

AN EPIDEMIOLOGICAL STUDY OF A RURAL OUTBREAK OF WHOOPING COUGH¹

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THE need for epidemiological studies of whooping cough is well recognized.² The studies so far made have been confined largely to records of reported cases and thus are incomplete for the reason that only a small proportion of the cases are ordinarily reported to the health department. In this study a somewhat new method of approach was attempted, namely, an intensive observation of cases as they developed in a strictly rural population where an accurate record could be made not only of the complete incidence of cases, but also of persons coming into contact with these cases in various ways. Because of the small number of cases involved, it is realized that the statistical results are of limited significance. However, as an experiment in epidemiological methods of observation it is not without interest.

The outbreak took place during January and February, 1931, in a rural area of about three square miles in Cattaraugus County, New York. Thirty-one families, containing 110 persons, resided in this area which roughly comprised a single school district. It was essentially a typical rural neighborhood of western New York. Eleven of the thirty-one families

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This is the first of a series of studies of whooping cough and other communicable diseases in Cattaraugus County. Another outbreak of whooping cough was under observation late in 1931 and will be reported upon in a later paper.

²Godfrey, E. S., M.D.: *Epidemiology of Whooping Cough*. *New York State Journal of Medicine*, December 1, 1928, xlviii, pp. 1410-1415.

constituted a small hamlet which was the social and trading center for this school district as well as for an adjoining school district. In the hamlet were the school, a church, a garage, and a general store. The principal industry was dairying, most of the farms being operated by the owners. Several families accommodated tourists, but during January and February there was little travel. One man worked on a railroad, three drove milk-collecting trucks, and several worked in near-by milk-collecting plants. The economic condition of the neighborhood was not out of the ordinary, six of the families being regarded as in good economic condition, fourteen as fair, ten as poor, and one as very poor. Figure 1 indicates the location of the households, church, store, and school in relation to the highway and local roads.

The outbreak was well limited both geographically and chronologically. The first case was introduced on January 5th. Subsequent to this and prior to the recovery of all cases of whooping cough, fifty-nine persons developed respiratory symptoms involving cough. Forty-nine of these fell into the group of common colds. Ten cases of whooping cough developed in the area during January and February and since then none to the present writing, November 1, 1931.

Method of Observation. The case imported on January 5th was discovered on January 14th, and on that day investigation was begun in order to observe closely the possible development of subsequent cases. The method of the study was to visit every family in the entire area every two weeks, and to obtain as accurate information as possible relative to current respiratory attacks of every variety; to get a record of all contacts with the general public at neighborhood gatherings, such as took place at the Grange, Ladies Aid, the general store, the church, or the school; and to discover current exposure to persons with whooping cough or any other respira-

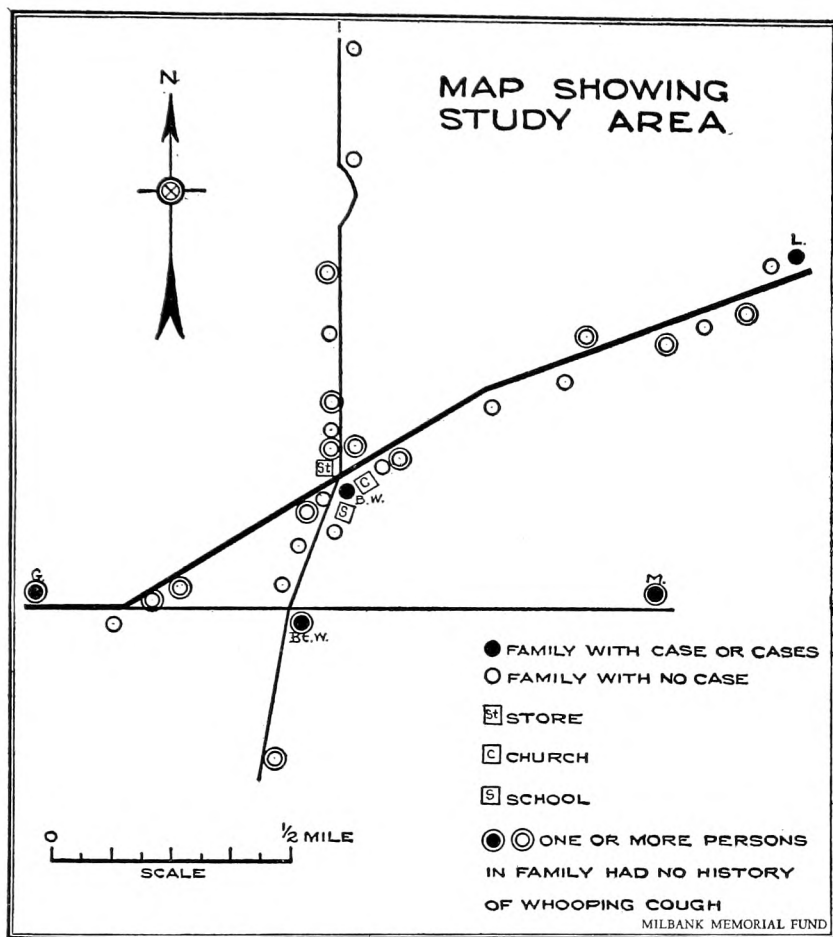


Fig. 1. Area of whooping cough outbreak in rural Cattaraugus County, December 25, 1930 to February 28, 1931.

tory disorder. This information was recorded for each individual on sheets headed, "contact with disease diagnosed as whooping cough," "contact with undiagnosed upper respiratory infections," "contact with neighborhood public," and "contact with public out of the neighborhood." At the first visit a census of every household was taken.

In order to determine as completely as possible the total incidence of the disease, careful observation was instituted

whenever any respiratory symptom appeared and was maintained until the termination of the disorder, a narrative being kept for each person under the heading, "history of illness." Especial watch was kept for symptoms of differential value, such as prolonged coughing, truly paroxysmal coughing or sneezing, vomiting, croupy cough, and whooping. Coughing and sneezing were considered truly paroxysmal when several coughs or sneezes occurred on a single expiration. For persons with whooping cough a narrative was kept headed, "persons with whom individual is known to have had contact."

Experience in tentative investigations of the same character in other areas in Cattaraugus County had shown that the proportion of apparently atypical cases found in an outbreak was less when the interval between the investigational visits was shorter. When much time had elapsed, the parents would occasionally forget even such striking manifestations as whooping or vomiting until it was recalled to their minds.³

It became evident in the present experience that when the elapsed time was more than a week, significant details were forgotten and dates confused. Beginning on March 4th, therefore, the visits were made weekly. At this interval observation of contacts and of the prevalence of respiratory disease was satisfactory. Weekly visits were continued until six weeks after the onset of the last suspicious cough. Thereafter for two months coughing convalescents and all persons reported never to have had the disease were observed.

Results of Observation. The chronology and extent of the outbreak may be summarized as follows: the first or imported case, B.W., age 5, onset January 5th, and the next two cases, C.W., age 5, and E.W., age 9, whose onsets were January 9th and 10th, respectively, were all exposed to one

³Dr. Luttinger mentions this same point. Luttinger, P., M.D.: *The Epidemiology of Pertussis. American Journal of Diseases of Children*, September, 1916, xii, pp. 290-315.

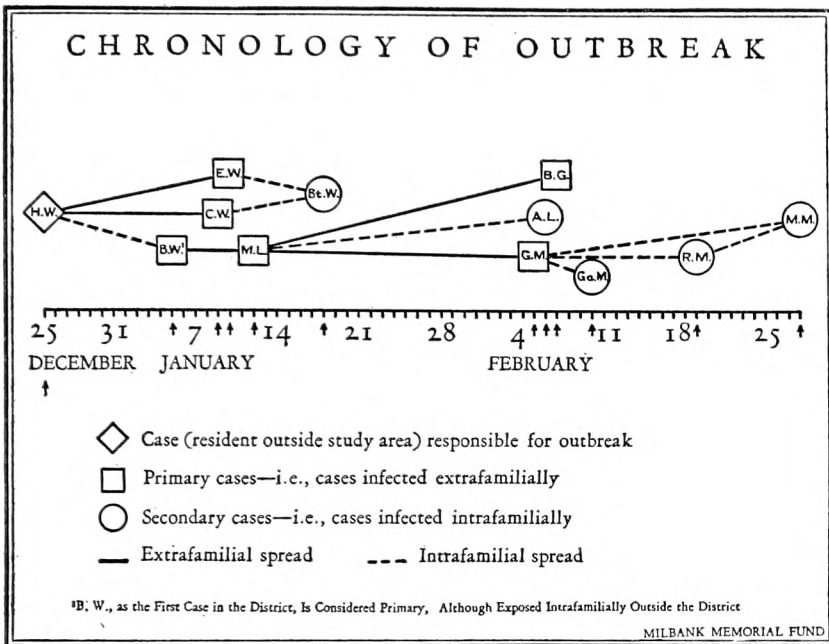


Fig. 2. Date of onset and mode of contact of each case of whooping cough in an outbreak in a rural area of Cattaraugus County, December 25, 1930 to February 28, 1931.

H.W., age 6, brother of B.W., and nephew of C.W. and E.W., the exposure being familial for B.W., and extrafamilial for E.W. and C.W. in their own home. Bt.W., age 53, whose onset was January 18th, was the father of E.W. and C.W., and was exposed familiarly to them. At school, M.L., age 9, was exposed daily to B.W., and began to cough on January 12th. She familiarly exposed her mother A.L., age 25, whose onset was February 6th. At school M.L. also exposed G.M., age 12, whose cough was dated by his mother from February 5th, and B.G., age 6, whose onset was February 7th. In his family, G.M. exposed Ga.M., age 7, a brother who had no other exposure and whose onset was February 10th. In the same family, R.M., age 5, was exposed to both G.M. and Ga.M., and began to cough on February 19th.

NUMBER OF PERSONS IN FAMILY	NUMBER OF FAMILIES	NUMBER OF FAMILIES ATTACKED	PER CENT OF FAMILIES ATTACKED
<i>Total</i>	31	5	16.0
1	1	0 }	10.0
2	9	1 }	
3	7	1	14.0
4	6	1	17.0
5	5	1	20.0
6	2	0 }	33.0
9	1	1 }	

Table 1. Per cent of families in which whooping cough cases occurred, by size of family.

A sister of these three, M.M., age 8, was exposed to all of them and developed symptoms on February 28th. This was the last case in the neighborhood. (Figure 2.)

Of the thirty-one families, five were definitely attacked by the disease. The geographical distribution is shown in Figure 1, and the distribution according to size of family in Table 1.

In the five attacked families there were twenty-three persons. Six of the eleven cases, including the initial case in the neighborhood, were primary cases, leaving seventeen persons, among whom five secondary attacks occurred, or a gross secondary attack rate of 29 per cent. The distribution of cases and attack rates by age groups was as shown in Table 2.

This age incidence of whooping cough is unusual, since ordinarily the highest rate is among children under five years,⁴ but this experience may be regarded as not unlikely in small population groups and in sparsely settled areas. In this outbreak, four of the eight children under the age of five

⁴Sydenstricker, Edgar: Hagerstown Morbidity Studies No. VIII, The Incidence of Various Diseases According to Age. *Public Health Reports*, May 11, 1928, xliii, pp. 1124-1156.

years were not exposed at all. One was exposed to a patient whose onset was more than eight weeks previous. Two had play contact in the home on a single occasion with a patient

Table 2. Age incidence of cases.

Age Groups	Number of Persons	Cases	Per Cent of Persons Attacked
All ages	110	11	10.0
0-4	8	0	0.0
5-19	28	9	32.0
20 and over	74	2	2.7

in the first week of illness, and one played at home and in the store on five days with patients in the first week of disease. No child under five had familial⁵ exposure.

Among the factors involved in the spread of this disease in a population, three seem to be of principal importance: (1) Infectiousness of the cases, especially at different stages; (2) susceptibility of the population; (3) contact of susceptible persons with patients in an infectious stage.

Although these factors cannot be regarded as operating independently, it will be easier to summarize the evidence bearing on each before considering them together.

Whooping cough is thought to be most infectious in its earliest stages,⁶ and it is in the first weeks of its course that *Hemophilus pertussis* is thrown off in the largest numbers,⁷ thereafter becoming increasingly difficult to demonstrate. In eight cases of the present series, there had been exposure to

⁵“Familial” includes contacts in the household between persons resident there. Under the term “extrafamilial,” “home” includes contacts between persons one or both resident elsewhere; “school” includes contacts in the school and on the school playground; “store” includes contacts between customer and customer, or customer and clerk; and “other” includes contacts at Grange, Ladies Aid, and outdoors.

⁶See footnote 3, p. 44.

⁷Lawson, G. M., M.D., and Mueller, M.: The Bacteriology of Whooping Cough. *Journal of the American Medical Association*, July 23, 1927, lxxxix, p. 275.

DURATION OF CASE AT TIME EXPOSURE OCCURRED	TOTAL PERSONS EXPOSED			PERSONS WITHOUT HISTORY OF PREVIOUS ATTACK		
	Persons	Cases	Per Cent Attacked	Persons	Cases	Per Cent Attacked
Less than 3 weeks	54	8	15.0	18	6	33.0
3 to 4 weeks	43	3	7.0	11	2	18.0
5 to 8 weeks	60	0	0.0	15	0	0.0
Over 8 weeks	13	0	0.0	1	0	0.0

Table 3. Incidence of whooping cough among persons exposed to whooping cough at different durations.

the disease during its first week, and in the other three cases, exposure during or prior to its third week. (Table 3.)

The history of previous attacks in the population was obtained at the first visit. These histories are summarized and compared with other findings of a similar kind in Table 4.

In this investigation, although the numbers are small, it is interesting to note that the lag in the percentage is greater for this strictly rural area than for five rural townships of the County where there are a few villages with populations up to 1,000, and is much greater than for urban communities.

Three persons with a history of a previous attack had second attacks during this outbreak. One of them, M.L., a girl of 9, had a light case with whooping at the age of 2, according to the statement of her father and grandfather; the present attack was typical, with both whooping and vomiting. A.L., age 25, mother of M.L., was stated by her father to have had typical whooping cough with whoop at the age of 8, at a time of local and familial prevalence; the present attack was characterized by a cough of sixty-six days' duration, with prolonged paroxysms of coughing, lacrimation, facial suffusion, and frequently with gagging at the end of the paroxysm. The third case was that of a man, Bt.W., age 53,

who, according to his mother's statement, had had typical whooping cough when he was about five years old, at a time of familial prevalence; the present attack was also typical and characterized by vomiting.

Second attacks are generally described as rare, Laing and Hay⁸ reporting a rate of only 0.26 per cent in a series of 20,405 cases, but *Hemophilus pertussis* is sometimes isolated from presumably immune persons who have been exposed to the disease and who present some respiratory symptoms.⁹ Bearing in mind that the number of persons in this study is small and the effect of a few inaccurate histories may be large, the attack rate (Table 5) of 3.8 per cent among persons with a positive history of previous attacks is not significantly different from a rate of 2.2 per cent reported for two outbreaks of the disease in Hagerstown, Maryland,¹⁰ and is

Table 4. History of prior attacks of whooping cough.

AGE GROUPS	THIS INVESTIGATION			OTHER AREAS— PER CENT	
	Total Persons	Persons with Positive Histories		Five Rural Townships ¹	Various Urban ²
		Number	Per Cent		
Total	110	76	69.0		
0-4	8	0	0.0	19.0	38.0
5-19	28	16	57.0	64.0	75.0
20 and over	74	60	81.0	78.0	77.0

¹Sydenstricker, Edgar, and Collins, Selwyn D.: Age Incidence of Communicable Diseases in a Rural Population. *Public Health Reports*, January 16, 1931, xlii, pp. 100-113.

²Collins, Selwyn D.: Age Incidence of the Common Communicable Diseases of Children. *Public Health Reports*, April 3, 1929, xlii, pp. 763-826.

⁸Laing, J. S., and Hay, M.: Whooping Cough in Aberdeen. *Public Health*, July, 1902, xiv, pp. 584-589. Quoted by Stallybrass in "Principles of Epidemiology," p. 254.

⁹See footnote 7, p. 47.

¹⁰Sydenstricker, Edgar: Private communication based upon studies in Hagerstown in 1921-1924.

AGE GROUP	WITH HISTORY OF ATTACK			WITHOUT HISTORY OF ATTACK		
	Persons	Cases	Per Cent	Persons	Cases	Per Cent
<i>Total</i>	76	3	3.8	34	8	24.0
0-4	0	0	—	8	0	0.0
5-19	16	1	6.2	12	8	66.0
20 or over	60	2	3.3	14	0	0.0

Table 5. Attack rate among persons with and without history of attack.

roughly one-sixth the magnitude of the attack rate among persons with no history of a previous attack.

In gathering information in regard to exposure, the investigator was careful to keep in touch with all local activities and to check the information from one informant with that from all others. When there was a conflict of statements, an attempt to reconcile them was made on the next visit. By friendly cooperation, a clear oversight was maintained over local contacts. A history of definite contact with one or more persons having prolonged paroxysmal cough, accompanied in seven instances by whooping and vomiting, and in the other four instances by vomiting, was obtained for each of the eleven persons exhibiting the disease.

The number of contacts that persons ill with whooping cough had in the population was surprising, particularly for the winter season in a rural area. Familial contacts of patients, identical for all weeks of the illness, included all persons in the homes affected. The sixteen school children were exposed for five consecutive weeks to children with unrecognized whooping cough of less than three weeks' duration.

Exclusive of familial and school exposures, each patient had seven to ten contacts per week, chiefly with adults.

Except for the first week of illness, which showed the greatest number, the gross amount of these varied little during the course of the illness. The number of persons thus exposed per week was nearly constant at a level of about three until the last weeks, when exposures at Grange and Ladies Aid made a nearly tenfold increase. There were a few contacts outdoors that were considered exposures.

Of the fifty-nine persons who were exposed to the disease during the first four weeks of its duration, fifty were exposed in only one way. Nine persons were exposed in two ways, seven having extrafamilial exposure at home in addition to exposure in the family, at school, or other. For these nine instances, the exposure apparently more significant was tabulated. (Tables 6 and 7)

The attack rate was greatest among persons with familial exposure and next greatest among those with school exposure. Attacks following extrafamilial exposure in the home were notably less frequent than those following familial

Table 6. Exposure to whooping cough in the first four weeks of its duration by type of exposure.

TYPE OF EXPOSURE	NUMBER OF PERSONS	PER CENT POPULATION EXPOSED	CASES	PER CENT EXPOSED PERSONS ATTACKED
<i>All</i>	110	—	11	10.0
Familial	18	16.0	6	33.0
Extrafamilial ¹	41	37.0	5	12.0
Home	29	26.0	2	6.9
School ²	11	10.0	3	22.0
Store ³	1	0.9	0	0.0
None	51	46.0	0	0.0

¹Excluding five persons with familial exposure.

²Excluding two persons with extrafamilial exposure.

³Excluding two persons with extrafamilial home exposure.

exposure. Exposure at the general store, Grange, Ladies Aid, or outdoors was followed by no cases.

In this rural neighborhood with a mean population density of thirty-one persons per square mile, over half the people, fifty-nine persons in 110, were exposed to active whooping cough during the first four weeks of the disease. In addition, twenty other persons were exposed during the fifth to eighth weeks, and five further persons were exposed to coughing convalescents after the eighth week, making a total of eighty-four persons exposed to whooping cough at some time. There were very few contacts between patients and children under the age of five, and no cases occurred in this age group. The eleven cases which occurred followed recognized familial, school, or extrafamilial home exposures. Three second attacks were recognized. At some time during the outbreak, forty-nine other persons showed respiratory disorders involving cough. All cases arose from contact with other cases during their first weeks before they could be diagnosed clinically.

Table 7. Exposure of persons with no history of whooping cough to whooping cough in the first four weeks of its duration by type of exposure.

TYPE OF EXPOSURE	NUMBER OF PERSONS	PER CENT OF SUSCEPTIBLE POPULATION EXPOSED	CASES	PER CENT EXPOSED PERSONS ATTACKED
<i>All</i>	34	—	8	24.0
Familial	6	18.0	4	66.0
Extrafamilial ¹	14	41.0	4	29.0
Home	9	26.0	2	22.0
School	5	15.0	2	40.0
Store ²	0	0.0	0	0.0
None	14	41.0	0	0.0

¹Excluding one person with familial exposure.

²Excluding one person with extrafamilial home exposure.



