Temporal Barriers to Accessing Defibrillators Placed in Public Locations

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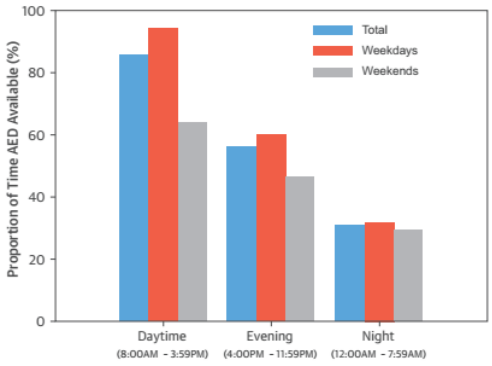
Background

For cardiac arrest occurring outside hospital environments (OHCA: out-of-hospital cardiac arrest), the use of automated external defibrillator (AED), coupled with cardiopulmonary resuscitation (CPR), is known to increase the likelihood of survival of the victim. These AEDs are designed to be simple to use during an OHCA incident. However, there are many potential barriers to AED use by bystanders when a person collapses, including considerations of legal liability, awareness, training, technological limitations, psychological factors, and availability of AEDs.

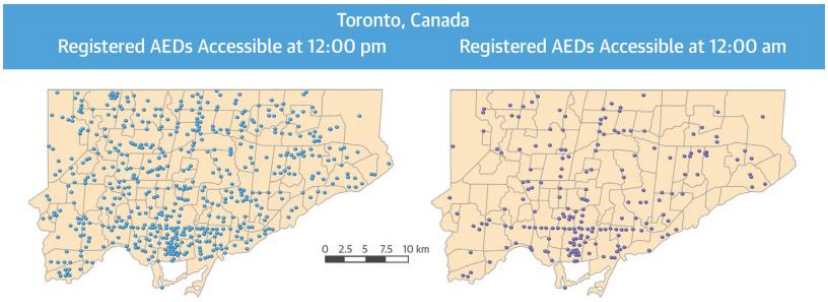


Availability of AEDs placed in public locations depends on time of day and part of week.

Guidelines recommending the strategic placement of AEDs in high-risk locations have been made to improve the likelihood of survival from OHCA in communities around the world. Similarly, mathematical models have been developed as assistive tools to optimize the coverage of OHCAs by AED deployment. However, these AED placement guidelines and mathematical models have only considered geographical information, e.g. location of the OHCA, in their placement decisions. Temporal accessibility is a critical factor that has largely been overlooked even though AEDs placed in public locations are not necessarily always available for use. Often buildings housing AEDs are not open 24 hours a day, 7 days a week.

Methodology

Using data from the Toronto Regional RescuNET Epistry cardiac arrest database for the period between January 2006 and August 2014, we identified all OHCAs that occurred in public locations without external physical trauma. We then obtained a list of registered AEDs as of March 2015 from Toronto Paramedic Services. Using these data sources, we performed two main analyses in the study. In analysis one, we calculated the OHCA coverage of the registered AEDs, in two ways, to find the effects of limited temporal accessibility. "Assumed Coverage" was determined by the number of OHCAs that occurred within 100 meters of a registered AED, from which "Actual Coverage" was determined by the number that also occurred when the AED was available based on its location's hours of operation. We then



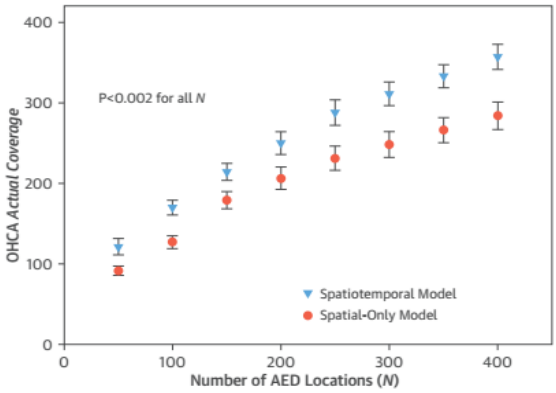
Availability of AEDs placed in public locations depends on time of day.

calculated the relative "Coverage Loss", defined by the difference between these two coverage measurements, expressed as a percentage of "Assumed Coverage".

In analysis two, we developed a novel spatiotemporal AED placement optimization model that identifies optimal AED locations using both temporal and spatial information of OHCA cases and candidate locations for placing AEDs, and compared it to a previously developed spatial-only model. The models were evaluated according to improvement of "Actual coverage" above the baseline provided by the existing registered AED network in the city. The gain of "Actual coverage" from using the spatiotemporal model was then calculated.

Results and Impact

Toronto had 2,440 OHCA cases in a public place during the study period. Of the 737 public locations having AEDs, 74% were not open 24-hours a day, and 29% were closed on weekends. "Assumed coverage" of the identified OHCAs was determined to be 451 (AED availability assumed to be 24 hours a day) and "Actual coverage" was 354 (AED availability corrected for hours of operation of the placement locations). These results indicated a coverage loss of 22%, when OHCAs occurred near inaccessible AEDs.



Actual coverage of OHCA by AED is improved when public locations are chosen using a spatiotemporal model instead of a spatial-only model.

When the new spatiotemporal model was used to optimize the deployment of select numbers of AEDs ranging from 50 to 400, a 25% increase in actual coverage was achieved compared with the spatial-only approach. This improvement was statistically significant at $p < 0.002$.

AEDs must be both geographically and temporally accessible to assure maximal availability for OHCA treatment and response. Incorporating both temporal and spatial data to determine optimal AED placement could enhance accessibility for these victims and improve outcomes.

Partner Profile

St. Michael's Hospital is located in downtown Toronto and is one of University of Toronto's teaching hospitals. The hospital has over 460 adult inpatient beds, and accommodates over 25,000 patient visits a year. Home to the Li Ka Shing Knowledge Institute, the hospital brings together researchers, educators and clinicians to take best practices and research discoveries to patient bedsides faster.

Reference: Sun, C.L.F., D. Demirtas, S.C. Brooks, L.J. Morrison & T.C.Y. Chan (2016) Overcoming Spatial and Temporal Barriers to Public Access Defibrillators Via Optimization. *Journal of the American College of Cardiology* **68**(8):836-845.

January 2017