached a point of thematic saturation where no new information was being obtained and enrollment was stopped.[26] Saturation of themes in qualitative research refers to the point in which new information is no longer being gathered from the focus groups.[28]

All focus groups were audiotaped. A transcription service was used to transcribe each focus group verbatim. Transcripts were stripped of personal identifiers. Participants were also asked to complete a brief survey of socio-demographic characteristics and their familiarity with CPR prior to the start of the focus group. Dr. Sasson led the study team members, which included the community liaisons, through the reading of all the transcripts, coding and identification of preliminary themes.
Data Analysis and Processing

We conducted a content analysis of these data. Coding and analysis of data was facilitated by use of NVivo 9.0 (QSR International, Doncaster, Victoria, Australia), a qualitative software package which enables the investigators to code, index, and retrieve participant responses containing key themes, concepts or events, and group them into larger categories. A qualitative content analysis was used with a five stage iterative process to analyze each transcript: (1) development of a coding schedule; (2) coding of the data; (3) description of the main categories; (4) linking of categories into major themes; and (5) the development of explanations for the relations among themes.[29] [30, 31] Prior to data collection, an initial codebook was created containing codes and categories (groups of codes) of themes, concepts, events, people, actions and things that may be encountered in the data (e.g., barriers to CPR include fear, poor self-efficacy). These a priori codes were based on what the investigators may expect to find based on the literature and what the investigators hoped to find based on the research questions. Coding strategies were based on the grounded theory techniques of open, axial and summary coding.[28] Open coding is used to name and categorize key concepts, categories and patterns of experience, by breaking down, examining, comparing and grouping phenomena. Axial coding is used to specify the relationship of categories to the phenomenon under study (i.e., preferences for time of day for messages, and gender-defined preferences for message content). Summary coding synthesized open and axial codes into key themes and categories to summarize all the content.

First, overriding themes were identified and compared across the content areas. These themes were then grouped together or assigned to subthemes. Two reviewers (CS, LBY) read through
each transcript independently and coded all transcripts line by line. The two reviewers then met to discuss the transcripts, in order to expand and refine existing categories in an iterative manner. With the full study team, including the community liaisons, the final coding structure and definitions were defined. No intercoder agreement statistics were calculated, but disagreements were resolved by consensus by the full study team. The two reviewers met to question, discuss, and document interpretations and findings. Two types of audit processes were used to ensure that the content was validated. First, respondent validation was conducted: At the end of the first three focus groups, and then again at the end of the coding of the study, the codebook was distributed to the entire research team (including the community liaisons) for input and validation. Second, multiple coders also independently coded each transcript and then met together to discuss major themes. [32] The final data was then presented to the community via printed materials and two oral presentations in two of the high-risk neighborhoods.

RESULTS

Demographics of the 64 focus group participants and key informants are included in Table 1. The majority of the participants were ≥30 years (70%), female (75%), and Latino (88%). Forty-seven percent of the participants had not completed high school. Almost half (46%) of the participants had an annual household income of <$30,000.

Barriers to Calling 9-1-1

Our analyses identified six key barriers to calling 9-1-1: (1) fear of getting involved, (2) financial, (3) immigration status, (4) lack of recognition of cardiac arrest event, (5) language concerns, and (6) violence (Table 2). For example, the impact of documentation status, on the
individual and for others that lived in their residence, was an important determinant of whether
or not 9-1-1 would be called. Multiple study participants voiced concerns about police first
responders coming on-scene and asking for identification before the victim would be assisted.
There was a general distrust of law enforcement, of which 9-1-1 services were bundled into.
Participants did not want to call 9-1-1 for others, because they were afraid to get involved,
especially if illegal activities were occurring in the neighborhood. Gangs, violence and fear of
retaliation for calling 9-1-1 and having police show up in the neighborhood were all major
concerns voiced in all 6 focus groups. In addition, participants were concerned about the
financial implications of calling an ambulance, as many were currently working multiple jobs
just to afford bare necessities such as food and shelter. Finally, language concerns affected the
likelihood of calling 9-1-1. Participants were frustrated that they may be placed on hold during
an emergency situation because a 9-1-1 dispatcher would need to connect with a translator.

Barriers to Learning CPR

Study participants reported the following barriers to learning CPR: financial, (e.g. cost,
transportation to site, child care), informational (e.g. lack of understanding about what a cardiac
arrest is and how CPR can save a life, lack of awareness about upcoming classes, lack of access
to technology, few resources for non-English speaking people), and motivational (e.g. personal
health concerns, financial disincentives). However, there was a unique barrier that related to
cultural issues of 1st versus 3rd or 4th generational immigrants. One study participant stated,

"Just because we don’t have people knocking on the door doesn’t mean that people don’t want
it. I think part of it is that people don’t know what the potential benefits of it are. You know, I’m
not sure how many people are exposed. We have had a lot of folks that have emigrated from
Mexico, so I don’t know what their health awareness level is, versus maybe folks that have been
here a long time. Or even if they have been here a long time... how important it is. All of a sudden
they realize that all their family members have died of a heart attack or a stroke and they don’t really know what that all means yet.”

As immigrants move to the U.S., it is possible that the awareness of cardiac arrest and importance of bystander CPR may not be as high in other countries. As a result, there may be a significant lack of understanding or even familiarity with CPR. Multiple study participants believed that a first step to facilitating the learning of bystander CPR was to lobby for policy environment change by requiring CPR as a graduation requirement. Then, schools could be utilized to train not only students, but also families. A focus group participant stated,

“In conjunction with the students being educated, is that it gets to the parents of those same students. Then they talk about it and then with the large Hispanic and the large Mexican population that has recently immigrated. Then they would feel more comfortable that this is, especially within a school setting, that they would just feel the authority that is behind it, more confidence and more willingness to do it.”

Unique Cultural Barriers to Performing CPR

Study participants reported commonly cited barriers to performing CPR: fear of legal consequences (e.g. fear of lawsuit, misunderstanding of Good Samaritan laws, age of cardiac arrest victim), emotional disconnection from community (e.g. lack of community cohesion, questioning if other residents would stop to assist), knowledge (e.g. unsure of how and when to perform CPR, confusion from frequent CPR guideline changes, fear of doing it incorrectly) and risk to personal health (e.g. administering mouth to mouth to a stranger, unsafe setting).

There were some additional cultural barriers that were identified in the primarily lower-income Latino study population (Table 3). Age and gender affected the likelihood of performing CPR on a person of a different gender or age. For example, participants believed that there may be concerns about performing CPR on a child, male performing CPR on a woman, or touching the
chest of a cardiac arrest victim. In both instances, participants were concerned that their attempts to help by performing CPR on a victim may be misconstrued. There was also fear that if police and paramedics arrived on-scene, they would ask the bystander for identification or blame the bystander for the victim’s health condition. Language concerns were an additional reason for not performing CPR. Participants were concerned there would not be a bi-directional mode of communication either with the dispatcher or with the responding emergency medical services.

Finally, racism affected the likelihood of performing CPR. For example, participants stated that there are many gangs in their community that are Latino or African-American, based on the victim’s race, people were afraid that bystanders would not get involved.

**Facilitators to Increasing the Training and Performance of Bystander CPR**

Participants suggested ways to increase the number of people who were trained in bystander CPR. They believed that having their own data, such as the number of people who receive bystander CPR in their own neighborhood, was very motivational to increase training numbers. They would be more likely to take on opportunities to spread CPR training. Personal survivor stories, especially in their own cultural groups, were also impactful and would increase people’s motivation to learn CPR if the person was similar in age, race/ethnicity or gender. Participants also believed that two policy changes could have a major impact on increasing the number of people who are trained in CPR. Participants suggested that making CPR a requirement for graduation from high-school and/or for receiving a driver’s license were also important methods to increase training. Finally, working with local, trusted community-based organizations such as churches, recreation centers, and small businesses was an important way to spread knowledge about cardiac arrest and the importance of bystander CPR.
Participants also suggested ways to increase the performance of bystander CPR. At the individual level, participants stated that certain cues to action, such as culturally tailored messaging and bilingual 9-1-1 dispatchers would play a critical role in their decision to perform bystander CPR. Participants believed that they would be more likely to perform CPR now that they had had the training, and were able to practice on performing CPR on the manikins.

Increasing the number of people who knew CPR, as well as the level of trust and reciprocity between neighbors would make them more likely to act in a cardiac arrest. Finally, increasing the knowledge of Good Samaritan laws would also make them more likely to act, knowing that they would not get into trouble if the victim did not survive the cardiac arrest.

LIMITATIONS

This was an exploratory study to help understand barriers to calling 9-1-1 and cultural barriers for CPR provision in high-risk neighborhoods. We had a small number of participants, so generalizability is a concern. However, the individuals we interviewed were from the target areas, primarily Latino and the majority had household incomes below $30,000 per year. While it is possible that additional focus groups would elicit newer information; the team believed that a saturation of themes was obtained in the process of analyzing the 6 focus groups and 9 key informant interviews. Second, there may also be some selection bias in the sample, as the study participants were all recruited from the area, by community liaisons who lived and worked in the neighborhoods. However, because we were most interested in reaching a target population living in the highest-risk neighborhoods that is traditionally difficult to reach, this was actually a strength of the study. Future research will need to be conducted to examine how the barriers and
to calling 9-1-1 elucidated in this research may be similar or different in both non-minority populations and other groups (e.g. limited English proficiency, lower income neighborhoods in other cities). Groups were also recruited by community liaison who lived in the area as to allow participants to feel more comfortable disclosing their thoughts on why bystander CPR prevalence was low in their neighborhoods.

**DISCUSSION**

This is the first study of primarily lower-income, Latino neighborhood residents to understand common barriers that may decrease utilization of the 9-1-1, and learning/performing bystander CPR for OHCA victims. The barriers identified in this research may change the way in which public education campaigns for early recognition and activation of 9-1-1 are implemented in the community. The lessons learned in OHCA may also be applicable to other public education campaigns for time-sensitive conditions such as myocardial infarction and stroke. These study findings have laid the foundation for the next phase of research, to work directly with residents from these neighborhoods to design and implement a community-based intervention to overcome the identified barriers.

Distrust of law enforcement, due to possible undocumented status or outstanding search warrants, were common barriers that precluded our high-risk neighborhood residents from calling 9-1-1. The fear and distrust of police has been documented in other disease states,[33-36] however, this concern has never been addressed in the activation of 9-1-1 services for OHCA victims. Communities may want to work closely with law enforcement and emergency medical services to ensure that police, fire and first responders do not ask for any type of documentation.
prior to assisting the person. This information must be addressed in community-based CPR trainings so that the fear of deportation or outstanding search warrants does not deter them from activating 9-1-1 services. Another suggestion provided by our study participants was that law enforcement should participate in the trainings in the community to help assure residents in these high-risk neighborhoods that police are willing to help.

Language barriers were also an important concern for study participants. Prior research has shown that callers with limited English proficiency are more likely to have significant delays in the timing and receipt of life-saving interventions by dispatchers (e.g., Hands-Only CPR instruction). [37, 38] Many of our participants believed that if they called 9-1-1, they were unlikely to have a competent interpreter who could assist them in their primary language. In addition, participants were unsure of where to go to get CPR training in Spanish outside of the school system. Prior research has shown that there is a paucity of accurate information available on CPR for Spanish-speaking audiences on the Internet. [39] Therefore, a concerted public education effort must be made to educate Spanish-speaking audiences about CPR. It is also imperative that 9-1-1 call centers are equipped to handle calls in multiple languages, without significant holding periods for limited English proficiency callers. Because there can sometimes be a delay in communicating the urgency of the situation, community CPR trainings should also teach callers to say key words to say such as “heart stopped,” and “Spanish interpreter,” so that delays can be avoided in identifying the type of call being made (with the corresponding level of emergency response) and the language that is needed for interpretation services.

Lack of recognition of OHCA symptoms was also identified as a common barrier to calling 9-1-
1 and performing CPR. Study participants suggested that additional time must be given to
discussing how to recognize a potential OHCA victim given that the awareness of cardiac arrest
and bystander CPR is low in Spanish-speaking countries such as Peru (the only country to
publish its CPR rates).[40] This highlights the importance of continuing public education efforts
by organizations like the American Heart Association and the American Red Cross in educating
the public about the myriad of ways in which OHCA patients can present, whether it is syncope
versus agonal breathing versus complete asystole arrest. Once again, the importance of early
recognition, especially for community members who may emigrate from other countries must be
considered core content for community-based CPR training.

Finally, financial costs of 9-1-1 activation were another significant barrier to 9-1-1 use. Per study
participants, in Mexico, patients’ families must pay first before transport can occur. Even in the
U.S. these cultural attitudes about 9-1-1 persist and community members are hesitant to call for
emergency medical services because they do not have the means to pay for transport at the time
of EMS arrival.[33, 36] Once again, this vital information must be addressed in community-
based CPR trainings, so neighborhood residents are aware they do not need to pay up front and
can be billed at a later time. Even with this barrier addressed, community members may still be
hesitant to call 9-1-1 due to the high cost of ambulance transport, versus waiting for a family
member or friend to drive them to the hospital. This may be an important consideration for
public education campaigns that are being created to decrease time to the hospital for time-
sensitive conditions, such as cardiac arrest, myocardial infarction and stroke.
CONCLUSION

This study highlights common barriers that may preclude residents of higher-risk, primarily Latino and/or lower socioeconomic status residents to call 9-1-1, learn and perform bystander CPR. Overall, study participants shared many similar concerns about the barriers to learning and performing CPR as has been described in other racial/ethnic groups; however, there were some cultural barriers that were unique to this primarily Latino study population. It may be beneficial to tailor these trainings to address the unique challenges that certain communities have based on race, ethnicity or socioeconomic status. Future research will need to be conducted to better understand how culturally-sensitive, tailored public education campaigns may affect the provision of bystander CPR and ultimately OHCA survival in high-risk neighborhoods.

ACKNOWLEDGEMENTS

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REFERENCES CITED


Table 1: Demographics of Focus Groups and Key Informant Interviews

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* Of the 64 total participants who filled out the pre-focus group survey, only 62 provided an age.

* Only 63 of the 64 participants provided a gender, race/ethnicity and education.
Table 2: Barriers to Calling 9-1-1

<table>
<thead>
<tr>
<th>Code</th>
<th>Illustrative Quotes</th>
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</table>
| Fear of Getting Involved          | Quote 1: Well, I think in order to avoid getting involved with problems with the law, or any other things... I think that it's one of the first fear(s) one can have. If I get involved, they'll think I did something to them, so it's better to...  
Quote 2: You are afraid that they'll think that you had something to do with what has happened and because of this sometimes you don't help right away to this person, because you could get involved in a problem. |
| Financial                         | Quote: We've talked about it before, 'cause it's happened to us where somebody called 911 over an allergy reaction and we all ended up with big, big bills, I mean, big expense and... and so we've learned, if I get sick don't call 911! |
| Immigration Status                | Quote 1: Interaction with the law enforcement if they had to give their name and would they be afraid that they would check, you know, we do have a lot of undocumented people who live in our neighborhood who are around here that are afraid, you know, the law enforcement is not positive.  
Quote 2: Also there are some people who don't have [legal] papers... they also think that if we go to the hospital they won't be able to treat us because of that. |
| Lack of Recognition of Cardiac Arrest Event | Quote: They may think that the person is going to come back, maybe, they have temporarily fainted, or something like that. They may not know what to do, so they are in a panic. They may not be able to respond right away to that, or know what they should do. |
| Language                          | Quote 1: Subject: But I think a lot of you also have to take into consideration that a lot of people that live in this neighborhood only speak Spanish, so if you have someone only speaking English trying to tell them how to do CPR, it's going to fail. So there is a need to have a translation there, and I know it's horrible to be put on hold but at the same time you want it done to where it's successful, and not hindered.  
Quote 2: I think it's held, everybody gets tired of being put on hold... and even if it's for a split second, they say, 'hold on, let me transfer you to someone' or whatever 'or hold on, let me have... no one wants to say, 'hold on', you know. Now here I am, trying to do something, and you're telling me to hold on. |
| Violence                          | Quote 1: And I think part of it too is sometimes there's a perception that there's a lot of illegal activity going on and they're afraid that if they call the police officers or the ambulance that the neighbors are going to get mad at them and retaliate.  
Quote 2: I actually called 911 once and the boyfriend of the woman who I felt had quit breathing came in and was going to kick my ass because she had overdosed on heroin. That would have been a pretty good motivation not to have called 911. |
### Table 3: Additional Cultural Barriers to Performing Bystander CPR

<table>
<thead>
<tr>
<th>Code</th>
<th>Illustrative Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Because people might look at you different, because it's like an older person, helping a younger person. Like maybe touching them wrong, or stuff like that.</td>
</tr>
<tr>
<td>Gender</td>
<td>If a guy sees a girl collapse, that like, he doesn't want to interact with her. There's, like I don't know, space issues, like, with female and male.</td>
</tr>
<tr>
<td>Immigration Status</td>
<td>I think people don't react because of fear, communication. They don't want to be involved...because they have a criminal history, or because of immigration issues.</td>
</tr>
<tr>
<td>Language</td>
<td>There needs to be two-way communication, not just simple instructions [with the dispatcher]. Like, if, the person receiving CPR begins to go into convulsions, or if they have a lot of bleeding also at the same time. I mean, there could be a lot of complications.</td>
</tr>
<tr>
<td>Racism</td>
<td>They don't want to get involved and be known as someone who is helping someone else's gang, or someone else's culture, or someone else's color, or creed because, you know, racism exists and hate exists and that probably is never going to go away.</td>
</tr>
<tr>
<td>Stranger</td>
<td>If it's a close person...but if it's a stranger you would think twice. I mean, I'm not going to give mouth to mouth respiration to a person I've never seen before in my life.</td>
</tr>
<tr>
<td>Touching another person</td>
<td>And then also, the hesitancy that there is, and I don't know if it's limited to Hispanic culture or not, but the hesitancy to touch another person, especially in the chest, and if it's a woman, oh my goodness... uh, there is great hesitations on the older people's part.</td>
</tr>
</tbody>
</table>
APPENDIX C: INTERVIEW GUIDE

1. Opening
   a. Tell us your name, where you are from. (get demographic info from registration form given in beginning)

2. Introductory
   a. What would you do if someone suddenly falls down in front of you and appeared to be unconscious?
   b. Have you ever seen someone do this? What did you do? What did other people do?
   c. What is your understanding of the things that can cause someone to fall down? (probe: do they know the difference between a heart attack and heart arrest)

3. Transition
   a. What is your understanding of cardiopulmonary resuscitation (CPR) and what is it that CPR is doing?
   b. Have you ever seen someone do CPR? (probe: If so, who and what were the circumstances)?
   c. Have you done it yourself? (probe: If so, why did you decide to perform CPR? If you did not do CPR, why did you not perform CPR?)
   d. How many of you have taken a course in CPR? When and what type of training have you done?
   e. How and why did you decide to learn CPR?
   f. How did you hear about CPR training?
   g. If you are not trained in CPR, what are your thoughts about taking a CPR course?

4. Key
   a. What would you do if you were out on the street in your neighborhood and you and your neighbors saw someone fall down in your neighborhood? [Probe: What if you found out they weren't breathing and didn't seem to have a pulse?] [Probe for reasons for answer] [Probe for possible differences if somebody they knew or if a stranger]
   b. What would be the obstacles that would make people not do CPR? What might make it easier for people to do CPR?
   c. Generally speaking, how do you think people in your neighborhood would respond if you if you were in trouble? [Probe for reasons]
   d. How do you think people in your neighborhood would respond if you fell down? [Probe: if you weren't breathing and didn't have a pulse] [Probe for reasons] [Probe differences between known vs. strangers] [Could probe for differences between in own neighborhood and other places (what places?) and based on race or other characteristics]
   e. What would make people want to or not want to take a CPR class?
   f. What would be the best way to let people in your community know that a CPR training was going to occur? (i.e. email, news media, flyers, etc.)
   g. What kind of incentives would it take to get people to attend a training (i.e. food, CPR kit, magnet)?
h. What is your understanding of hands only CPR?
i. How did you hear about this?
j. If we were to teach you to do CPR only with your hands, without having to blow into someone’s mouth, how might that affect your likelihood of doing CPR? Why or why not?
k. (Bring out CPR Anytime kit) Has anyone ever seen or used one of these?
l. (Play the first 8 minutes of the CPR Anytime kit) What do you make of this kit? (Probe: how do you feel about the people in the video? How does this training video make you feel? Would you feel comfortable performing CPR after this training?)
m. What would make you more likely to take this home and teach your family members?

n. What would make people in your community decide to take CPR training?
o. How can we best work together to get the message and trainings out to your communities (write things down on a flipchart)?
p. What do you see as the priority areas for your neighborhood right now? Do you see CPR training as being a high enough priority for this to be implemented in your area? Why and why not?
q. What kind of role would you be interested in playing in this promoting CPR in your community?

5. Ending
a. What else have we not covered? Have we missed anything?

Pre-focus group questions:

Now I’m going to ask you how many times you’ve done certain things in the past 12 months, if at all. For all of these, I want you just to give me your best guess, and don’t worry that you might be off a little. About how many times in the past 12 months have you (ACTIVITY):

Note: for all questions 6a-6k, interviewer probes for an actual number and if respondent can not provide an actual number, the interviewer follows up with: ‘Would you say you never did this, did it once, a few times, about once a month on average, twice a month, about once a week on average, or more often than that? (If respondent answers “a few times”, probe with.)

Would that be closer to 2-4 times or 5-9 times?

a. (How many times in the past 12 months have you) Had friends over to your home?
b. Been in the home of someone of a different neighborhood or had them in your home?
c. Been in the home of someone of a different race or had them in your home?
d. Worked on a community project?

e. Donated blood?

f. Attended any public meeting in which there was discussion of town or school affairs?

g. Attended a political meeting or rally?

h. Attended any club or organizational meeting (not including meetings for work)?

i. Been in the home of someone you consider to be a community leader or had one in your home?

j. Volunteered?

k. Served as an officer or served on a committee of any local club or organization?
APPENDIX G

PAPER 3: HANDDS PROGRAM OVERVIEW
The HANDDS Program: A Systematic Approach for Addressing Disparities in the Provision of Bystander Cardiopulmonary Resuscitation

Camillo Sasson, MD, MS, Jason S. Haukoos, MD, MSc, Brian Eigel, PhD, and David J. Magid, MD, MPH

Abstract

The current paradigm of bystander cardiopulmonary resuscitation (CPR) mandates a community-wide training. Recently, the authors have found that high-risk neighborhoods can be identified, and CPR training can be targeted in the neighborhoods in which it is most needed. This article presents a novel method and pilot implementation trial for the HANDDS (Identifying High Arrest Neighborhoods to Decrease Disparities in Survival) program. The authors also seek to describe example methods in which the HANDDS program is being implemented in Denver, Colorado. The HANDDS program uses a simple three-step approach: identify, implement, and train. This systematic conceptual framework uses qualitative and quantitative methods to: 1) identify high-risk neighborhoods, 2) understand common barriers to learning and performing CPR in these neighborhoods, and 3) implement and evaluate a train-the-trainer CPR Anytime intervention designed to improve CPR training in these neighborhoods. The HANDDS program is a systematic approach to implementing a community-based CPR training program.

Further research is currently being conducted in four large metropolitan U.S. cities to examine whether the results from the HANDDS program can be successfully replicated in other locations.

Out-of-hospital cardiac arrest (OHCA) affects more than 420,000 people annually in the United States. For almost 30 years, survival from OHCA in the United States has remained poor, at less than 8%. The American Heart Association's (AHA) “chain of survival” has been used to describe the key aspects of OHCA care that have been shown to affect survival: recognition of the arrest and activation of the emergency response system, early cardiopulmonary resuscitation (CPR), rapid defibrillation, effective advanced life support, and integrated postarrest care. The early provision of bystander CPR is vital to surviving OHCA. For every 30 patients who receive bystander CPR, one additional life will be saved. Communities in Arizona1 and Washington2 that increased bystander CPR have observed a corresponding increase in OHCA survival. In most communities,
Rationale

The neighborhood where a person arrests may also affect his or her likelihood of receiving CPR and ultimately surviving. Previous research has shown that residents who live in neighborhoods that are primarily Hispanic, African American, or poor are two to three times more likely to have OHCA, and when they experience an OHCA, they are 30% less likely to receive CPR and as a result are more likely to be found in asystole or pulseless electrical activity—cardiac rhythms that are associated with a very low likelihood of survival. Neighborhoods may be high risk secondary to an increased burden of chronic disease, lack of social cohesion (e.g., wanting to help a neighbor who may have an event), or underlying associations with poorer health due to lower socioeconomic status. Therefore, these high-risk neighborhoods (where the incidence of OHCA is high and the prevalence of bystander CPR provision is low) are an important target for public health interventions to help reduce disparities in bystander CPR and ultimately improve OHCA survival.

Once high-risk neighborhoods are identified, it is important to understand the community barriers for 1) learning and performing bystander CPR, 2) recognizing cardiac arrest symptoms, and 3) potential ways to plan community-based CPR programming that is congruent with community desires for training. In other chronic diseases, this type of community-based participatory research has been integral in designing successful community programs that have addressed health disparity needs. Interventions that have adhered to the principles of community-based participatory research by using culturally sensitive approaches, conducting interventions in settings such as churches and barbershops, and using local neighborhood residents as health promoters have been successful in promoting healthy behavior change.

However, to our knowledge no prior research has been conducted in OHCA to see if this type of systematic approach may be successful in reducing health disparities. The objective of this study was to present a novel method and pilot implementation trial for the HANDDS (identifying High Areas: Neighborhoods to Decrease Disparities in Survival) program. The HANDDS program, which is based on behavioral health theory to increase likelihood of action, challenges the traditional paradigm of blanketing a city with CPR training and moves toward the ultimate goal of focusing scarce public health resources for CPR training in the geographic locations in which it is most needed.

Conceptual Framework

The Health Belief Model (HBM) was originally created in the 1950s and is used to describe and explain why people choose to do certain health activities (e.g., perform CPR). The model has been changed over the years, but it is used to help promote people’s readiness to act. It is one of the most widely used health promotion models.

There are six core concepts in the model that affect a person’s likelihood of doing a specific behavior such as performing bystander CPR: 1) perceived susceptibility is a person’s belief that a cardiac arrest might happen to him or herself or a loved one; 2) perceived severity is a person’s belief in the consequences of not performing CPR on a person in cardiac arrest; 3) perceived benefits is a person’s belief that performing CPR will be efficacious and potentially increase the chance of surviving a cardiac arrest event; 4) perceived barriers is a person’s perception of the tangible and psychological consequences of performing CPR. These to action are the strategies to activate a person to readiness, such as dispatcher-assisted CPR or community-based CPR educational programs. Self-efficacy is a person’s confidence that he or she can perform CPR if

![Figure 1. Health Belief Model and likelihood of performing bystander CPR.](image-url)
the situation arises. Ultimately, for a person to act, the perceived benefits must outweigh the perceived barriers.

**HANDS Program Method**

The HANDS program, which is derived from the HBM, uses a three-phased approach to systematically implementing community-based CPR training programs in neighborhoods in which it is most needed (Figure 2). The three phases are to identify, implement, and evaluate. We present each phase of the HANDS program, how it relates to the HBM, and the sample research methods that can be used to implement the HANDS program based on our Denver-based pilot program. It is important to note that other research methods can be used to complete each phase of the program.

**Human Subjects Considerations**

All research conducted in the HANDS study was approved by the Colorado Multiple Institutional Review Board. One author (CS) is the principal investigator for all three phases of the HANDS program. Phase 1 includes a secondary data analysis of the Cardiac Arrest Registry to Enhance Survival (CARES), which is a continuous quality improvement tool and surveillance registry designed to help local officials monitor and improve their provision of prehospital emergency cardiac care. To ensure each patient's confidentiality, case reports are stripped of all individual identifiers before the data are permanently entered in the registry. Each patient receives the standard care available in his or her community, and no patient is subjected to any experimental intervention. In light of these safeguards, the institutional review boards of all participating sites have determined that CARES is exempt from the requirement to secure verbal or written consent. Phase 1 step 2, phase 2 and phase 3 are considered expedited studies by the Colorado Multiple Institutional Review Board. All participants sign written consent forms to participate in the studies.

**Phase 1: Identify**

**Step 1: Location of High-risk Neighborhoods.** Spatial epidemiologic clustering techniques have been used in infectious disease mapping for more than 20 years to identify outbreaks, trends in disease incidence, and clustering of patients. The HANDS program uses this method, based on prior research, to identify high risk neighborhoods for OHCA incidence and low provision of bystander CPR. This “personalizes” the data by giving a community member insight into their or his own perceived susceptibility to having a cardiac arrest and not receiving bystander CPR.

In the Denver-based HANDS program pilot, we use a five-step spatial analytical process to identify high-risk neighborhoods using existing secondary data of OHCA. We use the standardized data elements from the CARES database. CARES is a surveillance registry that is funded by the AHA, ARB, Medtronic Foundation, and Zoll and is sponsored by the Centers for Disease Control and Prevention and Emory University. CARES links a standard set of data elements from three sources: 9-1-1 call centers, EMS providers, and receiving hospitals. The registry was established in 2005 and includes 40 major U.S. cities and six U.S. states, 20 with a catchment area of more than 64 million people.

First, OHCA address data are geocoded into census tracts using ArcGIS software, and census tract socioeconomic and demographic data, obtained from the 2010 Census.21 are added to each OHCA event. Second, adjusted OHCA incidence and proportion of arrests receiving bystander CPR are calculated for each census tract using Spatial Empirical Bayes methods.22 This method adjusts rates toward the average rate of the surrounding census tracts with the amount of shrinkage inversely proportional to the size of the population at risk.23 Third, after calculating adjusted OHCA incidence and bystander CPR, a Local Moran’s I statistic is calculated for each census tract with R software.24 Local Moran’s I is a measure of local spatial autocorrelation and can be used to identify spatial clusters or hot spots (census tracts where adjacent tracts have similar values).

**Figure 2. Three-phase HANDS program approach. HANDS = Identifying High Arrest Neighborhoods to Decrease Disparities in Survival.**
or spatial outliers (tracts with very distinct or different values than their neighbors). Clusters of increased OHCA incidence are then determined if the p-value resulting from nonparametric Monte Carlo simulations is <0.05. Fourth, the process is repeated to identify spatial clusters of low bystander CPR providing by census tract. Finally, an overlay of the high OHCA incidence clusters with the low bystander CPR clusters is conducted to find those high-risk tracts that have both statistically significant high rates of OHCA and low bystander CPR.

Because there is no "standard" method for conducting spatial cluster analysis, a sensitivity analysis is conducted using four other spatial analysis methods: Empirical Bayes adjusted rates, G* Statistic, Getis-Ord Gi*, and Kernel Density. Results are then stratified by a public (outside of the home/residence) versus private (home/residence) location of arrest, with 80% of all arrests occurring in a private location. The p-value is set at <0.05 for all sensitivity analyses. The community-level structural, organizational, economic, and demographic characteristics are then described to understand the composition of each high-risk neighborhood and to inform the census tracts to target in the second step of the identification process.

**Step 2: Barriers to Recognition of OHCA and Learning and Performing Bystander CPR.** Despite a strong evidence base for CPR, the widespread translation of this practice into the community has not always been accomplished.13 CPR training is based on convenience and is typically offered at workplaces,65 schools,71 and community events.69 This CPR training is not targeted based on needs or tailored to specific social or cultural groups that are less likely to perform CPR. This historical approach to CPR training fails to consider who is getting training, the setting in which the training occurs, and how the training is being delivered. No previous studies have been conducted to understand how these three contributing factors, particularly in certain racial/ethnic and socioeconomic groups, and at the individual and neighborhood levels, may affect a person's likelihood of learning and performing CPR. As a result, we use community-based participatory research with qualitative methods to understand the underlying causes of health disparities in OHCA and provision of bystander CPR in the target neighborhoods and how a tailored, culturally sensitive, neighborhood-based intervention could be designed and implemented in the high-risk neighborhoods identified in step 1.

This step in the HANDS program allows for a better understanding of community members' perceptions of severity of sustaining OHCA, benefit of performing bystander CPR, and the barriers that may prevent people from performing CPR in an emergency situation. This information is critical to understanding what fears must be overcome and addressed to increase a person's likelihood of action.

In the Denver-based HANDS program, participants who reside in the identified high-risk neighborhoods are purposefully sampled to participate in focus groups or semistructured key informant interviews carried out by a moderator trained in qualitative methods and in the primary language of the participant. Participants are queried on the barriers to calling 9-1-1, recognition of OHCA symptoms, and learning and performing bystander CPR. Other topics addressed are the neighborhood residents' thoughts on how to design, develop, and implement a community-based CPR training program that is congruent with the needs of the neighborhood residents and provides appropriate incentives to draw in populations that are traditionally difficult to engage in training programs. This formative work provides the basis for the next phase of implementation.14

**Phase 2: Implement.** The uptake of CPR training and other health interventions has been limited in Hispanics and African Americans.15 Health disparities have been reduced in these populations by 1) understanding the social and cultural context of the target population, 2) developing appropriate settings for the intervention, and 3) working with local community members to design and implement the intervention.16 According to the HBM, cues to action (implementing a community-based educational program), as well as increasing a person's self-efficacy (by psychomotor practice of hands-only CPR), are integral in increasing the desired behavior (performing CPR).

Informed by steps 1 and 2 of the identification process, the next step of the community-based CPR educational program is implementation. In the Denver-based HANDS program, the implementation strategy is tailored to racial, ethnic, and socioeconomic groups (e.g., Spanish language for non-English speaking participants) and is being conducted in local settings based on community preferences (at churches and schools) and using local resources (local bilingual residents as health educators) to implement and disseminate CPR training in high-risk neighborhoods. Careful attention is given to the data collected during these trainings to ensure that the fidelity, scalability, and reproducibility of this targeted, culturally sensitive program is being adequately captured.

In the Denver-based HANDS program, we conduct a feasibility study of a community-based, culturally sensitive CPR intervention to teach 300 participants how to perform CPR and indirectly teach 600 to 900 friends and family of the 300 participants how to perform CPR using a train-the-trainer approach. The AHA CPR Anytime take-home kit contains an inflatable manikin, an oral and educational video (in both English and Spanish) that describes when to call 9-1-1 and how to perform hands-only and traditional CPR. The participant watches the video, practices CPR on the manikin, and receives feedback when the correct chest compression depth is achieved. These kits are specifically designed to be used in a train-the-trainer program, and the average kit has been shown in prior studies to train two to three additional people.16,26 Participants are then encouraged to train family and friends on CPR and to keep a record (contact information) of the people they train. We conduct CPR interventions (approximately once a month, alternating locations within the high-risk neighborhoods) with both a didactic session and a hands-on training session. We follow-up with
participants, in person, after 2 to 4 weeks to assess the
numbers of family and friends they trained through the
take-home CPR kit and comfort and knowledge acquisi-
tion of the family and friends.

The participants who directly received the CPR inter-
vention complete a survey pre- and postintervention
that assesses their knowledge of and comfort with per-
forming CPR and calling 9-1-1. At 2 to 4 weeks postin-
tervention, the participants are then provided a $10
grocery store gift card as an incentive to bring back
both the data collection sheets and the pre- and post-
knowledge surveys that were given to five family and
friends.

Phase 3: Evaluate
Outcome 1: Metrics for Program Success. Primary
outcome measures were 1) the number of people
directly trained in CPR, 2) participants’ satisfaction with
the CPR intervention, 3) participants’ knowledge acqui-
sition (via pre- and postintervention knowledge test),
and 4) dissemination into the target high-risk neighbor-
hoods (by collecting addresses of the participants who
attend the training). Secondary outcome measures were
bystander CPR prevalence and OHCA incidence in the
high-risk neighborhoods pre- and postintervention and
the comfort and knowledge acquisition of family and
friends who were educated by the participants.

Outcome 2: Program Evaluation Framework. The
intervention can also be evaluated using the Reach
Effectiveness Adoption Implementation Maintenance
(RE-AIM) measures (Table 1). The RE-AIM framework
has been used extensively for evaluating the effective-
ness of community-based interventions and is well vet-
ted in the program implementation literature. RE-AIM
This program evaluation framework has been designed to

Table 1
RE-AIM Evaluation for Denver HANDOS Program

<table>
<thead>
<tr>
<th>Evaluation Measure</th>
<th>Proposed Strategies to Enhance Overall Impact</th>
<th>Outcome Measures to Evaluate Impact</th>
<th>Denver HANDOS Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>REACH: Extent of representation of participants</td>
<td>A. Clearly defined target population and numbers of people eligible for the intervention.</td>
<td>Proportion of residents from high-risk neighborhoods who participated in CPR intervention.</td>
<td>344 participants</td>
</tr>
<tr>
<td>B. Major barriers and facilitators to CPR intervention identified in step 2 to develop targeted intervention.</td>
<td>No settings were unwilling to host the intervention.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EFFECTIVENESS: Short-term impact/outcomes for participants</td>
<td>A. Tailored messaging approach based on community recommendations.</td>
<td>Postintervention survey assessing the participants’ satisfaction with the training, knowledge acquisition, and recommendations for improvement.</td>
<td>Increase in knowledge acquisition from 1.71 (±1.33) to 3.98 (±1.07) out of possible five questions.</td>
</tr>
<tr>
<td>B. Reinforced CPR intervention with direct training and take-home kit.</td>
<td>In-person follow-up at 2 to 4 weeks to understand how participants felt training family and friends.</td>
<td>89% of family and friends feel comfortable performing hands-only CPR.</td>
<td></td>
</tr>
<tr>
<td>ADOPITON: Interface between researchers and potential program settings</td>
<td>A. Settings for intervention based on community input.</td>
<td>Not applicable</td>
<td></td>
</tr>
<tr>
<td>B. Intervention can be easily conducted in multiple settings with few resources.</td>
<td>Record which settings were willing or unwilling to participate and why.</td>
<td>Not applicable</td>
<td></td>
</tr>
<tr>
<td>C. Commitment to piloting intervention from key community organizations.</td>
<td>Record which settings initially participated and then dropped out and why.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMPLEMENTATION: Fidelity or intervention integrity</td>
<td>A. Meet with participants who completed the CPR intervention to understand how to make intervention better.</td>
<td>Record number of participants who complete the followups.</td>
<td>Continuation of two community-based programs in stroke and hypertension in same populations: 154 participants (44.8% response rate)</td>
</tr>
<tr>
<td>MAINTENANCE: Both individual participant and program sustainability level</td>
<td>A. Reduce level of resources needed for starting and maintaining this type of project.</td>
<td>Creation of a &quot;how-to guide&quot; for the entire intervention that can then be &quot;taken off the shelf&quot; and used in other communities.</td>
<td></td>
</tr>
<tr>
<td>B. Work with existing network of community organizations locally to develop sustainability plan.</td>
<td>Number of formal local collaborations established by the end of the intervention period.</td>
<td>154 participants</td>
<td></td>
</tr>
</tbody>
</table>

HANDOS = identifying High Arrest Neighborhoods to Decrease Disparities in Survival; RE-AIM = Reach Effectiveness Adoption Implementation Maintenance.
increase the speed in which promising, evidence-based community interventions are translated into the real world. This systematic evaluation framework concentrates on five major areas: reach to the intended target population, efficacy/effectiveness, adoption, implementation consistency, and maintenance of the intervention over time.¹⁴

**DISCUSSION**

There are major health disparities in the provision of bystander CPR by race, ethnicity, and socioeconomic status. Prior research has shown that residents of priority neighborhoods are more likely to have bystander CPR performed compared to residents of white, higher-income neighborhoods. In addition, these same neighborhoods compose of racial/ethnic minorities and lower-income residents are more likely to have a higher incidence of cardiac arrest and lower provision of bystander CPR. These neighborhoods are potential high-risk areas that may be targets for community-based interventions to increase the provision of bystander CPR.⁴⁰

We propose the novel, systematic HANDDS program and method to identify, implement, and track a community-based CPR training program that is focused in the areas where it is most needed and potentially most likely to have the greatest effect. The systematic approach outlined by the HANDDS program has been successfully used in other areas such as community policing and is an effective tool to quickly and efficiently address community problems, such as increase in violence near establishments serving alcohol or a Chagas disease outbreak. However, the HANDDS program’s systematic approach, based on the HBM, has never been applied to increasing the likelihood of bystanders performing CPR. Traditional CPR paradigms of offering training to those who seek out the training, can afford it, and speak English have created a culture in which disparities are normalized and perpetuated. The paradigm must shift, but in a manner in which data and evidence can drive the implementation of this type of community-based CPR programming.

There are three key points that must be in place before the HANDDS program can be used in the community. First, a mechanism for the collection of surveillance data is required to be able to identify the highest-risk neighborhoods and track the successful adoption or implementation of this program. Second, the buy-in and trust of the community is paramount to the successful implementation and evaluation of this program. Community leaders must be engaged in all aspects of the study. Finally, studies have shown that the most successful community-based programs are ones in which the interventions are conducted in the community, developed by the community residents, and value the residents’ time by providing a one-on-one or small group approach. The HANDDS program and method follows these principles and we believe these are important to replicating similar success in other communities. Finally, the sustainability and reproducibility of the program are paramount. In the Denver-based pilot, the biggest barrier faced by the team has been sustainability. Because of the success of the initial pilot, as well as overwhelming community support and engagement, additional funding and community partners have been established to sustain the initiative in the area. The goal of this initiative is to integrate hands-only CPR training into the culture of the school system and the community organizations that service the high-risk neighborhoods.

**LIMITATIONS**

There are some potential limitations to this type of systematic approach to community-based CPR training. Future research will need to conduct assessments to assess how the transition from conceptual framework to actual implementation is carried out. Most importantly, can this systematic approach be replicated in other locations? Current studies are underway in four major metropolitan areas to test the reproducibility of the HANDDS program for the identification of health disparities in OHCA and bystander CPR, followed by targeted, culturally relevant train-the-trainer approaches. The lessons learned from the multiple other sites will provide a perspective on the applicability, sustainability, and reproducibility of this type of program. It is also possible that the steps that we have outlined in this conceptual framework may not be feasible for every community to complete. Finally, further refinement and tailoring of this framework will be needed by each community that chooses to implement this stepwise approach. We believe that this local customization process is inherent to doing community-based educational programming.

Future research is also possible testing how the HANDDS program may function in other disease states. Specifically, the lessons we have learned from developing this program may also be used for other diseases states in which health disparities are present and health care resources are scarce. For example, a similar program could be used for the targeted identification, implementation, and evaluation of a culturally sensitive intervention to reduce sexually transmitted infections, teenage pregnancy, and uncontrolled hypertension. The HANDDS program provides a systematic approach to both targeting resources where they are most needed, and conducting the formative work that ensures that the public health intervention is successful and done in conjunction with the community that it is serving.

**CONCLUSIONS**

There are large health disparities in the provision of bystander cardiopulmonary resuscitation in underserved populations. We have provided a HANDDS program, based on the Health Belief Model, that outlines a rigorous, stepwise approach to changing the paradigm of community bystander CPR training from a one-size-fits-all approach to one that is targeted where the need is greatest. We hope that the novel HANDDS program will begin to address and correct the disparities we see daily for out-of-hospital cardiac arrest victims in the United States.
References


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