Rodent Control in Urban Areas

An Interdisciplinary Approach

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Abstract

In 1992, Baltimore Mayor Kurt L. Schmoke created the Rodent Control Committee to combat the increasing Norway rat population in Baltimore City. Following a pilot project, programs were conducted in two sections of the city from which high numbers of rat complaints had been reported. These three-month programs attacked the rodent problem via an integrated pest management approach that emphasized public education by trained community leaders and health department workers, increased community cleanup projects coordinated by the Bureau of Solid Waste, and intensified baiting by the city's Rat Rubout Program. Direct intervention eliminated up to 90 percent of rat burrows present in the target neighborhoods. Follow-up surveys, however, showed that in neighborhoods with environmental factors favoring rat populations, reinfestations achieved preintervention levels within six months. Attempts to modify the behavior of residents, which is vital in reducing and eliminating rodent infestation, were generally unsuccessful.

Introduction

Rodent infestation is a problem endemic to many urban areas, affecting the quality of life as well as damaging the infrastructure and affecting public health by the transmission of infectious diseases. As in other older cities, the *Rattus norvegicus* (Norway rat) population in Baltimore appears to be increasing, as indicated by increased complaints from residents over the past decade (1). The increases in rat populations are due to poor sanitation practices and plentiful harborage (Baltimore City Housing Department, unpublished data). Exposure to the zoonotic diseases carried by these animals and their ectoparasites represents a growing threat to public health (2). For example, leptospirosis, a "re-emerging" bacterial disease often associated with occupational exposures or epidemics in developing countries, has been identified in inner-city residents (3). The source of infection and the frequency of serious disease are, however, unclear. Recently, several cases of severe leptospirosis were identified in inner-city Baltimore (4). In these cases, exposures were linked to direct contact with *Leptospira*-contaminated soils; nearly all rats tested at these sites were infected with *Leptospira*.

Many factors common to urban living contribute to rat proliferation (improperly stored refuse, lack of sanitation, abandoned properties, pet food and waste, etc.). Successful, long-lasting rodent control programs must include physical measures by authorities to reduce harborage and food availability as well as education of residents to modify behavior that leads to rodent infestation.

To have the greatest impact upon rodent infestation, it has been proposed that such programs use an approach called "integrated pest management." This approach requires cooperation between local authorities, residents, and pest control operators. Any group working alone can affect only certain components

of the environment that contribute to rodent infestation. Coordination among these groups leads to reduction of rodent-friendly environments on a large scale. Municipal authorities can improve sanitation and limit harborage, while pest control operators can use baits to immediately influence the abundance of rodents. Residents can be educated and motivated to change behaviors that lead to infestation (5).

Although this approach to rodent infestation management should be widespread, relatively little has been reported about the impact of such programs; several authors have pointed to the need for such data. An examination by Drummond of rodent control programs in urban areas throughout the world showed the necessity for a preliminary survey and pilot scheme to discover the level of a particular rodent infestation and to determine which methods would be most suited to control that infestation (6). Drummond's study concentrated, for the most part, on programs in underdeveloped countries, for which few preliminary studies were conducted and in which less emphasis was placed on community involvement.

Baltimore City provides an ideal environment in which to monitor the implementation of a program with the components Drummond suggested, as well as a larger resource base that permits more widespread efforts to incorporate activity on the part of residents. This study attempts to assess the efficacy of such an integrated management program in reducing the population of Norway rats in both low- and moderate-income neighborhoods. The integrated management strategy included community education, improved waste removal services, baiting of active infestations, and housing code enforcement. This strategy was combined with pre- and postprogram surveys of infestation levels in the treated neighborhoods, as well as in adjacent control neighborhoods where standard levels of treatment were maintained.

Materials and Methods

To develop the most appropriate methods of encouraging community acceptance of the control strategies and to identify the most effective treatment schemes for the integrated management approach, the pilot program was implemented in a neighborhood in east-central Baltimore. According to Department of Housing records, rat complaints that mentioned bites, burrows, droppings, or sightings were reported from this neighborhood at significant levels. The pilot project used this neighborhood, which had 1,160 residences, to develop and test neighborhood involvement programs and the integration strategies of the Departments of Housing and Health and the Bureau of Solid Waste.

The pilot project produced information useful in assessing the success of the various rat control elements (e.g., survey, community education, special baiting, code enforcement, special cleanups and community participation). Because of the diversity of Baltimore's neighborhoods, however, programs were conducted in two other neighborhoods with different characteristics. The pilot project neighborhood consisted primarily of two-story, absentee-owned, single-family row houses. Residents were at the low-income level. The first evaluation neighborhood (Zone 1) contained

TABLE 1

Indicators of Rat Infestation at the Start and End of Each Study

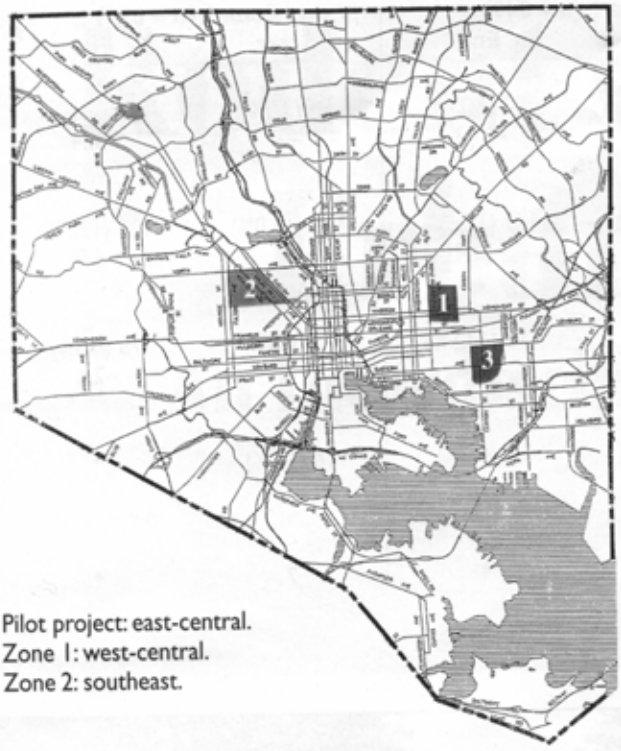
Condition	Zone 1 (n = 849) Start	Zone 1 (n = 849) End	Zone 2 (n = 899) Start	Zone 2 (n = 899) End
Rat-Infested Properties	181 (21.3%)	70 (8.2%)	35 (3.9%)	3 (0.3%)
% Change	—	–61.3	—	–91.4
No Trash Containers	172 (20.3%)	149 (17.6%)	135 (15.0%)	123 (13.7%)
% Change	—	–13.4	—	–8.9
Bulk Trash Present	182 (21.4%)	115 (13.5%)	77 (8.6%)	75 (8.3%)
% Change	—	–36.8	—	–2.6
Units in Violation	248 (29.2%)	*	16 (1.8%)	*
Responses from Units in Violation	45	*	7	*

*Data not available.

Example of an alley in Zone 1 that contributed to rodent infestation prior to implementation of the rodent control program in Baltimore, Maryland.

FIGURE 1

Locations of Rodent Control Projects



1. Pilot project: east-central.
2. Zone 1: west-central.
3. Zone 2: southeast.

mostly three-story multifamily rental properties with a significant number of vacant buildings (see photo on page 13). This target area also was composed of low-income residents. The second evaluation neighborhood (Zone 2) was inhabited by moderate-income residents and consisted essentially of owner-occupied two-story row homes. Although the pilot project and first program took place in low-income neighborhoods and the second program took place in a moderate-income neighborhood, no attempt was made to study the relationship between neighborhood demographics and rat infestation. The only criteria used in the selection of neighborhoods were high levels of rat complaints and variation in geographic area. As noted in the discussion section of this paper, different educational and enforcement methods were employed in each of the neighborhoods. As a result, different degrees of success were achieved.

In all projects, the outcome to be measured was the change in the number of rat-infested properties by the end of the study. A second measure, which assessed the persistence of the effects of the program, was determined through follow-up surveys conducted by staff from the city's Rat Rubout Program approximately six months after each program had ended. The general sanitary condition of the community, use of trash containers, rodent complaints, and community commitment to eliminating the rodent population were also used as measures of outcome. The evaluation neighborhoods were located in west-central (Zone 1) and southeastern (Zone 2) areas of the city (Figure 1). During the preceding three years, symptoms of rat infestation had been reported regularly from both neighborhoods; these reports suggested infestation was endemic to these areas. The neighborhoods consisted of contiguous blocks of primarily residential row housing. To measure the impact of the program, blocks adjacent to the evaluation neighborhoods were selected as controls; surveys of rat infestation were conducted in the adjacent blocks before and after the intervention. City services were continued in the control areas; however, the additional services and community education programs were not provided.

Surveys

Before intervention, the neighborhoods were surveyed for Norway rat burrows and environmental factors associated with the provision of food and harborage for rodents. A standardized form was used for the residences and public areas in each location. This form, originally developed by the Centers for Disease Control and Prevention (CDC), recorded the presence of rat burrows and signs of infestation (feces, rub marks, etc.) on the exterior of a property or in a structure. Teams of trained personnel from the Department of Housing Rat Rubout Program surveyed the exterior of each property in the study and control areas. Evaluations were confirmed by supervisors. The type of each premise was noted: residential, business/institution, food establishment, multiuse, or vacant lot. These teams also recorded the presence or absence of accessible food sources (exposed garbage, accessible pet and bird food and excrement) and harborage (abandoned vehicles and appliances, rubbish piles, outbuildings, and unkempt vegetation). These data were entered into a computer with a commercially available spreadsheet software program to generate summary statistics.

Integrated Management Program—Active Rat Control

Baiting

Following the initial survey, teams from the city Department of Housing treated all infested properties in the intervention areas, first with tracking powders containing bromodiolone (3-[3-(4'-bromo[1,1'-biphenyl]-4-yl)-3-hydroxy-1-phenylpropyl]-4-hydroxy-2H-1-benzopyran-2-1), bromethalin (n-methyl-2, 4-dinitro-n-(2,4,6-tribromophenyl) -6-(trifluoromethyl)benzenamine), and diphacinone (2-(diphenylacetyl)-1H-indene-1, 3-(2H)-dione). Burrow entrances were dusted. A second dusting was carried out three to four days after that, and was followed, four days later, by a solid baiting with bromethalin benzenamine. This cycle was repeated for the duration of the intervention. All new infestations observed during the intervention were also treated. Adjacent control blocks were surveyed for burrows but were not baited. At the end of the project, all properties in the intervention and control areas were surveyed for rat burrows. The follow-up surveys of the treatment areas were repeated six months after the end of the study; however, no additional baiting was performed. Current treatment practices were reinstituted after this time.

Food and Harborage Removal

Employees from the Department of Public Works Bureau of Solid Waste were sent to each study area to remove trash from sidewalks, alleys, public areas, and vacant lots, under the direction of a public works supervisor. Statistics were kept on the weight of mixed refuse collected from each project area. Vacant houses, either city owned or privately owned, constituted 15 to 20 percent of properties in the low-income area and less than two percent in the moderate-income area. After the owners were notified, these properties were cleaned and closed to restrict access by unauthorized individuals. To improve access to appropriate refuse storage, private companies donated 100 heavy-duty trash containers with tight-fitting lids. These 32-gallon trash cans were distributed to low- income families in

both zones who, according to interviews and reports from neighborhood organizations, needed receptacles for waste storage.

Education

After initial publicity campaigns by the mayor, advertisements and stories in local newspapers, and an educational program at the local elementary school, residents were approached directly (Figures 2 and 3). For each study area, a group of four neighborhood residents and college students was trained by the city housing and health departments to perform a door-to-door educational campaign. The groups were supervised and paid by the city health department. The educational campaign focused on the importance of recycling properly; using bulk trash pick-up services; properly storing waste in garbage cans with lids; putting trash out at the collection point on the morning of collection rather than one to three days prior to collection; and keeping yards free of pet food, bird food, feces, and harborage. Pamphlets, outlining the dangers posed by rats and providing suggestions for "ratproofing," were distributed to residents. Occupants of properties with any health or safety violations were educated about ways to correct them. Owners of properties with significant problems were contacted in writing and informed that they needed to cooperate to ensure the success of the project and to improve the sanitary condition of their properties. Individuals who failed to respond to written notification were subsequently served with legal notices and court summonses if violations were not abated.

Results

The low-income neighborhood (Zone 1) comprised 16 square blocks and 849 premises, mostly renter occupied. Four adjacent square blocks or 143 premises represented the control blocks for Zone 1. The moderate-income neighborhood (Zone 2) comprised 24 blocks and 899 residences, mostly owner occupied. Because of the somewhat larger size of the area and the lower prevalence of infestation, eight control blocks with 254 premises were selected for Zone 2.

Rat infestations were common in both project areas at the start of each program (Table 1). Active infestation levels were found in 21.3 percent of the properties in Zone 1 and 3.9 percent of the properties in Zone 2. Infestation levels in the control blocks for Zone 1 and Zone 2 were 21 percent and four percent, respectively. Before the program was implemented, there was no significant difference between the proportion of properties infested in the zones and the proportion infested in the respective control blocks.

Following the intervention, the prevalence of infestations decreased significantly in both zones (Table 1). The proportion of infested premises was reduced from 21.3 percent to 8.2 percent in Zone 1 (the low-income neighborhood) and from 3.9 percent to 0.3 percent in

FIGURE 2

Program Announcement in the *AFRO American Newspaper*

PILOT PROJECT

Mayor Kurt L. Schmoke will kick off an environmental pilot project in the middle east section of Baltimore City on Monday, May 10 at the Tench Tilghman Elementary School. At this site, he will unveil plans to spruce up the area while reducing the number of rats. For details, call the Baltimore City Health Department at 396-9932. No matter what neighborhood you live in, the following information will be helpful.

If the block looks better… you'll feel better!

Spruce-Up Tips

- **Trash ...**
  If trash isn't contained properly, it will attract some nasty critters, including rats.
  Make sure trash is in heavy cans and/or goes out the morning of trash pick-up. The idea is to get the trash out of your neighborhood and to a landfill.
- **Ask the Kids to Help... RECYCLE!**
  Start recycling… It's easier if you start by "keeping it simple."
  It's a good project for young children to help with, especially during the summer.
  Paper products are sometimes the easiest to begin with—Set aside one small area with a box or paper bag.
  Start putting these items in your recycle pile—newspapers, magazines, phone books, junk mail, cardboard, clean cereal and tissue boxes. (Don't recycle any paper with a waxy finish, carbon, foil, or with food stains like pizza boxes).
  Your recycling day is based on whether you live in the East or West Zone, and is Thursday, Friday, or Saturday—whichever is your SECOND trash collection day that week. Call 396-5916 for details.
- **Know Your Trash Days!**
  Questions about trash collection days, bulk trash, or tires? Call 396-4515 at the Department of Public Works (DPW).
- **What to Do with Couches and Tires?**
  Couches and mattresses are too big for regular trash pick-up and need a special pick-up, which you have to schedule by calling 396-4515.
  Tires are a nuisance. DPW will take four rimless tires at a time, but call 396-4515 to schedule it.

Don't Attract Rats!!!

- **Inside:**
  Sweep up food scraps or spills and place in trash cans.
  Keep all rooms clean.
- **Outside:**
  Close off any openings in exterior walls/foundations—1/4 inch or bigger.
  Use metal/tough plastic trash cans.
  Remove leftover pet food from the yard after each feeding and clean up the dog feces each day.
  Call 396-4515 to remove from your yard—old appliances, stuffed furniture, or tires.
  Cut down high grass and weeds.

KNOW YOUR TRASH DAYS.
Support the Upcoming "Afro Clean Block Campaign".

FIGURE 3

Education Campaign Flier

FACT SHEET

Tips on What to Do with:

1) *Used Tires, Old Couches, and Mattresses:*
Set out on Clean Sweep Day.
This service is provided on the 2nd Thursday of every month.
Only three (3) large items will be picked up at a time.

2) *Mixed Refuse Collection Days: Tuesdays*
One Tuesday would be for the collection of paper, and the alternating Tuesday would be for Blue Bag collection, which includes glass jars, glass bottles, aluminum cans, tin (steel) cans, plastic milk jugs, and plastic soda bottles. Recycling inquiries should be directed to 396-5916.

- Remember to set out recyclable material at the same location as your regular trash.
- Set out recyclable material by 7 a.m.
- Mixed paper is collected wet or dry. Staples and window envelopes are okay. Please do not include waxed paper, carbons, or soiled paper.
- Use blue bags only for recycling bottles and cans. (Blue bags are not for trash.)

Rat Behavior:

Outdoors, rats live in burrows in the ground, in piles of rubbish and garbage, and under building foundations. Indoors, rats live between floors, ceilings, and walls, in cabinets, and in piles of rubbish and other concealed places.

Rats usually begin their search for food and water after sunset. They feed twice a night—once shortly after dark and again in early morning. They live on garbage, decaying meat, and spoiled vegetables and fruit.

Signs of Rats:

Since you usually cannot see them, look for:
• Tracks • Rub Marks • Droppings • Gnawing • Burrows

Rats are dangerous in that they attack and occasionally bite humans. They can transmit diseases to humans by their urine and droppings, or by lice on their bodies—all of which carry germs. Rats can destroy and contaminate food, as well as damage property. If you or anyone in your family is bitten by a rat, that person should be treated by a doctor to prevent infection. All rat bites in Baltimore must be reported to the Baltimore City Health Department at 396-4688.

Zone 2 (the moderate-income area). By contrast, the infestations in the control areas remained virtually unchanged throughout the intervention programs. For Zone 1 control blocks, the proportions were 21 percent before and 16.2 percent after; for Zone 2 control blocks, the proportions were 4.1 percent before and 3.4 percent after. Thus, the program significantly reduced levels of rat infestation, even in high-infestation areas such as Zone 1.

The impact of the community behavior modification components was less clear. The amount of standard trash and garbage collected at the start and end of the program, as measured in tonnage, did not differ significantly, although for both sites, the amount of bulk trash collected at the end of the program was less than the amount collected at the beginning (Table 1). This reduction, together with a drop in the number of premises on which bulk trash was observed, seems to indicate that many residents set out their bulk trash for collection early in the program and did not return to poor bulk-storage habits (Table 1). With respect to trash containers, an important indicator of good sanitary practices, Table 1 shows only marginal improvements in both zones. The number of premises without trash containers dropped from 20.3 percent to 17.6 percent in Zone 1 and from 15 percent to 13.7 percent in Zone 2.

Contacts with housing code violators showed that in Zone 2, evidence of housing conditions that favored rat populations was substantially (approximately 10-fold) less than in Zone 1. In addition, violators in Zone 2 were more likely to be responsive to violation letters issued by community inspectors (44 percent responded) than were violators in Zone 1 (18 percent responded). Follow-up surveys indicated that the significant reduction in rat-infested properties in Zone 1 was relatively short-lived. Within six months of project termination, surveys showed that the proportion of infested premises was close to the initial level of 21.3 percent. By contrast, the six-month follow-up survey in Zone 2 recorded no reinfested premises.

Discussion

Rats are found in all parts of Baltimore, regardless of the ethnographic composition of the neighborhood. The social issues, however, were distinct for each program; they affected the methods used and probably influenced the long-term results. The first project took place in a low-income neighborhood where bulk trash littered the lots and alleyways of large, multifamily rental properties. A drug problem present in this part of the city led many residents to believe that community inspectors and project workers were undercover police officers. This belief reduced cooperation on the part of the residents not directly involved with the community association. The second project focused on an area dominated by small, one-family, owner-occupied houses with relatively low levels of rodent infestation. During this project, the placement of community inspectors at a neighborhood office of the Department of Housing resulted in various referrals to the Department of Social Services, thus reinforcing the conclusion that rodent control is not strictly about rodents, but involves all the reasons people cannot or will not practice proper sanitation.

The initial success of direct intervention was striking. The decrease in rat infestations in the intervention areas relative to the control blocks was evidence that the program had achieved one of its goals. Because the decrease was only initial, the primary success of this project appears to be attributable to government intervention. The nearly total lack of impact on bulk trash, housing violations, and unsuitable trash receptacles indicates that the infestation reductions primarily resulted from baiting. A substantial decrease in bulk trash collected at the end of the study, compared

with the amount collected at the beginning, may indicate that large items, such as furniture, automobiles, and appliances, accumulate fairly slowly and that such harborage may be kept to a manageable level with adequate surveillance and response by authorities. By contrast, the high levels of inappropriate trash containers on premises (or a lack of any trash containers) suggests a significant problem with personal behaviors that allow rats access to a nearly inexhaustible supply of food. Those behaviors can be viewed as predictors of a return to preintervention status. Photographs taken in the project areas show that the sanitation practices in the neighborhoods during follow-up appeared to be the same as they were before intervention.

A primary objective of these projects was to reduce rodent infestation through health and sanitation education. With respect to this objective, the projects failed. If the educational component had been successful, behavior would have been modified, if only to the slightest degree. So what went wrong? The sanitation inspectors and Rat Rubout Program treatment team workers were equipped with all the information necessary to educate communities about the dangers of rats and the means of preventing rats from infesting properties. If we assume that good health is enough of an incentive for compliance with proper sanitation practices, then we can conclude that education needs to be brought to more people over a longer period of time to achieve its desired effect. The expenses involved in implementing these targeted projects even for a limited time indicate that this approach may not be feasible for financial reasons. Expenses included campaign kick-off; give-aways; promotional materials; printing of educational handouts; salaries for college students and residents conducting door-to-door education; cost of T-shirts, hats, and equipment for these individuals; preproject and postproject surveys; extra baiting materials; salaries of Rat Rubout Program employees; and the salaries of city officials and workers involved in various project activities such as meetings with community leaders and residents, field inspections, and cleanups. Consequently, citations and fines, which serve as disincentives for the current behavior patterns, may have to be issued more frequently to ensure a high level of compliance.

Even in the area with the worst infestation level (Zone 1), 79 percent of the properties were not initially infested. Residents in these properties were aware of which occupants on the block contributed to the problem. However, neither informed contacts nor city intervention made an obvious contribution to resolving the problem. No change was evident in the behavior of the small proportion of residents who engaged in practices such as placing trash in plastic bags without using other trash containers, housing pets outdoors in close proximity to exposed food, not cleaning up animal feces, illegally dumping, not clearing yard debris, and placing unsecured trash bags in collection sites several days prior to trash collection. These practices explain the modest success rates and, unfortunately, could entail a return to preintervention infestation rates.

The ability of the Zone 2 area to actually eradicate rats from the neighborhood suggests that the approach taken by this program may be effective in areas with relatively low infestation levels, where rat populations may be susceptible to chance extinctions if numbers are sufficiently reduced. Behavioral modification has always been recognized as a difficult, yet important, factor in influencing human health. The difficulty, coupled with the fact that just a few individuals resistant to changing their behaviors can support substantial rat populations and affect entire communities, makes the interventions problematic. The ability of urban areas to significantly affect overall rodent infestations with interventions of this type probably depends on the proportion of areas in which different socioeconomic conditions prevail.

Summary

The success of the projects described in this study appears to be due to direct government intervention, not to changes in the behavior of community members. Although the vast majority of community members were responsive to the educational messages and most properties did not support infestation, a portion of the community was unresponsive to education about the behavioral changes needed for successful, long-lasting rodent control. Nevertheless, education is and should be the foundation of rodent control projects like those conducted in Baltimore. To be successful, the educational effort must reach all residents and property owners in the project area. This effort must, at the least, include the following elements: door-to-door visits during day and evening hours to ensure that all residents are reached; sufficient time spent with all residents to gain their trust and induce them to accept the education; and contact by phone and mail with all absentee property owners to educate them about their responsibilities and gain their support and cooperation. Strong ongoing educational efforts, government extermination programs and support, and a consistent program of code enforcement will lead to rodent control or rodent elimination only if these strategies are coupled with behavioral changes on the part of residents.

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