Appendix D

Tasks That May be Involved in Investigating Epidemics

APPENDIX D

TASKS THAT MAY BE INVOLVED IN INVESTIGATING EPIDEMICS

A. Determine the existence of an epidemic.

1. Identify level of current transmission requiring investigation.

   a. Establish criteria for initiating investigation.
   b. Apply criteria for initiating investigation.

2. Verify or establish diagnosis for all known and suspected cases.

   a. Establish criteria by which cases will be identified and/or classified for the purposes of analyses - definite, possible, suspect.
   b. Confirm that for all cases:

      1) Clinical examinations have been performed.
      2) Etiologic agents have or have not been identified.
      3) Appropriate diagnostic tests have been or are being performed.
      4) Case criteria have been met.

3. Perform a quick case count.

   a. Determine information to be acquired and source of infection.
   b. Contact the sources and obtain the necessary information.

4. Define high-risk groups.

   a. Determine distribution of cases (using criteria established by time, place, and person).
   b. Identify population from which cases come.
   c. Calculate incidence rates.

5. Determine if current incidence represents an epidemic or other situation requiring further investigation.

B. Characterize the epidemic.

1. Determine data needed to characterize the epidemic (with or without the benefit of a diagnosis) by time, place, and person.

   a. Select variables to characterize persons affected (e.g., age, sex, race, occupation, etc.).
   b. Select variables to identify place of exposure (e.g., home, school, place of work, hospital, etc.).
   c. Determine time of onset of illness of all cases.

d. Obtain case investigation form. Identify information needed and:

1) Select appropriate form, or
2) Develop appropriate form.

e. Develop procedures for data acquisition.

2. Obtain data.

a. Intensify existing, and/or implement new, appropriate surveillance techniques.
b. Interview physicians, cases, and contacts.

3. Collate data.

a. Identify criteria (including intervals) for grouping data by time, place, and person.
b. Calculate rates, ratios, and proportions.
c. Prepare tables, graphs, and charts.

4. Analyze and interpret data.

a. Identify high-risk groups in terms of time, place, and person.
b. Interpret epidemic curve to determine:

1) source (common, propagated).
2) probable time of exposure of cases to common source.

c. Identify periods of exposure.
d. Identify incubation periods.
e. Select the most probable source and mode of transmission.

C. Formulate hypothesis as to the source and mode of transmission.

D. Test hypothesis.

E. Recommend and/or implement control measures.

F. Prepare and distribute epidemic report.

1. Summarize all relevant data obtained, methods of collection, analyses performed, and interpretations derived.
2. Describe preventive and control measures implemented.
3. Describe effectiveness of control measures.
4. Describe other impacts relevant to prevention and control.
5. Make recommendations regarding future surveillance and control.
6. Distribute report to others in disease control programs.

G. Assess investigative procedures.

Exercise in Investigative Techniques

EXERCISE IN INVESTIGATIVE TECHNIQUES

In this exercise the various investigative techniques discussed in the preceeding reference will be applied to the investigation of an outbreak of a disease in an urban area. The investigation will proceed in a step-by-step fashion, as outlined in the introduction, and at each step the appropriate techniques, etc., will be applied. The general format of the exercise will be that for each step of the investigation: (1) selected information will be provided, (2) one or more questions will be posed for solution, and (3) the answers to the questions will be provided. You should attempt to answer the questions before looking at the answers provided. While working on this exercise it will be helpful to have available for reference a copy of Control of Communicable Diseases in Man (APHA) or a similar reference.

For the purposes of this exercise we shall assume that this outbreak occurred in your area of jurisdiction, that you are the one responsible for epidemiologic practice in your jurisdiction, and that among your strong points are a high level of intellectual curiosity, self-motivation and tenacity. You also like to deal with other people, and statistics turns you on.

Step 1. Establish or verify the diagnosis

A. Given:
During the month of July you receive notice from a private physician of the occurrence of 7 cases of an as yet undiagnosed disease. She is reporting them to you since the clinical appearance of each of the cases is similar and appears to be the result of an infection. She also indicated her willingness to cooperate in an investigation if you think one is indicated.

B. Question:

What kind of response is appropriate for this situation?

C. Answers:

1. In most health jurisdictions the investigation of a group of cases having an apparently similar disease, occurring in a short span of time, would be perfectly appropriate.

2. The investigation at this point should focus on two things: (1) establishing a diagnosis, preferably with laboratory confirmation, and (2) identifying additional unreported cases. To do the latter would require the characterization of signs and symptoms of the 7 known cases. Contacts should then be made with other medical practitioners in the area to discuss the nature of the illness, inquire about other possible cases under their care and encourage prompt reporting of any possible cases which come to their attention. As part of this search you would contact among other sources, the known cases' family and other contacts and associates.

Steps 2 and 3. Confirm the existence of an outbreak and characterize the cases.

A. Given:

In the following weeks a diagnosis is established (Q fever) and a total of 50 laboratory-confirmed cases are identified. For each of these cases you have name, address (census tract number), age, sex, date of onset, and occupation (Table 1). You also have obtained selected demographic information (Tables 2, 3, & 4) and a map (Figure 1). You have also reviewed annual morbidity summaries and abstracted the appropriate information for review (Table 5).

B. Questions:

Using the information provided,

(a) determine whether an epidemic exists, and
(b) characterize the cases by time, place, and person

Table 1

Selected Characteristics of Persons Having Q-fever Antibodies (>1:8), Sample City, March Through September, 1975

No.	Name	Residence (Census Tract)	Age	Sex	Onset	Occupation
1	A.D.	3	26	M	18 Mar	Truck Driver
2	F.M.	31	47	M	21 Mar	Rancher
3	L.D.	11	32	M	30 Apr	Steel Sales
4	E.M.	2	52	M	1 May	Bartender
5	A.L.	9	43	M	3 May	Tr. Mfg. Worker
6	E.A.	9	48	M	4 May	Mechanic
7	J.P.	11	45	M	4 May	Supt., Mfg.
8	E.B.	3	39	M	8 May	Mfg. Worker
9	J.C.	7	58	M	8 May	Insurance Sales
10	F.C.	11	49	M	9 May	Presser, New Clothing
11	C.H.	19	67	M	10 May	Retired
12	J.H.	20	50	M	11 May	Clerk, Personnel
13	M.C.	2	45	F	16 May	Clerk, Employment
14	M.F.	3	53	M	17 May	Clerk, Court
15	F.M.	7	59	M	17 May	Concrete Sales
16	R.S.	9	41	M	17 May	Mgr., Collection Agency
17	L.W.	10	33	M	18 May	Orderly, Hosp.
18	W.F.	11	35	M	20 May	Physician
19	L.R.	11	37	F	20 May	Sewing Mach. Sales
20	F.M.	21	44	M	21 May	Janitor
21	R.S.	3	43	M	27 May	Bartender
22	A.V.	10	53	M	28 May	Unemployed
23	R.A.	3	53	M	29 May	Supervisor, Trucking
24	W.M.	11	60	M	1 Jun	Retired
25	M.H.	20	57	M	2 Jun	Contractor, Drainage
26	M.W.	22	53	M	4 Jun	Repair Worker
27	W.H.	21	61	M	5 Jun	Physician
28	A.C.	2	43	M	12 Jun	Engineer, Chemical
29	T.B.	7	29	M	14 Jun	Laborer, Inactive
30	H.C.	9	66	M	14 Jun	Retired
31	R.O.	9	50	M	14 Jun	Music Sales
32	R.P.	11	65	M	16 Jun	Retired
33	J.B.	20	58	M	17 Jun	Supervisor, Carpentry
34	D.W.	3	41	M	20 Jun	Laborer, Farm
35	A.N.	2	61	M	26 Jun	Freight Rep.
36	D.G.	3	37	M	27 Jun	Mail Handler
37	D.B.	9	19	M	30 Jun	Laborer, Carpentry
38	F.D.	11	65	F	1 Jul	Homemaker

(Continued)

Table 1 (continued)

No.	Name	Residence (Census Tract)	Age	Sex	Onset	Occupation
39	O.U.	11	45	M	1 Jul	Janitor
40	S.B.	9	57	F	2 Jul	Counter Worker Laundry
41	H.S.	10	42	M	3 Jul	Garage Worker
42	C.S.	11	59	M	10 Jul	Fruit Salesperson
43	G.P.	11	53	M	2 Aug	Chive Grower
44	D.C.	20	50	M	4 Aug	Sanitarian
45	G.M.	2	46	F	10 Aug	Homemaker
46	L.A.	3	39	F	11 Aug	Inspector, Cannery
47	I.W.	11	55	F	Unk.	Paper Products Worker
48	F.L.	3	21	F	6 Sep	Student
49	L.B.	11	21	F	Unk.	Homemaker
50	T.M.	21	59	M	Unk.	Executive Dairy

Table 2

Population of Selected Census Tracts in Sample City, 1970

Census Tract*	Population	Census Tract	Population
2 - M	1,927	19 - M	1,518
3 - L	2,856	20 - M	1,232
7 - L	882	21 - U	2,607
9 - M	2,846	22 - U	4,706
10 - U	1,988	31 - M	5,038
11 - U	2,735	TOTAL	28,335

*U = Upper socioeconomic level
M = Middle socioeconomic level
L = Lower socioeconomic level

Table 3

Population, by Age Group and Sex,
Sample City, 1970

Age Group (years)	Population Total	Population, by Sex	
		Male	Female
0 - 4	15,779	7,939	7,840
5 - 14	24,151	12,084	12,067
15 - 24	17,995	8,102	9,893
25 - 39	25,503	11,817	13,686
40 - 64	26,842	12,380	14,462
65+	6,509	2,382	4,127
TOTAL	116,779	54,704	62,075

Table 4

Population by Race and by Socioeconomic Level,
Sample City, 1970

Variable	Population
1. Socioeconomic level	
a. Upper	19,922
b. Middle	31,561
c. Lower	65,296
Total	116,779
2. Race	
a. White	85,232
b. All other	31,547
Total	116,779

Figure 1
Sample City
Census Tracts--1970

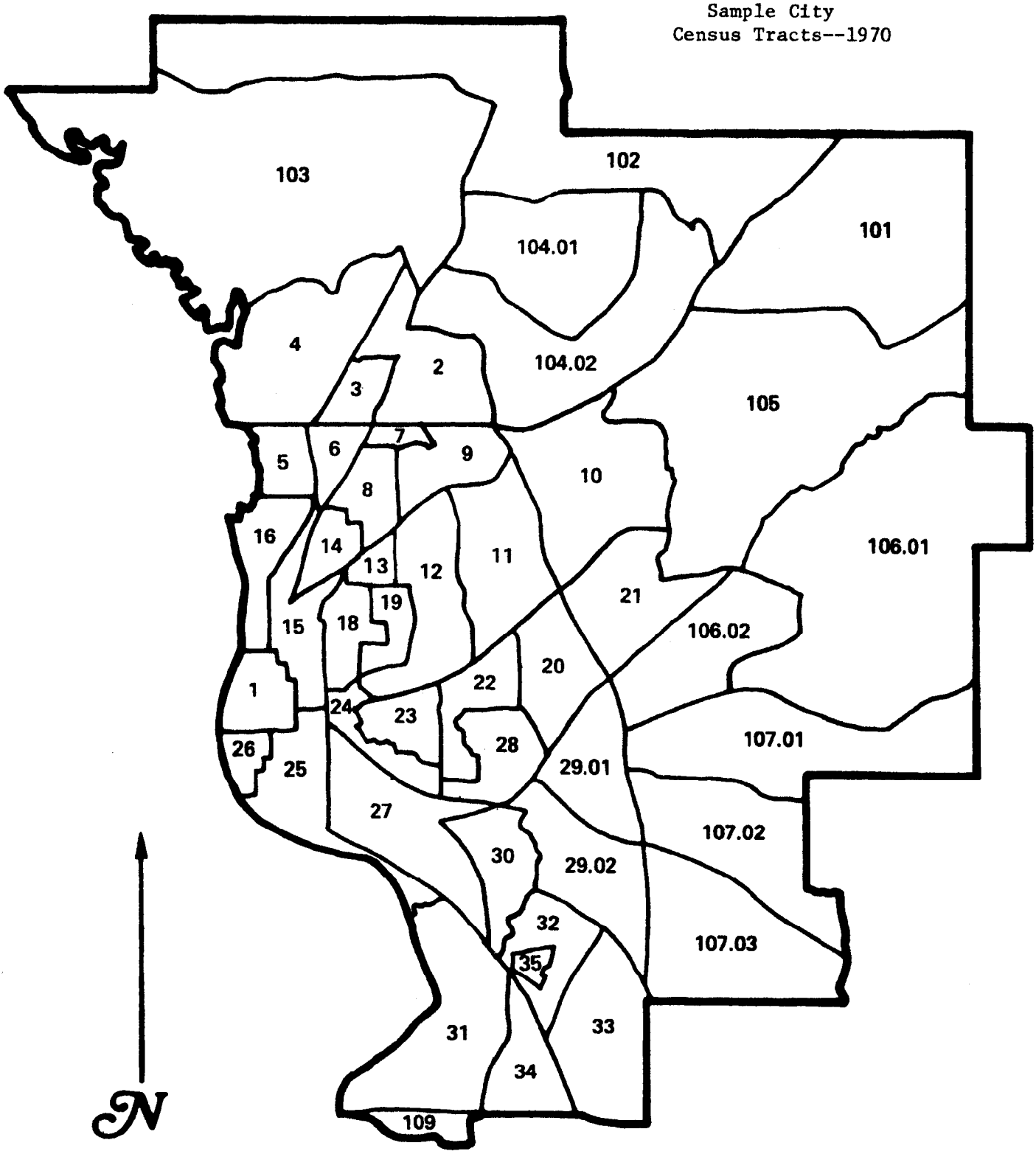


Table 5

Annual Number of Reported Cases of Q-fever,
Sample City, 1965-1974

Year	1965	'66	'67	'68	'69	'70	'71	'72	'73	'74	10-Year	
											Mean	Median
Number of Cases	9	0	3	7	4	1	6	13	2	3	4.8	3.5

C. **Answers:**

1. During the seven-month period of March through September, 1975, 50 cases of Q-fever were identified in Sample City. As can be seen in Table 5, the average annual incidence of Q-fever in Sample City is 4.8, and the median is 3.5. By almost any criterion, the current incidence exceeds the usual incidence by an amount sufficient to label the current incidence an outbreak.

2. The outbreak is characterized by time, place and person in the tables, graphs and charts which follow. Subsequent to the characterization of an outbreak, the data must be analyzed in order to establish a hypothesis. The analysis must be restricted to the identification of the important points that can be observed in or derived from the data used to characterize the outbreak.

Reported Cases of Q-fever, and Attack Rates
per 100,000 Population, Sample City,
March Through September, 1975

Table A
By Age-Group and Sex

Age Group (years)	Male		Female		Total	
	Cases	Rate	Cases	Rate	Cases	Rate
0- 4	0	0.0	0	0.0	0	0.0
5-14	0	0.0	0	0.0	0	0.0
15-24	1	12.3	2	20.2	3	16.7
25-39	7	59.2	2	14.6	9	35.3
40-64	30	242.3	4	27.7	34	126.7
65+	3	125.9	1	24.2	4	61.5
TOTAL	41	74.9	9	14.5	50	42.8

Ratios of rates: (1) Age group 40-64:All other age groups combined = 126.7:17.8 = 7.1:1
(2) Male:Female = 74.9:14.5 = 5.2:1

Table B
By Socioeconomic level

Socioeconomic Level	Number of Cases	Rate
Upper	20	100.4
Middle	18	57.0
Lower	12	18.4
TOTAL	50	42.8

Ratio of A.R.'s = U:M:L =
100.4:57.0:18.4 = 5.5:3.1:1

Table C
By Race

Race	Number of Cases	Rate
White	38	44.6
All other	12	38.0
TOTAL	50	42.8

Ratio of rates = White:All others =
44.6:38.0 = 1.2:1

Table D
By Month of Onset

Month	Number of Cases	Rate*
March	2	1.7
April	1	0.9
May	20	17.1
June	14	12.0
July	5	4.3
Aug.	5	4.3
Sept.	3	2.6
TOTAL	50	42.8

*Based on total city population.

Table E
By Census Tract

Census Tract	Number of Cases	Rate*
2	5	259.5
3	9	315.1
7	3	350.1
9	7	246.0
10	3	150.9
11	13	475.3
19	1	65.9
20	4	324.7
21	3	115.1
22	1	21.2
31	1	19.8
TOTAL	50	176.5

*Based on population of specific tract affected.

Table F
Number of Cases and Percent Distribution by Occupation

Occupation	Number	Percent	Cumulative Percent
1. Sales	6	12	12
2. Service	6	12	24
3. Retired/unemployed	6	12	36
4. Manufacturing	5	10	46
5. Laborer	5	10	56
6. Farming/Ranching	4	8	64
7. Professional	4	8	72
8. Transportation	3	6	78
9. Clerical	3	6	84
10. Homemaker	3	6	90
11. Others	5	10	100
TOTAL	50	100	---

Figure 2

Laboratory Confirmed Cases of Q-Fever, by Week
of Onset of Illness, Sample City, March--September, 1975

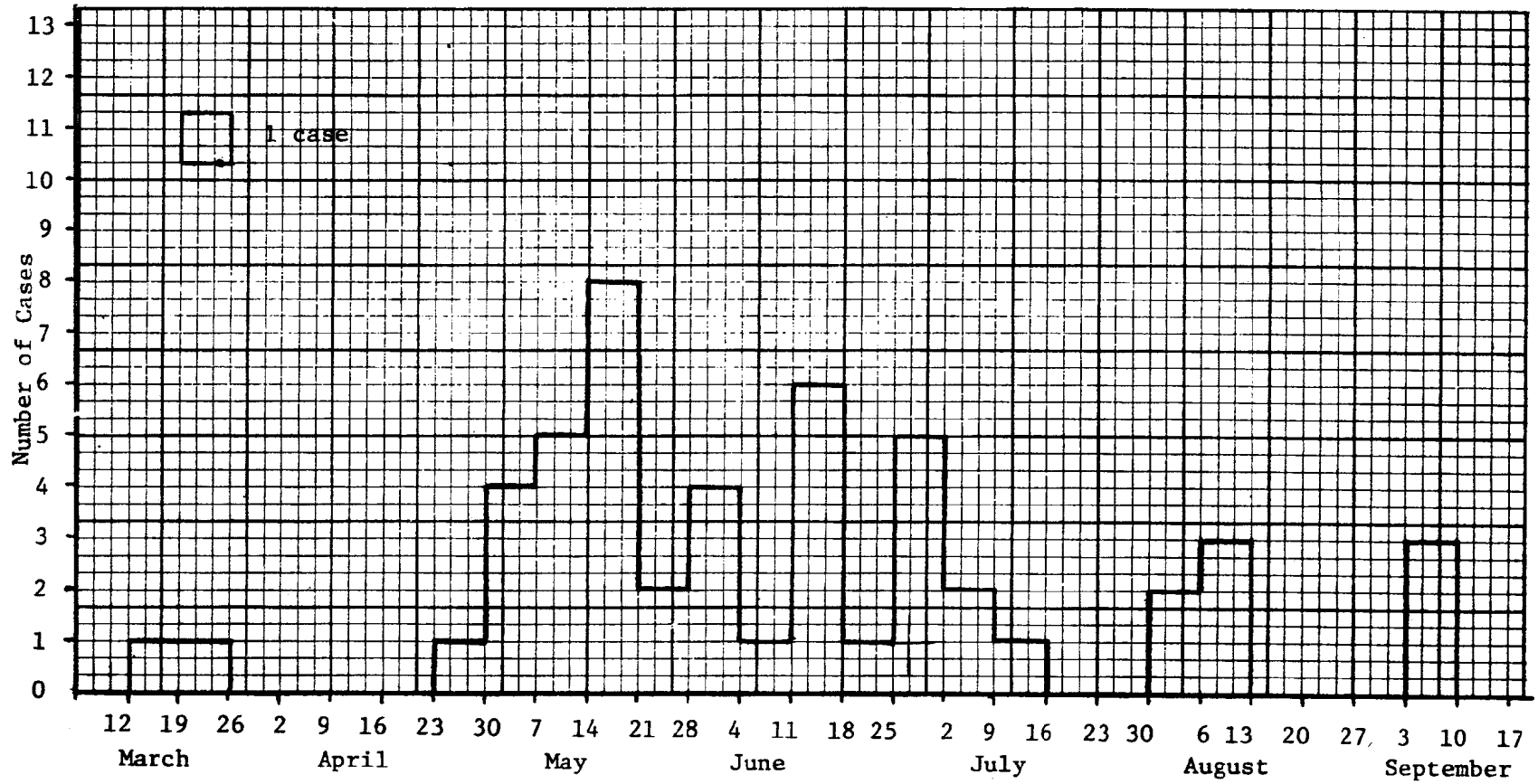
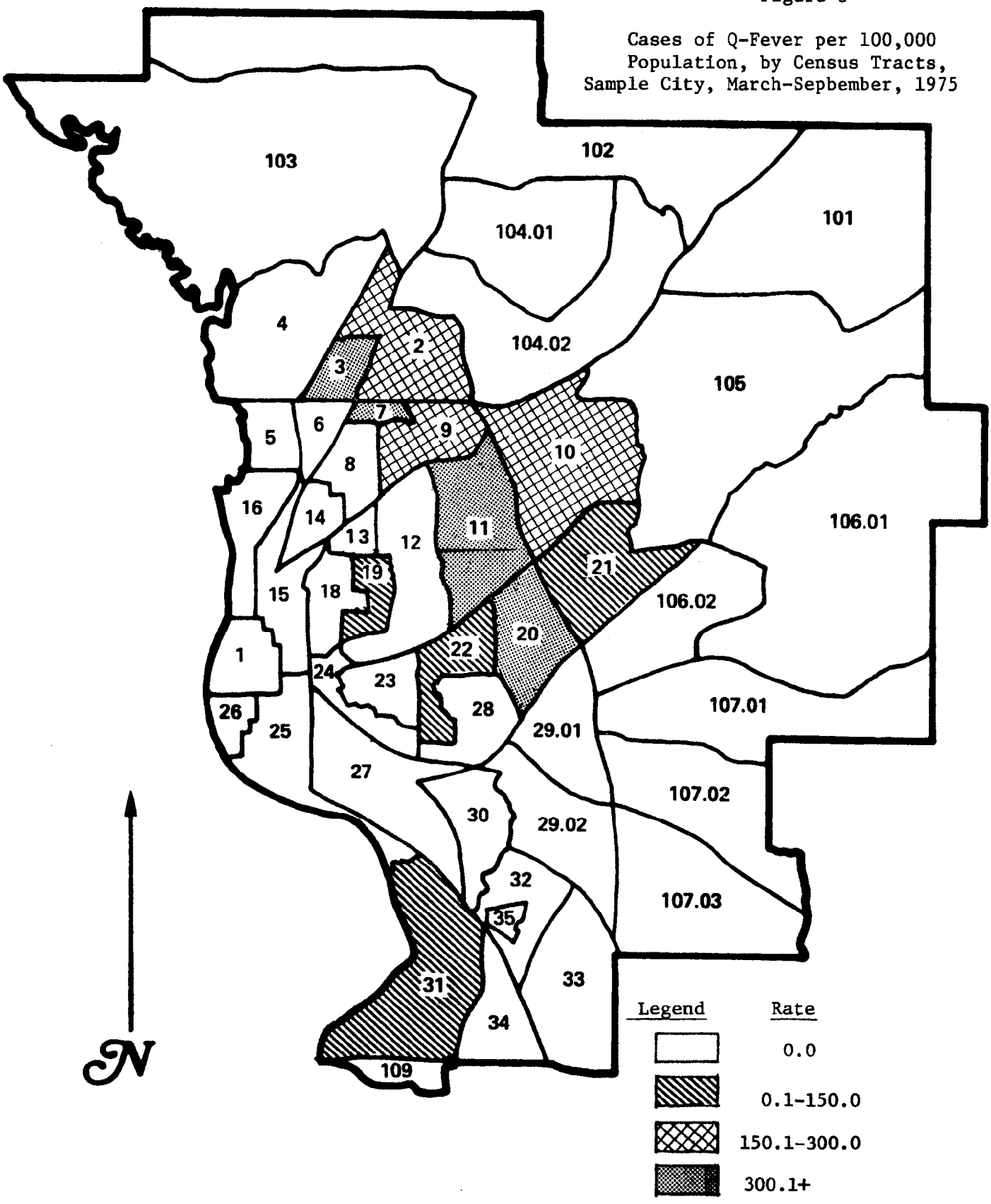


Figure 3

Cases of Q-Fever per 100,000 Population, by Census Tracts, Sample City, March-Sepbember, 1975



Analysis of the Data

1. Age-group and sex (Table A). The 50 confirmed cases yielded an overall attack rate of 42.8/100,000. The age-group having the highest attack rate, 126.7 (7.1 times greater than the other combined age groups) was the 40-64 year-olds. The next highest attack rate, 61.5, was in the 65+ age-group. In other age groups the attack rates tended to decrease with decreasing age, and there were no cases under 15 years old. The attack rate in males, 74.9, was 5.2 times greater than the attack rate in females (14.5). The greatest difference in age and sex-specific attack rates (AR's) was in males and females in the 40-64 year age group, where the male rate was 8.7 times the female rate.

2. Socioeconomic level of the cases (Table B). The AR in the upper socioeconomic level (100.4) was 5.5 times greater, and the AR in the middle socioeconomic area (57.0) was 3.1 times geater than the AR in the lower socioeconomic level (18.4).

3. Race (Table C). There were 38 cases that were white and a total of 12 cases of all other races combined, giving attack rates of 44.6 and 38.0 respectively. The risk of acquiring Q fever was 1.2 times greater among whites than all other races combined.

4. Occupation (Table F). The cases of Q-fever do not occur with any exceptional frequency in any of the various occupational groups, but instead are highly diverse. The Farming/Ranching group contains only 8% of the cases, and ranks 6th in the list. There are no cases among occupational groups having an obvious relationship with potentially infected animals.

5. Time of onset (Table D and Figure 2). The outbreak began in March with two cases, quickly peaked in May, with 20 cases occurring in that month, and declined slowly over the next 4 months, with a total of 27 cases occurring during that period. The duration of the epidemic was 26 weeks. Since Q-fever has an incubation period of 2 to 3 weeks it would appear that while a source of infection existed from about late February through the middle of August, most of the cases were exposed between the middle of April and early June.

6. Place (Table E and Figure 3). The census tracts that were most affected were numbers, 2, 3, 7, 9, 10, 11, 20 and 21, accounting for all but 3 cases. These census tracts are located approximately along a line running Northwest to Southeast through the geographic middle of the city. The census tracts having the highest AR's (3, 7, 11, and 20) all lie along this line. The most lightly affected tracts (19, 21, 22 and 31) do not form an obvious pattern. There are large geographic areas within the city - primarily in the North, Northeast, Southeast, and West Central where there were no cases.

Step 4: Identify the source of infection and the mode of transmission.

A. Given:

The information contained in the characterization of the cases and in the data analysis.

B. Question:

1. What hypotheses could be formulated to explain the data? Which of these best accounts for the known occurrence and distribution of cases? Why?

2. How would you test your preferred hypothesis?

C. Answers:

1. The preferred hypothesis is as follows:

This is a common source outbreak in which air was continuously or intermittently contaminated with C. burnetii, during the 6-month period from the middle of February to the middle of August, 1975, resulting in the exposure of the general population that lived or worked in the particular part of the city lying downwind from a source of contamination.

Four alternate hypotheses could be formed, but they are less satisfactory for various reasons:

-- This is an outbreak resulting from exposure of persons who visited a site at which one or more infected animals were present (e.g., zoo, farm, dairy, stockshow).

It is unlikely, however, that such persons would come from just one part of the city. If this hypothesis were true, the cases almost certainly would be distributed over a much larger area.

-- This is a tickborne outbreak of Q-fever in which the cases were exposed at one or more geographic areas during the six-month period of February through August, 1975.

This hypothesis suffers the same defect as the preceeding one.

-- This is a milkborne outbreak of Q-fever in which the cases were exposed to milk intermittently or continuously contaminated with C. burnetii during the 6-month period beginning in February 1975, and lasting through August of that year.

Again we have the problem of the cases not being generally distributed throughout the city. There also is a problem of the lack of known cases in the younger age groups, which would be expected to be exposed if milk were the vehicle of infection.

-- This is an airborne outbreak of Q-fever in which the source of contamination was infected animals being transported through or near that part of the city where the cases occurred, during the 6-month period from mid-February to mid-August, 1975.

Although there is no specific evidence available to rule out this possibility, it is less likely than the preferred hypothesis since the transportation route would have had to pass through a large area in the upper socioeconomic area of the city. While this is not impossible, it is unlikely.

2. Hypothesis testing.

a. In order to accept our preferred hypothesis as true, information would have to be obtained that resulted in:

(1) The identification of potential sources of contamination (herds, zoos, abbatoirs, rendering plants, etc.) which were located upwind from the cases during the period of exposure.

(2) The finding that C. burnetii was present at one or more of the potential sources or could have been present during the suspect period of time.

(3) The identification of a means by which the air-borne spread of C. burnetii organisms occurred.

(4) Ruling out any other possible source as being the (or one of the) actual source (or sources). Accomplishing this should include testing other reasonable hypotheses and finding them to be not true.

b. The other hypotheses specified could be tested as follows:

(1) Hypothesis that cases visited a place at which there were sources of infection. This could be checked by interviewing cases to determine whether or not they had any animal (cattle, sheep or goats) exposure from one to four weeks prior to the onset of their illness; and then demonstrate that the animal(s) was (were) or could have been infective at the time of exposure.

(2) Hypothesis that the cases resulted from tick bites. Two things must be demonstrated here, exposure of the cases to ticks, and that the ticks - or others from the same source - are infective.

(3) Hypothesis that the agent was milkborne. This requires determining whether the cases were exposed to possibly contaminated milk one to four weeks prior to their illness; identifying the source of the milk, determining whether there were any Q-fever infections among the animals

from which the milk came; and determining if the milk was consumed raw or, if not, whether any of the milk pasturization equipment was known to be malfunctioning.

(4) Hypothesis that the source was infected animals transported through the area in which cases are located. It would have to be demonstrated that animals were transported through or near the affected area during the suspected period of exposure and that these animals either were infected or could have been infected; or that the transporting vehicle was contaminated.

c. The use of control groups. For each of the preceding tests involving the demonstration that cases were or could have been exposed to any or all of the potential sources it is necessary to select an appropriate control group and demonstrate that the control group--not having been exposed to the potential source--had a significantly lower attack rate than did the exposed group.

Early in the investigation serologic studies were performed on employees working in the two slaughter houses and single rendering plant located in the city. The slaughter houses were located in the southern portion of the city while the rendering plant was located in census tract 4 near census tract 3. The results of the serologic studies were essentially negative, which lead the investigators to consider other sources of C. burnetti to explain the epidemic. While a case investigation was being conducted with one of the last cases to occur, it was found that many of the case's co-workers were suffering from what was described as "flu". The individual worked in a plant just downwind from the rendering plant. Subsequent serologic studies performed on symptomatic employees of the plant revealed that the infections were not "flu" but rather Q-fever. The investigators then returned to the rendering plant and gathered further information which indicated that C. burnetii organisms were probably carried by the prevailing winds from the rendering plant downwind over a distance of approximately seven and one-half miles.

Step 5: Identify populations that are at an elevated risk of infection.

A. Given:

That the preferred hypothesis in step 4 is true.

B. Question:

What are the characteristics of those persons who are at an elevated risk of acquiring a fever?

C. Answer:

Persons at high risk of acquiring Q-fever are primarily those who:

1. Live, work, or for some other reason spent time in the area downwind from the rendering plant during the period from February - August, 1975.

2. Are over 15 years of age, of either sex, but particularly males over 25 years of age.

3. Are in the upper and middle socioeconomic levels.

Step 6: Implement control measures.

A. Given:

All the information previously presented in this problem

B. Question:

What control measures should be implemented?

C. Answers:

1. Identify the herds from which the infected animals came and implement measures which prevent transmission of C. burnetii.

2. Ensure that the rendering plant does not emit C. burnetii into the air.

3. Ensure that infected individuals receive proper medical care.

4. Publicize the outbreak - among the general public and medical practitioners - to improve the recognition and reporting of new cases should they arise.

DHHS:PHS:CDC:TLPO
Division of Training

(FOR TRAINING PURPOSES ONLY)

U.S. GOVERNMENT PRINTING OFFICE: 1995 - 633-127/20001

34T616258708