Infectious Disease Exposures and Contact Tracing in Homeless Shelters

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Abstract

An outbreak among homeless shelter users of a communicable disease with a short generation time would pose serious public health challenges. Data from Toronto were used to examine the number of shelter residents potentially exposed in the event of such an outbreak. A shelter user had contact with a mean of 97 other residents (range, 1–292) in one day and a mean of 120 (range, 2–624) in eight days. After a single week, contact tracing becomes difficult due to the challenge of locating homeless people who have left the shelter system. Over an 8-day period, individuals who used more than one shelter had contact with an average of 98 more other shelter residents than those who stayed in a single shelter had. At the onset of a serious outbreak, it may be desirable to institute policies that strongly encourage individuals to remain at their current shelter for the duration of the outbreak.

Keywords

Homeless people; disease outbreaks; contact tracing

Homeless shelters are high-risk sites for infectious disease outbreaks, and the transmission of tuberculosis in this setting has been well-described.^{1,2,3} A communicable disease

outbreak with a shorter disease generation time than that of tuberculosis would pose novel public health challenges. In this study, we use shelter utilization data from Toronto to examine the number of homeless shelter residents potentially exposed and the feasibility of contact tracing in the event of such an outbreak.

Methods

We obtained Toronto's comprehensive database of all homeless shelter users in the city. The database included an identifier (the individual's first and last initials and date of birth), age, sex, shelter site, and dates of shelter admission and discharge. Because individuals with the same initials and date of birth shared the same identifier, a small number of identifiers were associated with simultaneous admissions to different shelters for more than one consecutive night. These identifiers were excluded from further analyses. Because homeless families tend to have longer shelter stays and move from shelter to shelter less frequently than homeless single people, contact tracing is less problematic for these families. We therefore restricted our analyses to the 84% of shelter users who were not accompanied by dependent children. These individuals stayed at 64 shelters with capacities ranging from 5 to 260 (median capacity, 50).

We studied all individuals who used shelters in February (2002), a time of year characterized by high utilization. For individuals who stayed in shelters for more than one day in February, one of those days was randomly selected. For each individual, we determined the number of other shelter residents that the individual came into contact with: (a) on that one day, (b) on that day and the preceding two days, and (c) on that day and the preceding seven days. These 1, 3, and 8-day periods were chosen to represent a clinically plausible range of hypothetical periods of infectivity. Based on the close proximity and mixing of residents at shelters, we considered every person staying at the same shelter on the same night as the individual to be a possible contact. We determined for these 1, 3, and 8-day periods the number of nights the individual spent in the shelter system, the number of different shelters used, and the maximum capacity of the shelter most often used. To examine the feasibility of contact tracing, we determined the number of shelter residents who had contact with the individual but were no longer residing in the shelter system on the last day of the 3-day or 8-day exposure period.

Linear regression models were developed in which the dependent variable was the number of other shelter users with whom each individual had contact. Independent variables were the individual's age, sex, and shelter utilization parameters as described above. The St. Michael's Hospital Research Ethics Board and the Institutional Review Board of the University of Utah School of Medicine approved this study.

Results

Our study included 4,565 individuals who used shelters in February 2002. Mean age was 37.6 years and 74% were men. Individuals had contact with a mean of 97 other shelter users (range, 1 to 292) over a 1-day period, and a mean of 120 other shelter users (range, 2 to 624) over an 8-day period (Table 1). At the end of the 8-day period, an average of 24 contacts

(range, 0 to 388) were no longer found in the shelter system. Multivariable regression models demonstrated that over a 8-day period, individuals who used more than one shelter had contact with an average of 98 additional shelter residents, compared with individuals who used only one shelter (Table 2).

Discussion

This study quantifies the magnitude of the public health challenge of controlling the spread of a communicable disease with a short generation time among homeless shelter users. After a single week, rapid contact tracing becomes difficult due to the challenge of locating homeless people who have left the shelter system. Although only a small proportion of shelter users stay at more than one shelter during a single week, this mobility significantly increases the number of potential contacts. At the onset of a serious outbreak, it may be desirable to institute policies that strongly encourage individuals to remain at their current shelter for the duration of the outbreak.

This study has certain limitations. We analyzed shelter data from a winter month; data from a warmer season might yield different results, such as fewer contacts and greater transience. An individual who reported different names or dates of birth at different shelters would be counted as multiple individuals in our database. We did not account for exposure of shelter staff or people outside the shelter system. Finally, our results do not apply to homeless families, who were excluded from these analyses.

This study provides data on the scale of the public health challenge if a communicable disease outbreak were to affect the homeless population of a large city. Given the time required to trace contacts in the homeless population, such a situation would place heavy demands on the human resources of public health agencies. Planning for future outbreaks should include the possibility of such a scenario.

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Notes

1. Centers for Disease Control and Prevention (CDC). Tuberculosis transmission in a homeless shelter population—New York, 2000–2003. *MMWR Morb Mortal Wkly Rep.* 2005; 54(6):149–52. [PubMed: 15716807]
2. McElroy PD, Southwick KL, Fortenberry ER, et al. Outbreak of tuberculosis among homeless persons coinfecting with human immunodeficiency virus. *Clin Infect Dis.* 2003; 36(10):1305–12. [PubMed: 12746777]

3. Prevention and control of tuberculosis among homeless persons. Recommendations of the Advisory Council for the Elimination of Tuberculosis. MMWR Recomm Rep. 1992; 41(RR-5):13–23. [PubMed: 1314323]

Table 1

CHARACTERISTICS OF 4,565 INDIVIDUAL HOMELESS SHELTER USERS IN TORONTO, AND THE NUMBER OF OTHER SHELTER USERS THAT EACH INDIVIDUAL HAD CONTACT WITH

Characteristic	Exposure interval		
	1 day	3 days	8 days
Number of shelters used			
1	4,565 (100%)	4,510 (99%)	4,400 (96%)
2	—	54 (1%)	155 (3%)
3 to 4	—	1 (.02%)	10 (0.2%)
Number of nights spent outside of shelter system			
0	4,565 (100%)	3,417 (75%)	2,601 (57%)
1	—	569 (12%)	148 (3%)
2	—	579 (13%)	146 (3%)
3 to 4	—	—	380 (8%)
5 to 7	—	—	1,290 (28%)
Number of other shelter users that the individual had contact with			
Mean ($\pm$ SD)	97 ($\pm$ 85)	105 ($\pm$ 92)	120 ($\pm$ 106)
Median	60	65	77
Range	1–292★	1–530	2–624
Number of other shelter users that the individual had contact with, who were not found in the shelter system★★			
Mean ($\pm$ SD)	—	9 ($\pm$ 15)	24 ($\pm$ 34)
Median	—	4	12
Range	—	0–277	0–388

★ Minimum of 1 occurred if the individual stayed at a small shelter that was not fully occupied, and maximum of 292 occurred if the individual stayed at a large shelter whose occupancy exceeded its stated capacity.

★★ On the last day of the 3-day or 8-day exposure interval.

Table 2

MULTIVARIABLE LINEAR REGRESSION MODELS OF THE NUMBER OF OTHER SHELTER USERS THAT AN INDIVIDUAL HAD CONTACT WITH

	Time frame					
	1 day		3 days		8 days	
	Parameter estimate (±SE)	p-value	Parameter estimate (±SE)	p-value	Parameter estimate (±SE)	p-value
Age ^a	0.05 (±0.02)	.02	0.05 (±0.02)	.05	0.03 (±0.03)	.46
Sex ^b	6.5 (±0.7)	<.0001	7.9 (±0.8)	<.0001	11.3 (±1.1)	<.0001
Number of nights spent in the shelter system ^c	—	—	2.8 (±0.4)	<.0001	3.4 (±0.2)	<.0001
Bed capacity of the shelter most often used ^d	1.0 (±0.004)	<.0001	1.1 (±0.004)	<.0001	1.2 (±0.006)	<.0001
Use of >1 shelter ^e	—	—	79.1 (±2.9)	<.0001	97.6 (±2.4)	<.0001
Model R-square	0.95		0.95		0.92	

^aNumber of contacts associated with each additional year of age.

^bNumber of contacts associated with male sex (compared to female sex).

^cNumber of contacts associated with each additional night.

^dNumber of contacts associated with each additional bed.

^eNumber of contacts associated with use of >1 shelter (compared to use of a single shelter).