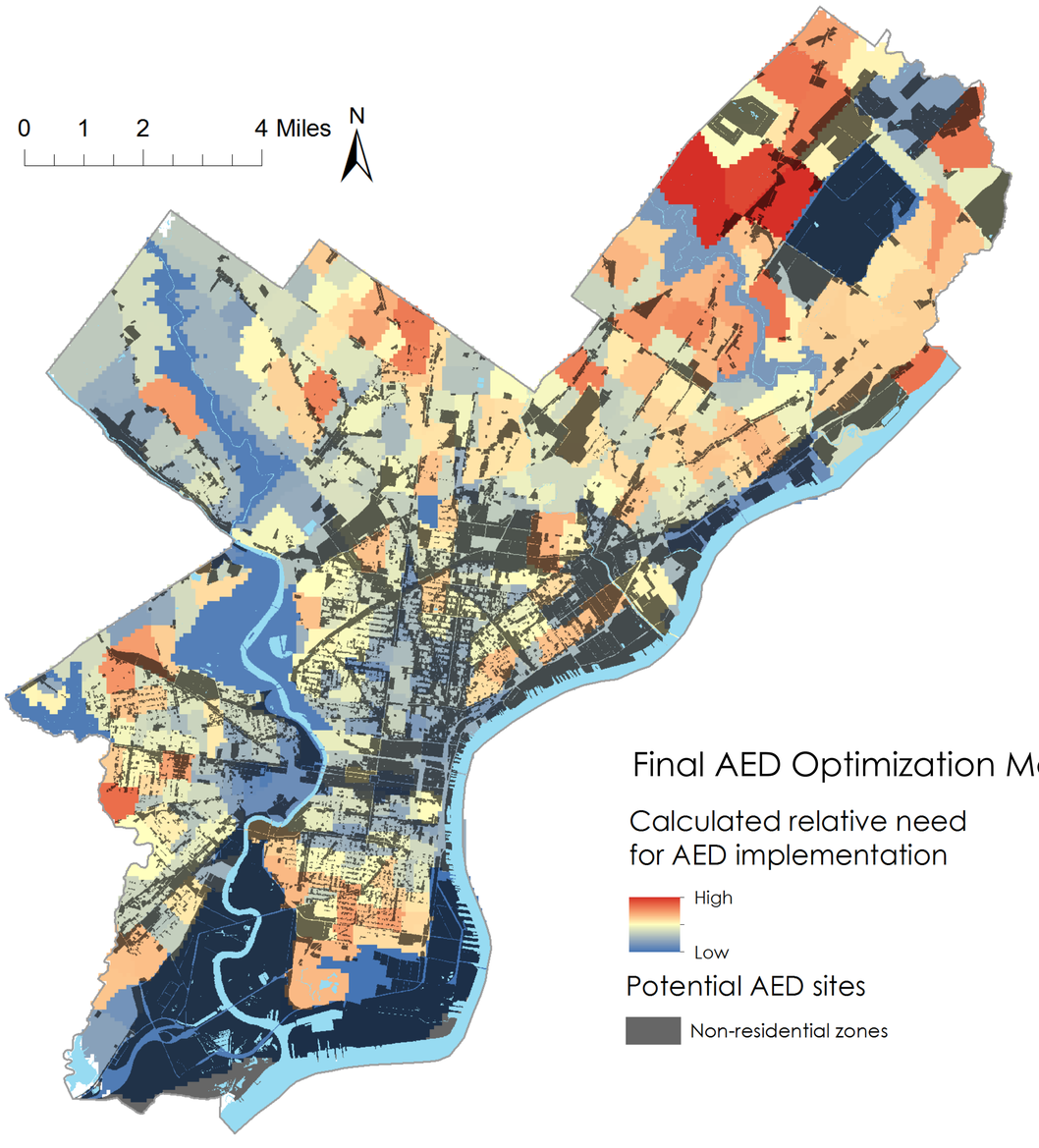
OPTIMIZATION MODEL FOR AED PLACEMENT | PHILADELPHIA, PA



Final AED Optimization Model

Calculated relative need for AED implementation

High

Low

Potential AED sites

Non-residential zones

Introduction

Cardiac arrest onset can occur suddenly and in every location imaginable. For cardiac arrests that occur outside of a medical setting, limitations on Emergency Medical Service (EMS) response time often delay such treatment and put the patient at greater risk for lasting injury or death. A patient's chances of survival decrease 7-10% for every minute that passes without treatment and permanent brain damage begins to occur within 4-6 minutes of onset. To help bridge this gap in care, there has been increased investment in Automated External Defibrillators (AEDs). These compact, easy-to-use defibrillators can automatically diagnose the patient's heart rhythm and determine whether to administer an electric shock, thereby returning the patient's heart to a normal rhythm. Many businesses and cities have adopted AED placement programs as a way to enable bystanders to rapidly administer defibrillation aid—without previous training—prior to EMS arrival. As AED programs continue to expand, it is important to direct such resources to areas that are most at risk for cardiac arrest, namely, areas with a high prevalence of cardiac arrest health risk factors. Spatially assessing the distribution of these health factors allows for the identification of potential gaps in emergency response within areas of high cardiac arrest vulnerability. Using this methodology, this study focused on the development of an optimization model for ideal AED placement within the city of Philadelphia, PA.

Methodology

An optimization model for ideal AED placement was created using datasets related to population and health demographics, EMS response capabilities, and health outcome statistics of cardiac arrest victims. First, the distribution of cardiac arrest risk factors was assessed for areas throughout the city. Previous studies have shown that individuals aged 45 years or older are most likely to experience a cardiac arrest event; this age demographic was mapped by calculating the number of persons in this age group by census tract using the 2010 US Census data. Similarly, obesity and hypertension have been linked to increased cardiac arrest risk; these were mapped separately using data regarding the percent of the population (by planning district) that were overweight/obese and the percent that had hypertension.

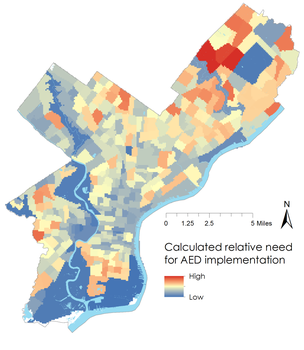
Next, predictions were made regarding the EMS response times for stations throughout Philadelphia (actual EMS response time data is protected and not available for public use). Due to the increased rates of injury and death related to prolonged cardiac arrest without treatment, patients that are a greater travelling distance away from an EMS station are more likely to be negatively affected by delayed EMS response. The response times were calculated by identifying all Philadelphia EMS stations and using network analyst to predict 1 minute travel intervals from these sites. Based on general urban speed limits and permitted ambulance speeds, all roads were set to 35 mph.

The health factor data and the network analysis layers were then converted to rasters and were additively combined without additional weighting. The resulting map highlighted areas of least and greatest need for AED placement based on these factors. However, in order to be accessible to the most number of people, the placement of an AED is limited to non-residential areas. Non-residential Philadelphia zoning units were thus overlaid onto the existing map to show potential placement locations.

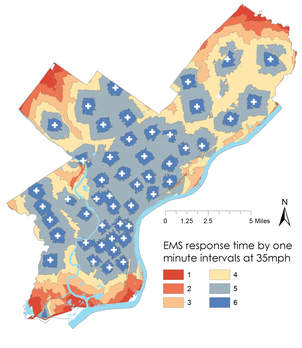
Results

The analysis revealed several areas throughout Philadelphia that are at an elevated risk for cardiac arrest and cardiac arrest-related injury, and would thus be in great need of future AED placement. The overlay of the non-residential zoning areas allowed for the specific identification of placement sites within these highlighted areas. In these areas, AEDs could potentially be placed in easily accessible locations, such as convenience stores, information booths, etc. However, some areas that display high need, such as the northeast region of Philadelphia, have very few non-residential areas to place an AED. Such areas might consider implementing public, outdoor AED stations that can be readily accessible to the surrounding residential population. For high risk areas that have not already begun their own AED programs, this analysis provides a target for future cardiac arrest risk awareness and effective AED placement.

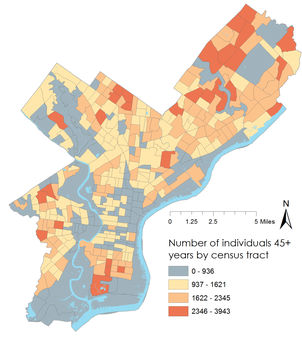
Overall Relative Need



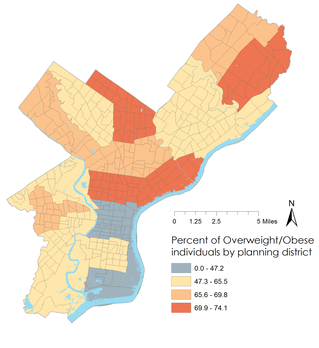
EMS Response Times



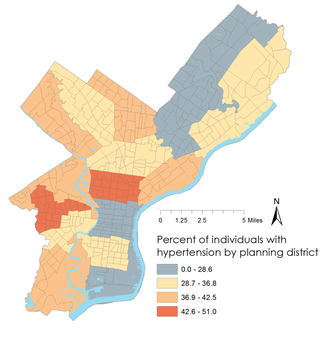
Age Risk Factor



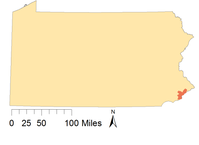
Obesity Risk Factor



Hypertension Risk Factor



Location of Philadelphia within Pennsylvania



Cartographer: Lucia Smith
Course: GIS 001, Spring 2013
Projection: NAD_1983_StatePlane_Pennsylvania_South_FIPS_3702_Feet
Scale: 1 : 63,360
Data Sources: PASDA, 2010 US Census, 2010 PHMC Household Health Survey