Use of a Modified Cluster Sampling Method to Perform Rapid Needs Assessment After Hurricane Andrew

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Study objective: To rapidly obtain population-based estimates of needs in the early aftermath of Hurricane Andrew in South Florida

Methods: We used a modified cluster-sampling method (the Expanded Programme on Immunization [EPI] method) for three surveys. We selected a systematic sample of 30 quarter-mile square clusters for each survey and, beginning from a random start, interviewed members of seven consecutive occupied households in each cluster. Two surveys were of the most affected area (1990 population, 32,672) at three and ten days after the hurricane struck; one survey was of a less affected area (1990 population, 15,576) seven days after the hurricane struck.

Measurements and main results: Results were available within 24 hours of beginning each survey. Initial findings emphasized the need for restoring utilities and sanitation and helped to focus medical relief on primary care and preventive services. The second survey of the most affected area showed improvement in the availability of food, water, electricity and sanitation ($P \leq .05$). There was no evidence of disease outbreaks.

Conclusion: For the first time, the EPI method provided population-based information to guide and evaluate relief operations after a sudden-impact natural disaster. An improvement over previous approaches, the EPI method warrants further evaluation as a needs assessment tool in acute disasters

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INTRODUCTION

At 4:45 AM on August 24, 1992, Hurricane Andrew, with estimated maximum sustained winds of 145 mph and gusts exceeding 175 mph struck the east coast of Florida in South Dade County. On a scale of 1 to 5, Hurricane Andrew was a category 4 hurricane, with a minimum central pressure of 922 millibars, the third lowest central pressure this century for a hurricane making landfall in the United States. Although high winds accompanied this major storm, little flood damage resulted from the light rainfall or from a maximum storm surge of 16.9 ft above mean sea level. Hurricane Andrew was also a relatively compact hurricane. With an 11-mile radius of maximum winds, the hurricane cut a 40-mile-wide path of destruction across the Florida peninsula as it passed in a westerly direction.[1] The area of first impact, in South Dade County, was one of the most densely populated in the state, with a pre-hurricane population of about 375,000 people who lived in a developed area of 270 square miles.[2] Many people left the area before the storm; therefore, the resident population at the time of impact is unknown.

In the immediate aftermath of the storm, electrical power and communications within the affected area were severed, roadways were blocked by debris, neighborhoods were severely damaged or destroyed, and street signs were blown away. These conditions hampered initial relief efforts, especially because many local officials had lost their homes or were otherwise unavailable, and outside relief personnel were unfamiliar with the area.

A primary objective of the public health response to Hurricane Andrew was to address the health and medical needs of residents in the storm-damaged area. To identify these needs and provide an objective basis for relief interventions, we conducted three population-based surveys using a modified cluster-sampling method, the Expanded Programme on Immunization (EPI) method, which was originally developed to assess immunization coverage in areas where baseline demographic information was unknown.[3-5]

One of several emerging rapid assessment techniques in recent years, the EPI method has been adapted for the evaluation of health status, such as acute undernutrition, or health care delivery services.[6,7] The widespread application of this method in particular is attributed largely to its operational simplicity in field settings and its ability to provide reasonably accurate and useful information with a minimal amount of personnel and resources. For the first time, we applied this method to the rapid assessment of needs after a sudden-impact natural disaster.

The results of our surveys were used to help guide the relief effort at a time when major decisions were being made hourly. Many different agencies, including health departments, law enforcement agencies, and utility companies, used this information, and the fact that all were relying on the same data facilitated coordination of efforts. The information also was released quickly to the news media, helping the public to understand the nature and extent of the crisis and to control rumors (eg, rumors about epidemics of communicable diseases).

MATERIALS AND METHODS

Site Selection Aerial surveillance identified the communities of Homestead (1990 census population, 26,866) and adjacent Florida City (1990 census population, 5,806) as having suffered the most destruction. After ground transportation was restored, we conducted a cluster survey of the Homestead-Florida City area on August 27 and repeated the survey on September 3. On August 31, we surveyed the less severely affected Perrine area, 12 miles northeast of Homestead.

Sample Selection The EPI method calls for the systematic sampling of 30 clusters from the area of interest. In our surveys, we defined clusters using a grid of quarter-mile square areas on detailed street maps of the communities that were to be surveyed. For example, a grid constructed to scale defined 120 quarter-mile square clusters in the Homestead-Florida City area (Figure). We assigned each cluster a number in sequence from 1 to 120. We then used a cluster-sampling interval of 4 (120÷30) to select 30 clusters beginning from a random start between 1 and 4 that we chose from the serial number of a dollar bill. Using the same cluster grid and sampling interval but a different random start, we conducted a second survey of the Homestead-Florida City area, sampling different clusters than those sampled during the first survey.

The sampling units within each cluster were households, defined as groups of persons sharing meals and residence. Red Cross emergency shelters were not included, as none existed in the surveyed communities, which had been designated evacuation areas. Tent cities also were not sampled, as none were established until after the surveys were completed.

After arriving near the center of each cluster, interviewers proceeded in a randomly chosen direction (indicated by the top of the inscription of a tossed coin) to the nearest occupied household, where they interviewed an adult member of that household. Interviewers then went consecutively to the next nearest household until they had completed a total of seven interviews of occupied house-

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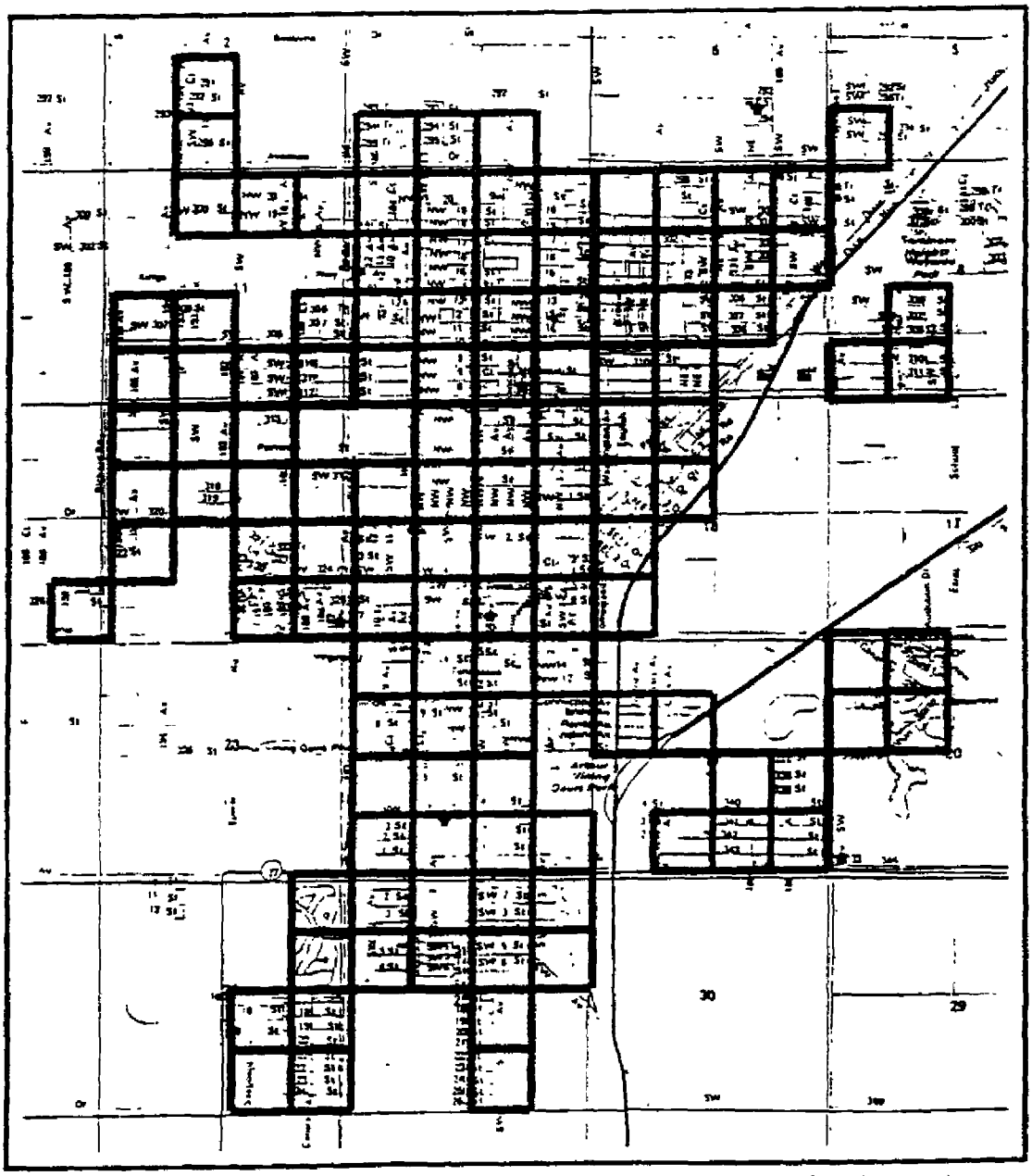
holds. We targeted the number of interviews per survey at 210 households. Interviewers did not revisit unoccupied households. In apartment building and other multi-unit dwellings, interviewers surveyed only residents of the first occupied unit. If a cluster was nonresidential or destroyed, interviewers moved to the next closest cluster in a randomly chosen direction. We included in our analysis any interviews that exceeded the target of 210 households.[3]

Figure.
Grid defining a sampling frame of quarter-mile square clusters on a detailed street map of the Homestead-Florida City area



Interview Method Three to four teams were used to complete each survey. Teams consisted of an epidemiologist-team leader and three or four volunteer interviewers (including at least one Spanish-speaking person) who were recruited either from students at a nearby medical school or from staff of the county public health unit. Interviewers received two hours of instruction in survey procedures and use of the one-page questionnaire. They also were instructed to inform residents about the location of medical treatment and supply distribution sites and to pass on preventive health messages regarding the importance of hand washing, water treatment, proper food handling and storage of food, mosquito control, and injury prevention.

Data Analysis Data were entered into an Epi Info data file on laptop computers and analyzed by using the same software package.[8] Results were reported as sample proportions. We determined the statistical significance of differences in sample proportions between successive surveys of the Homestead-Florida City area using previously published guidelines for immunization surveys.* These guidelines, shown in Table 1, define the minimum and maximum proportions (%) needed in a follow-up survey to define significant increase or decrease respectively ($P \leq .05$, two-tailed test). These guidelines were adjusted for design effect and defined for 18 different initially observed proportions. Design effect is defined as the ratio of the variance of the cluster sample result to the variance of the result from a simple random sample of the same size. A design effect of 1.0 indicates a high degree of uniformity between clusters, and values between 1.5 and 2.5 indicate a moderate tendency for households within a cluster to be more similar to each other than to households between clusters.

Table 1.
Immunization coverage levels required when using the EPI method in a second survey to establish a statistically significant change from the level observed in the first survey ($P < .05$, two-tailed test)†*

First Survey Observed Coverage (%)	Assumed Design Effect‡	Second Survey: Minimum Coverage to Detect Improvement (%)	Second Survey: Maximum Coverage to Detect Deterioration (%)
10	2.30	20.6	2.8
15	2.20	26.7	6.2
20	2.64	33.9	8.9
25	2.38	38.9	13.3
30	2.74	45.5	16.5
35	3.10	51.9	19.8
40	2.72	55.9	25.1
45	3.06	61.9	28.7
50	4.08	69.1	30.9
55	2.92	71.0	38.5
60	3.00	75.6	43.3
65	2.83	79.5	48.9
70	2.60	83.2	54.9
75	2.70	87.4	60.1
80	2.40	90.6	66.7
85	2.50	94.3	72.5
90	2.40	97.3	79.2
95	1.84	99.4	87.6

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† Thirty clusters of seven children were assumed in both surveys. The figures given should be taken only as approximate indications, as the intra-cluster correlation is unlikely to be constant.
‡ The intra-cluster correlation for corresponding coverage levels is assumed to be the same for the two surveys and gives rise to the design effect as indicated. These design effects have been calculated from the 60 actual immunization coverage surveys in the source paper. For each initially observed level of coverage shown, the design effect would be at, or smaller than, the level shown for 90% of the results analyzed.

RESULTS

Results of the three needs assessment surveys are shown in Table 2. Each survey was completed within five hours of the interviewers' arrival at the survey site. No households refused interview. Results were available to relief planners within 24 hours of beginning each survey, with the first results reported 98 hours after storm impact.

In the initial survey of the Homestead-Florida City area, 91% of households reported having no electricity and 86% had no telephone service. One third of households had no functioning toilet, 17% had no car or truck, and 17% reported they did not have enough food for immediate needs (24 to 48 hours). All available electrical power was supplied by portable generators, and all telephone service was by cellular telephone.

The high proportion (33%) of households with children less than 2 years old, a particularly vulnerable group, emphasized the need to quickly restore adequate housing and utilities, especially water and sanitation services. The relatively low proportion (7%) of households with injured residents and the minor nature of the injuries they described (eg, bruises, lacerations, puncture wounds) changed the focus of medical relief away from mass-casualty trauma services toward primary care and preventive services. Restoration of pharmacy services also became a priority.

Our follow-up survey of the Homestead-Florida City area showed significant improvement in the availability of food, water, electricity, and functioning toilets. No significant change in the prevalence of illness or injury was observed. The survey of Perrine reflected less disruption of services, except for electricity, and showed that the

prevalence of illness was comparable to that seen in the Homestead-Florida City area.

DISCUSSION

Rapid needs assessment is widely recognized as an essential component of any efficient disaster relief operation.[9-12] To be useful, any such assessment must provide valid information quickly, often under very adverse circumstances and with limited resources. In previous natural disasters, there has been little use of standardized methods, and assessments were more often based on rumor than on fact.[10,13] These approaches had the advantage of obtaining information rapidly, but they did not reliably reflect the needs of the affected populations and tended to lead to inappropriate and inefficient use of limited health resources.[10,11,13] The methodologic rigor necessary to obtain valid, precise population-based needs estimates after a natural disaster are generally too difficult, time consuming, and expensive to be useful in guiding relief operations. The EPI survey method appears to be a practical method of obtaining rapid population-based estimates of need with an acceptable level of precision.

The EPI methodology originally was developed to assess levels of immunization coverage. Application of the method varies, depending on how much is known of the age and geographic distribution of the population being studied.[3] When good baseline demographic information is available, clusters may be selected with probability in proportion to population size, and samples within clusters may be selected in a truly random fashion. When reliable demographic information is not available, a modified version of the EPI method can be used successfully, as other researchers have shown in surveys conducted to obtain estimates of immunization coverage, with a standard deviation of no more than ± 10%.[3,4] This modified method proved useful for rapid needs assessments following Hurricane Andrew, but it involved several important assumptions and limitations.

Because of extensive destruction and population displacement caused by Hurricane Andrew, South Dade County census data were not considered valid, and sampling of clusters with probability in proportion to population size could not be performed readily. Instead, we assumed that each cluster had approximately the same number of occupied households. This assumption seemed justified by the fact that we sampled only the rather densely (and evenly) populated area within city limits. If outlying rural areas were included in our sampling grid, their populations would have been over-represented. In fact, the number of occupied households we found in each cluster varied over a wide range at the time of our surveys. Cluster populations could not have been predicted from the prehurricane population distribution because some areas were destroyed, whereas others were relatively preserved.

We chose to interview a sample of seven consecutive occupied households within each cluster, beginning from a random start. One alternative would have been to select a simple random sample of all occupied households within each cluster. Although such a choice would have

Table 2.
Results of three rapid needs assessment surveys of South Dade County, Florida, communities affected by Hurricane Andrew, August-September 1992

Survey Variables	Community		
	Homestead-Florida City	Homestead-Florida City*	Perrine
Survey date (hurricane struck August 24)	August 27	September 3	August 31
No. of households visited	571	398	380
No. of occupied households visited and interviewed†	204	211	207
Mean no. of residents/household before storm	4.5	4.2	3.4
Mean no. of residents/household at time of survey	5.0	4.5	3.3
Percentage of households with:			
Children less than 2 years old	33	17‡	9
Persons more than 64 years old	19	25‡	21
Not enough food	17	6‡	4
No running water	28	10‡	12
No electricity	91	77‡	95
No functioning toilet	33	11‡	7
No telephone	86	92	37
No car or truck	17	17	4
Injured resident(s)	7	8	11
Ill resident(s)	15	22	11
Resident(s) in need of medical care	8	11	7
Resident(s) unable to obtain needed medications	13	16	13

* Clusters selected for the second survey of the Homestead-Florida City area were not the same as those selected for the first survey.
† No interviews were refused.
‡ Statistically significant change from the August 27 survey ($P \leq .05$, two-tailed test with adjustment for design effect).

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