Analyzing State-Based Silver Alert Programs: The Case of North Carolina

Takashi Yamashita, Dawn C. Carr, J. Scott Brown

BACKGROUND Recent discussions about securing the autonomy and safety of older people in a cost-effective way have culminated in the establishment of “Silver Alert” media-alert policies in more than half of US states over the past 5 years. Although these policies have been established with exceptional legislative speed, research has not yet examined how these policies have been implemented across geographic areas.

METHODS Data from the 587 Silver Alerts activated in North Carolina in 2008, 2009, and 2010 were analyzed. Zero-inflated negative binomial regression and exploratory spatial analyses were employed.

RESULTS Despite a policy focus on older adults and individuals with cognitive impairment, activation of Silver Alerts in a county was not related to the proportion of the population 65 years of age or older or to the prevalence of poor mental health in the county. Rather, a 1-unit increase in the proportion of the population comprised of African Americans increased the rate of Silver Alert activation by a factor of 1.019 (P<0.01). Additionally, spatial analyses suggested that the number of Silver Alerts in a county was related to its proximity to North Carolina’s state capital, Raleigh.

LIMITATIONS These results should be interpreted with caution because an exploratory analytic approach was employed in both regression and spatial analyses.

CONCLUSION The current mission and implementation of the Silver Alert program should be reviewed, given that significant effects were observed for the proportion of African Americans in a county and the county’s distance from the state capital, but not for the proportion of older adults in the county or for the prevalence of impaired mental status.

The population of older Americans has grown rapidly in recent decades, resulting in increasing political and social interest in programs that support older adults’ ability to continue living in the community [1, 2]. The Silver Alert (SA) program is a state-funded public notification program that provides media outlets (eg, television, radio, newspaper, Internet) with descriptive information (eg, name, sex, race, place last seen) about adults with cognitive impairments who have wandered away [3]. Support for SA programs has been inspired by anecdotal cases in which a delay in initiating search and rescue efforts may have contributed to catastrophic outcomes for missing older adults [4].

SA programs have been advanced as a key public health strategy for protecting older adults who are presumed to be at high risk of dangerous wandering [5]. Between 2006 and August 2010, 28 states enacted SA legislation [6], and an additional SA program went into effect in Nevada on January 1, 2012 [7], bringing the total number of states with SA programs to 29. However, no research has been published to date examining whether the programs operate according to their mission: to achieve specific target outcomes effectively and efficiently and to reach all populations equally across target areas [6, 8]. Such analysis is crucially needed, since SA programs serve a key role in states’ efforts to manage the risk of wandering by older adults.

Conceptual Model

A conceptual model described by Handler, Issel, and Turnock [9] can serve as a useful framework to guide analysis of public health system performance. This model calls for an explanation of how the public health system in question should operate, how it achieves specific target outcomes, whether these outcomes are achieved effectively and efficiently, and whether they are provided to target populations equally. This model is valuable for research seeking to understand both the intentions of programs that serve as a means of addressing essential public health practices (eg, monitoring a health problem, enforcing laws and regulations for individual safety) and how these programs function within the context of available resources. This conceptual model is therefore appropriate for assessing whether the mission of a public health program aligns with the way it is operationalized—which is the purpose of the present research.

So far, North Carolina is the only state to have provided information about the SAs that were initiated between 2008 and 2010. As a result, we were able to perform an exploratory analysis of the utilization patterns of North Carolina’s SA program. Specifically, our research was guided by the following question: Is the North Carolina SA program operating according to its mission?

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Address correspondence to Dr. Takashi Yamashita, University of Nevada, Las Vegas, Department of Sociology, 4505 S Maryland Pkwy, Box 455033, Las Vegas, NV 89154 (takashi.yamashita@unlv.edu).

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The mission of the SA program in North Carolina is explicitly stated in the legislation that established the program: “to provide a statewide system for the rapid dissemination of information regarding a missing person who is believed to be suffering from dementia or other cognitive impairment” [10]. The program was initially limited to individuals with cognitive impairments over the age of 18 years, but the legislature later added a special provision for individuals with autism who are younger than 18 years of age [11]. To address the question of whether the program was operating according to its mission, we conducted our initial exploration and description of the data using a combination of Geographic Information Systems (GIS) analysis (using a computer-based system to manage, visualize, and analyze spatially referenced data, such as data with county identifiers) [12] and model-based statistical analysis.

Methods

Data

Data on the SA notifications in 2008, 2009, and 2010 were obtained from the North Carolina Department of Crime Control and Public Safety (which has since been renamed the Department of Public Safety). A total of 587 alerts were activated: 128 in 2008, 239 in 2009, and 220 in 2010. The publicly available data on these alerts is limited to the last name of the missing person, county of residence, city where the alert was initiated, date the alert was canceled, and recovery status. However, we were able to locate more detailed information in some cases—such as age, sex, and race—by conducting an extensive search of all media articles and other reports relating to individual SA cases initiated during the study period (e.g., online news archives of local and regional newspapers, police reports). In many cases, complete data were not available: One or more pieces of basic demographic information—age, sex, and/or race—could not be obtained for approximately 54% of individuals.

Because of the limited availability of data, the common structure of local governments (i.e., county government), and concerns regarding personal privacy, we focused on county-level data as a reasonable unit of analysis. Additional county-level data came from multiple sources, including the 2007-2008 American Community Survey [13]; the 2007 US Census Current Population Survey Small Area Income and Poverty Estimates [14]; the 2002, 2004, 2006, and 2008 Behavioral Risk Factor Surveillance System (BRFSS) surveys [15]; the County Health Rankings compiled by the Robert Wood Johnson Foundation and the University of Wisconsin Population Health Institute [16, 17]; and the US Census Bureau [18].

Outcome Measure

The log population-adjusted counts of SAs activated in 2008, 2009, and 2010 for each county in North Carolina were measured in units per 100,000 county adult population and logged to standardize the unit for cross-county comparisons.

Predictor Measures

The predictor variables and covariates were selected based on the mission of the SA program as articulated in its legislation (i.e., to ensure the safety of older adults and adults with cognitive impairments) and based on the availability of data. Older population and African-American population are the proportion of the county’s total population that consisted of residents 65 years of age or older and the proportion that consisted of non-Hispanic African American individuals, respectively. Poor mental health days, derived from the County Health Rankings, is the average number of days per month when individuals in each county reported that poor mental health interfered with their daily activities. Median income is the median income of each county in 2007. Median income was measured in $1,000 increments and logged to address nonnormal distribution issues for statistical analyses. Rural area is recorded if a county is classified as rural according to the US Census 2000 criteria [19]. Other measures (e.g., political affiliation) were explored but were not found to be useful for understanding the factors shaping frequency of SA activation in North Carolina (analyses not shown).

Analysis

We performed 2 types of analyses: GIS analysis and model-based statistical analysis. The various measures were visualized and color-coded in a map format using ArcGIS 9.3 software [20] to document and visually identify the spatial distribution of SA activations. Ring buffer analysis was conducted to examine the spatial pattern of SA activations [21]. In this study, our preliminary visual examination of the maps suggested the application of a ring buffer analysis based on the geographic center (i.e., county centroid) of Wake County, where the state’s capital (Raleigh) and the North Carolina Department of Public Safety are located. To include surrounding counties, concentric rings 30, 60, 90, 120, and 150 miles from the Wake county centroid were added to the map, and we computed the average number of SAs within each ring (adjusted for the corresponding population of adults 18 years of age or older). Counties were included in each ring if their county centroids were located inside that ring.

All statistical analyses were conducted using SAS 9.2 software [22]. Descriptive summary statistics (means, proportions, and standard deviation [SD] as appropriate) are reported for all measures. Also, a zero-inflated negative binomial regression with maximum likelihood estimation was used to examine the association between the number of SAs activated and various predictors using the SAS PROC COUNTREG procedure [23-25]. Zero-inflated negative binomial regression is suitable for count data that have a highly skewed distribution with a large number of zero counts. Although a Poisson regression model is frequently used in studies with count data, our preliminary analysis showed significant overdispersion (the variance is larger than the mean), which violates one of the Poisson regression assumptions.
585 SA cases were used for the county-level analysis. Important information was missing (eg, name of county), so it was not possible to precisely separate unobserved zeroes due to low activation rates from such structural zeroes. Considering the uncertainty associated with the presence of several possible underlying mechanisms of structural/observed zeroes and the descriptive nature of our analysis, we did not employ empirical Bayes estimates. In other words, this study aims to document utilization patterns of the SA program so as to inform more advanced analytic approaches in future research, but it does not aim to address reasons for the underlying process of SA utilization. Although our preliminary analysis indicated a possible spatial autocorrelation in the residual term in the regression model, there is currently no commercial software that is capable of incorporating spatial autocorrelation (eg, a spatial lag model) into negative binomial regression models. Since a newly developed, advanced analytic approach—the spatial Poisson hurdle model—may be able to address possible spatial autocorrelation in regression analysis, we used a rigorous description of spatial patterns of SA policy utilization to establish a basis for future research. Therefore, we employed a combination of exploratory spatial analysis and standard regression analysis in this study.

**Results**

A total of 587 SAs were issued during the study period: 128 in 2008, 239 in 2009, and 220 in 2010. The vast majority of SA cases concluded with the missing person being recovered within the same year, although in 11 cases the person was found dead. The average length of time a person was missing was 3.45 days (range, 0 to 97 days). For the 371 cases in which the missing person’s age was known, the average age was 54.9 years (SD = 23.17 years). The majority of SAs issued for an individual whose race was known were issued for whites (n = 149), followed by African Americans (n = 109) and individuals in the racial category “other” (n = 11). Among the cases in which the sex of the missing person was known, there were more missing males (n = 292) than missing females (n = 139). After excluding 2 cases in which important information was missing (eg, name of county), 585 SA cases were used for the county-level analysis.

Table 1 summarizes 6 characteristics of the 100 counties in North Carolina and shows correlations between variables of interest. All variables of interest showed significant variability across counties in North Carolina. The numbers of SAs issued in counties also varied significantly (mean = 5.9; SD = 10.5): 9 counties had more than 15 SAs activated, but 24 counties (almost 1 in 4) had no SAs activated during the same time period. The disproportionate distribution of SAs across counties is shown in Figure 1.

Table 2 shows the results of a zero-inflated negative binomial regression predicting the number of SA cases with selected measures ($\chi^2 = 32.45$; degrees of freedom [df] = 6; $P<0.01$). Only the proportion of the population comprised of African Americans ($P<0.01$) was statistically significantly associated with the population-adjusted log count of SAs activated at the county level (ie, the logged rate). Among the counties with the opportunity to utilize SAs, a 1-unit increase in the proportion of African Americans in the population increased the expected rate of SAs by a factor of 1.019, holding all other covariates constant. In other words, counties with the opportunity to utilize SAs and with greater proportions of African Americans activated SAs more frequently than did counties with smaller proportions of African Americans. Because SA counts are population-adjusted, the significance of the proportion of African Americans is not the result of such counties having larger or smaller populations. We also examined the non–population-adjusted count and found that the county population was statistically significant (results not reported). Surprisingly, the proportion of the county’s population that was 65 years of age or older—a specific target population for North Carolina’s SAs—is not related to the number of SA activations.

Figure 2 shows the results of a ring buffer analysis based on the centroid (geographic center) of Wake County. For rings with radii of 30, 60, 90, 120, and 150 miles, the average number of SAs issued per 100,000 adult population and the number of counties within each ring (in parentheses) were 1.40 (4), 1.46 (22), 1.31 (38), 1.09 (61), and 0.92 (76), respectively. In terms of the geographic distribution, the number of SAs decreases with distance from the Wake County centroid beginning at a threshold of 60 miles.

**Discussion**

In this study, the conceptual model described by Handler and colleagues [9] was used to guide an examination of the utilization patterns of the SA program in North Carolina, focusing on its mission (purposes) and its role as a public health program. Although the legislated mission of SAs can be applied to all adults, and especially cognitively impaired adults, emphasis has been placed on the ability of SA policies to ensure the safety of older adults who are at increased risk of wandering and becoming missing [31, 32]. The fact that neither the proportion of older people in a county nor the average number of days per month when residents of the county reported being in poor mental health were sig-

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nificantly correlated with the number of SAs activated in the county suggests that the mission might not be a fit at the county level. With regard to utilization patterns, data visualization indicates that the population-adjusted number of SAs gradually decreases as the distance from the geographical center of Wake County increases. This “distance decay” effect may indicate that the mission is not being equally applied across all North Carolina counties.

Using the framework proposed by Handler and associates to enumerate our findings within a broader public-health-system context, we found that several factors appear to influence the inconsistencies between the mission of the program and its structure, processes, and outcomes. First, the structural capacity of the program might be shaped by the macro context of the program. The more populous geographic areas are often major media centers—with a greater number of television stations, radio stations, and newspapers—and thus they may be able to implement media alerts more efficiently and effectively. Furthermore, locations with more frequent use of SAs are also those closest to the state’s political center—Raleigh (located in Wake County)—which is also where the North Carolina Department of Public Safety and the state news media are located. In other words, commitment to the SA program may be greater in areas where the SA policy receives greater political support [33]. This poses major concerns about inequality in this public-health program, in that SAs are employed less often in places that are less populated (ie, rural areas), even though missing adults may be more difficult to locate in those areas.

Our other findings suggest that these macro-level factors might be associated with health disparities. Counties in which the population includes a greater proportion of African Americans have activated more SAs. Although this may be due to the fact that counties with a greater percentage of African Americans tend to be nearer to the political center of the state (Wake County), it may also be related either to the fact that African Americans are more likely than individuals of other racial groups to have mental health problems, including dementia [34, 35], or to the fact that African Americans are more likely to lack access to care for these problems [36]. Of the SAs in North Carolina in 2008, 2009, and 2010 for which we were able to obtain detailed information, about 40% of the missing individuals were African American. This is significant because African Americans made up only 21.6% of the state’s population in 2010, while whites comprised 73.7% of the population [37].

The lack of connection between the broader intentions of SA programs and the actual utilization of SAs in North Carolina precludes a full evaluation of the public health out-

*TABLE 1.* Correlations Between the Number of Silver Alerts in a County and Variables Thought to Affect this Number

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of counties</th>
<th>Mean per county</th>
<th>Standard deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Silver Alerts issued (N=585)*</td>
<td>100</td>
<td>5.85</td>
<td>10.55</td>
<td>0</td>
<td>85</td>
</tr>
<tr>
<td>Total population in 2009</td>
<td>100</td>
<td>93,809</td>
<td>141,085</td>
<td>4,078</td>
<td>913,639</td>
</tr>
<tr>
<td>Percentage of population aged 65 years or older*</td>
<td>100</td>
<td>14.9</td>
<td>3.7</td>
<td>7.3</td>
<td>24.8</td>
</tr>
<tr>
<td>Median income in 2007 US dollars</td>
<td>100</td>
<td>$41,808</td>
<td>$7,586</td>
<td>$29,043</td>
<td>$65,487</td>
</tr>
<tr>
<td>Percentage of population comprised of African Americans*</td>
<td>100</td>
<td>21.2</td>
<td>16.5</td>
<td>6.0</td>
<td>61.6</td>
</tr>
<tr>
<td>Percentage of population with 4 years of college or more education*</td>
<td>100</td>
<td>16.1</td>
<td>7.9</td>
<td>8.2</td>
<td>51.5</td>
</tr>
<tr>
<td>Number of days per month when residents reported that poor mental health interfered with their functioning</td>
<td>100</td>
<td>3.43</td>
<td>0.6</td>
<td>1.9</td>
<td>4.7</td>
</tr>
<tr>
<td>Rural area designation*</td>
<td>100</td>
<td>21.0%</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

*Correlations between variables of interest*

<table>
<thead>
<tr>
<th>Variable number</th>
<th>Description of variable</th>
<th>Number of counties</th>
<th>Pearson's correlation coefficient (r) for variable numbers 1-7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Number of Silver Alerts issued (N=585)*</td>
<td>100</td>
<td>—</td>
</tr>
<tr>
<td>2</td>
<td>Total population in 2009</td>
<td>100</td>
<td>.73***</td>
</tr>
<tr>
<td>3</td>
<td>Percentage of population aged 65 years or older</td>
<td>100</td>
<td>−.39***</td>
</tr>
<tr>
<td>4</td>
<td>Median income in 2007 US dollars</td>
<td>100</td>
<td>.38***</td>
</tr>
<tr>
<td>5</td>
<td>Percentage of population comprised of African Americans</td>
<td>100</td>
<td>.15</td>
</tr>
<tr>
<td>6</td>
<td>Percentage of population with 4 years of college or more education</td>
<td>100</td>
<td>.56***</td>
</tr>
<tr>
<td>7</td>
<td>Number of days per month when residents reported that poor mental health interfered with their functioning</td>
<td>100</td>
<td>−.18</td>
</tr>
</tbody>
</table>

Note. *P<0.05, **P<0.01, ***P<0.001.

*This is a raw count (not used in regression analysis) after 2 cases were excluded due to insufficient information.
*Data from the American Community Survey 2008.
*Rural area designation is a dichotomous variable excluded from the table of correlations (Table 1B). Data sources: North Carolina Department of Public Safety; US Census Bureau; County Health Rankings [16].
comes and efficacy of these programs [38]. Based on issues identified in our exploratory analysis, several steps need to be taken in order to ensure the appropriateness of SAs as a public health program: more meticulous record keeping by local and state governments (including the locations at which the individual went missing and was recovered, detailed demographic information about the missing person, and his or her health status) and use of a computer-based surveillance/analysis system (eg, GIS) [39-41].

The current study is not without limitations. First, despite an exhaustive search, detailed demographic information regarding all SAs was not publicly available. Also, our summary statistics and analyses were limited to the data available. Second, whereas our exploratory spatial analysis and regression analysis of SAs at the county level provided a useful descriptive summary and insights for future research, the descriptive nature of the modeling approach requires that results be interpreted with caution. Third, individual-level analysis (eg, the locations at which the missing individual was last seen and recovered) was not possible. However, it would be more desirable to capture within-county spatial patterns of SA activations. Fourth, one of the covariates in our statistical model—the average number of poor mental health days—might not serve as the most accurate indicator of the prevalence of specific cognitive impairments in the county, although the number of poor mental health days is likely to be highly correlated with the prevalence of such impairments. Finally, because we conducted an exploratory analysis of only the first 3 years of the North Carolina SA data, the results of this study should be viewed as an initial evaluation, not a conclusive critique.

Conclusion

This study shows that initial utilization of SAs in North Carolina differs from the intention of the SA policy. Given that the number of SAs activated was significantly affected by the proportion of African Americans in the county’s population and by the county’s distance from the state capital, but not by either the proportion of the population consisting of older adults nor by the prevalence of poor mental health

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation coefficient</th>
<th>Standard error</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of population aged 65 years or older</td>
<td>0.019</td>
<td>0.032</td>
<td>0.554</td>
</tr>
<tr>
<td>Median income, measured in $1,000 increments and logged</td>
<td>−0.148</td>
<td>0.789</td>
<td>0.851</td>
</tr>
<tr>
<td>Percentage of population comprised of African Americans</td>
<td>0.019</td>
<td>0.007</td>
<td>0.007</td>
</tr>
<tr>
<td>Number of days per month when residents reported that poor mental health interfered with their functioning</td>
<td>0.091</td>
<td>0.136</td>
<td>0.506</td>
</tr>
<tr>
<td>Rural area designation</td>
<td>−0.288</td>
<td>0.321</td>
<td>0.370</td>
</tr>
</tbody>
</table>

Note. Model fit: $\chi^2 = 32.45$, degrees of freedom (df) = 6, P<0.01. $\chi^2$ value was computed as $2 \times [\log\text{-likelihood (full model)} − \log\text{-likelihood (null model)}]$. *Logged (base 2).

Data sources: North Carolina Department of Public Safety; US Census Bureau; County Health Rankings [16].
in the county, we recommend that the mission and current implementation of SA policy be reviewed. Also, this study demonstrates the usefulness of GIS-based initial exploratory data analysis for evaluating newly implemented health policies such as the SA program and for generating hypotheses for future research. Although the SA program is still in the initial stage of implementation and SAs sounds like a very important way of ensuring the safety of older adults, we need to be cautious in an era when state resources are scarce about whether the funds used to address the broader problem of wandering are being used in the most efficient and effective way possible [42]. We have concerns about this policy having been implemented without the collection of publicly available data to assess its utilization patterns and its contribution to the public health system. Thus, detailed record-keeping and systematic review of the policy clearly need to be an immediate focus of the research and public policy agenda. NCMJ

Takashi Yamashita, PhD assistant professor, Department of Sociology, University of Nevada-Las Vegas, Las Vegas, Nevada. Dawn C. Carr, PhD researcher, Stanford Center on Longevity, Stanford, California.

J. Scott Brown, PhD associate professor, Department of Sociology and Gerontology, and research fellow, Scripps Gerontology Center, Miami University, Oxford, Ohio.

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References
6. Silver Alert Initiatives in the States: Protecting Seniors with Cogni-


