EPIDEMIOLOGY OF WHOOPING COUGH IN A RURAL AREA*

by RALPH E. WHEELER, M.D., D.P.H.

IV. CONTACT AND SPREAD

IN preceding sections of this report the incidence of whooping cough was discussed from the point of view of the survey area as a whole or of broad subdivisions of the area. It was observed that the average annual incidence for all ages was about twenty per thousand and that cases tended to occur at somewhat later ages on farms than in villages. The incidence of recorded overt attacks was slightly greater among females. A general confirmation of these observations was secured in the data on histories of prior attack. In examining the proportions without history of prior attack it was noted that these seemed to vary inversely with the concentration of population, suggesting that a study of individual relationships or contacts might prove profitable.

1. *General Character of Contacts in the Survey Area.* It will be necessary to differentiate rather sharply between the relationships in the farm areas and in the villages, for the contact possibilities differ widely.

In the farm areas outside the villages, the houses were quite widely separated and children frequently had to go some distance to find playmates. The child of preschool age, therefore, seldom had contacts outside his own home, and his chief risk of contracting whooping cough came from contact with an infected older brother or sister. The child of grade-school age had the added hazard of school attendance. He usually went to a small one-room neighborhood schoolhouse with four to twenty schoolmates. Although his contacts were thus still limited, there were a

* From the Milbank Memorial Fund. The first two sections of Dr. Wheeler's monograph were published in the October, 1935, issue of the *Quarterly,* xiii, No. 4, pp. 366-380; the third section in the January, 1936, issue of the *Quarterly,* xiv, No. 1, pp. 81-91.

number of factors which increased the risk of infection because the contact relationships of country schoolmates are as a rule much more intimate than are city ones. These are, however, by no means limited to contact in the schoolroom. The children frequently ride or walk to school together, lunch at the same table in the schoolroom in winter or during inclement weather, play together after school for a time, and visit some one of the children's homes in a body on their way back. It is thus difficult, if not impossible, to differentiate actual school from play contact—a fact which should be borne in mind in the course of the more detailed analysis of contact factors below. There was one parochial grade school in the area taking children from considerable distances, but in the main farm grade-school attendance was limited to the immediate neighborhood. During school vacations, the grade-school child had contacts almost as limited as his younger brother, although he occasionally rode in with his father to a near-by village or city or did local errands for his family.

The farm child of high-school age, if he attended, always went to one of the village schools. When whooping cough was epidemic in the village school, such a child when susceptible frequently brought the infection back to his home. The paucity of other contact in these high-school children is manifested by the fact that their infection usually did not spread to other households in the vicinity of their homes. Theoretically, an attacked farm child attending high school in the village could start an outbreak in a local grade school by infecting a younger brother or sister attending one, but no such satellite outbreaks were observed.

The child of high-school age not going to school usually worked on the parental farm, although boys sometimes hired out as farm laborers and sometimes lived on distant farms where their contacts were usually household ones except in harvest time.

There was one farm custom which may have been responsible for not a little of the periodic importation of whooping cough

into the area. Farmers are frequently great visitors, and on Sundays and holidays they often leave the care of livestock to a neighbor while they take the whole family off to visit more or less distantly located friends and relatives or into the nearest large city for the day. Whooping cough is known to have entered the area on two occasions when families under observation either made or received visits in this way, and it is not unlikely that the failure to trace local contacts in successive outbreaks of whooping cough could be thus explained more often than the fragmentary contact records would indicate.

Farm relationships are thus relatively limited in this area during the younger ages but are rather peculiarly intimate. In rural regions where both the grade and the high schools are centralized, it is probable that outbreaks of the disease would be much more widely distributed.

The relationships in the villages, on the other hand, resemble much more those in urban centers than those on the farms, for even in these small villages of the study area (none of which contained more than a thousand inhabitants) individual contacts were far more numerous and of a more varied sort. They doubtless, however, do represent a transition from rural farm to urban, for even in the largest of the three villages it was not always as possible as in the cities for a preschool child to find playmates of compatible age and temperament, so that at least this stage of life may remain relatively free of extrafamilial contacts.

Because the etiological agent of whooping cough is known to be short-lived outside the body, this discussion emphasizes particularly the direct contacts made in rural life. It seems doubtful whether fomites are of great importance in the spread of whooping cough in the country districts. The possible rôle of carriers has also been disregarded, as the meager evidence at hand[23] indicates

[23] Kline, Edmund K.: Whooping Cough Plates in a Public Health Laboratory. *American Journal of Public Health,* 1933, xxiii, Part I, p. 493.

that they are also not an important factor in disseminating the disease.

It is now possible to outline the actual course of whooping cough attacks during the survey period as a preliminary to a study of the relative importance of the various contact factors.

2. *Geographical and Chronological Occurrence of Whooping Cough.* It was observed in Section II that there were four major periods of whooping cough prevalence during the three-year survey period. Each of these periods showed four to twelve geographically distinct occurrences either limited to one household or grouped in localized outbreaks involving two or more homes. The location of attacked households in each of the four periods of prevalence is shown in Figure 7. Each neighborhood occurrence, whether sporadic or an actual small outbreak, has been lettered in the order of the appearance of the primary case in time, but it should not be concluded that each succeeding one resulted from contact with the previous one. Whooping cough frequently appeared in townships bordering on the survey area and must frequently have been imported from outside by some chance contact or by visiting. Because of the importance of the complex of contact possibilities inherent in school attendance, the location of each of the country grade schools has been indicated by a small "S" and the location of the village schools (combining village grade and district high school) by an "S" in heavy type. There were three of these latter, one in West Valley Village (which also had a parochial grade school) in southeast Ashford, one in Ellicottville Village in southwest Ellicottville, and one in Great Valley Village in northern Great Valley. Households of which one or more cases were attacked while attending the indicated school are shown in black. Those which had no cases attending school are indicated by a dot and a circle. The majority of these latter families included only cases in children of preschool age, but a few included cases in children of school age although not

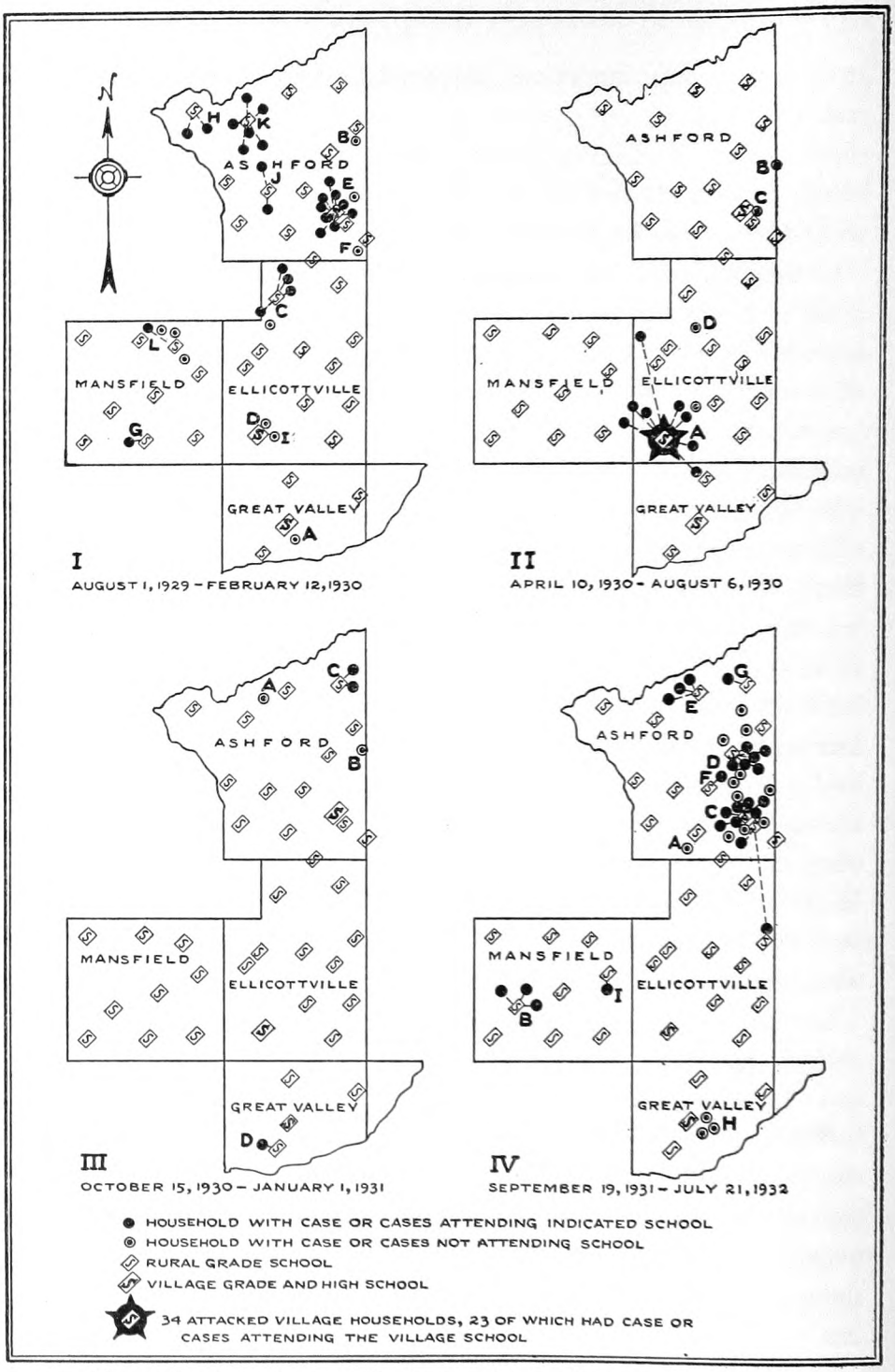

Fig. 7. The sequence of neighborhood occurrences in each of the four periods of whooping cough prevalence, Cattaraugus Morbidity Survey, 1929-1932.

attending because school was not in session. The dates given for each period in Figure 7 are those of the onset of the first and of the last cases recorded for the period. As no occurrences were noted in Humphrey or the southern half of Great Valley township, Figure 7 does not show these portions of the survey area.

In general it will be noted that the outbreaks in the country grade-school districts tended to be localized in extent, although sometimes contiguous school districts were attacked during the same period, suggesting a certain amount of infective contact between them or infection from a common source. In spite of the occasional spread between school districts, however, a relatively small proportion of the total number of school districts showed attacks during the entire survey period. The village school outbreaks, of which the best example is shown in II:A, were much less localized. This is because the village schools include not only village grade pupils but high school pupils from all the surrounding farm grade-school districts as well. However, the winter outbreaks in the village grade and high school in Ashford (I:E and IV:C) tended to be localized because the high school is a small one and because winter road conditions in this high-school district often made it necessary for children living at a distance to lodge in the village itself. In the latter of these (IV:C) the coincident outbreak in the parochial grade school involved two households well outside the village limits.

It will be observed that attacked households without cases attending school are scattered among the larger school outbreaks and undoubtedly acquired the infection largely by casual neighborhood contact. The factor of school attendance is so universal that it can seldom be ruled out in any given occurrence, but there appear to be two small outbreaks (I:L and IV:H) in which neighborhood contact alone seems to have been responsible for the spread, giving rise to very limited outbreaks. A high proportion of these households without cases attending school are seen

to have been isolated occurrences even when (as in the apparently independent occurrences I:D and I:I) they were located in a neighborhood which, as shown by subsequent outbreaks, contained many susceptible children.

First Period (Figure 7:I). The first cases of whooping cough recorded in the survey occurred in a household in Great Valley Village (A). The next occurrence to be recorded was in northeastern Ashford (B) where seven children were attacked. The cases in both of these first two families occurred among children of school age but not attending because of the summer vacation. The next occurrence was a small school district outbreak (C) in northern Ellicottville, school having meanwhile begun. Next were recorded cases in preschool children in a household of Ellicottville Village (D). The next cases were noted in a household in West Valley Village (E). The children were attending school when attacked and the infection spread to a limited number of village and farm homes in the vicinity. While this outbreak was in progress, a case occurred in a neighborhood in southern Ashford (F). There was also recorded in southern Mansfield (G) one of the occasional sporadic occurrences in a child attending school. The disease next appeared in northwest Ashford (H) in a school district and another sporadic occurrence was recorded in Ellicottville Village (I). This second Ellicottville Village occurrence took place more than two months after the first and has, therefore, in the absence of other known cases in this village, been considered a new infection from outside the neighborhood. Two more school district outbreaks were next recorded in Ashford (J and K), and, finally, an outbreak in northern Mansfield (L) in a small hamlet. As Mansfield had been quite heavily attacked within the previous twelve months, it is possible that a good many of the school children had acquired immunity.

Second Period (Figure 7:II). Two months elapsed before another case was recorded in the area. It is possible that one or more atypical cases may have been missed and that the Ellicottville Village epidemic (A) was directly related to the previous outbreaks, but in the absence of definite evidence it has

been necessary to consider it as having arisen as a new importation from outside the area. The first case occurred in a child attending school and the outbreak was at first limited to school children. Thirty-four village households were attacked and nine farm homes. There were, during this outbreak, three other sporadic occurrences in the area (B, C, and D) of undetermined origin. A little over two months now elapsed without a recorded case.

Third Period (Figure 7:III). This period was really one of endemic whooping cough. After two sporadic household occurrences in northern Ashford (A and B), a small school district outbreak of eleven cases in only two households made its appearance. This same school area was attacked again in the following period. One sporadic household occurrence was also recorded in Great Valley (D). Like the Mansfield area, this part of the survey region had also been quite heavily attacked by whooping cough, and it is possible that others in the district were immune.

Between the third and fourth periods there was an interval of nine months during which no cases were recorded.

Fourth Period (Figure 7:IV). This began on September 19, 1931, with a case in a household in southern Ashford (A), the child having been infected while visiting relatives in a large city sixty miles away. The next occurrence (B) was a small school outbreak observed in western Mansfield which may well have originated independently. The disease spread thence to West Valley Village (C) in a definitely ascertained manner. A member of one of the attacked Mansfield households lived and worked as a hired man on a farm home near West Valley Village. He acquired whooping cough on a visit to his family in Mansfield and gave it to children on the farm where he was employed. These, in turn, were pupils in the West Valley high school and gave it to schoolmates. When it became general in the village, the local parochial school was also attacked. Infection was next carried to school districts (D, E, and F) north of West Valley where cases had previously occurred among children not attending school without causing outbreaks, and attacked again the school in northwest Ashford (G) which

was, by this time, pretty well immunized. It also appeared in the form of a small localized outbreak in Great Valley Village (H), the second in which school attendance as a possible disseminating factor could be definitely eliminated. The final occurrence of whooping cough was in a school family in Mansfield (I). No cases were noted in the survey area after July 21, 1932.

3. *Relative Importance of Contact Factors.* Because the recorded data on the sources of infection for the survey cases are so fragmentary, it is necessary to obtain information as to the relative importance of these various contact factors indirectly. It is felt that this can be done with a very good degree of accuracy from the regional and chronological outline just given. The conclusions from a study made in this way must necessarily be somewhat general and tentative, but they can be checked by the observations of the staff which lived in this area for three years while doing the field survey work and by somewhat more detailed studies of epidemics and contacts which were carried on simultaneously with the survey in attacked neighborhoods outside the survey area.

Of the total of 280 cases, 34, or 12.1 per cent, had dates of onset such that they were very probably the original cases in their respective neighborhoods. It is suspected, from such contact records as are available, that a fairly large proportion of these cases acquired their infection while visiting or being visited by an infectious case. In one case a farm laborer is known to have introduced the disease into the household of his employer, whence it spread very widely.

Once introduced into the neighborhood, whooping cough may be considered to spread locally in two ways. The first of these is general neighborhood contact, here called "vicinal" contact for brevity. This includes relationships entered into at play, while on errands, and during local visiting; in short, the activities of the

child when not attending school. Definitely in this category were thirty-eight cases, or 13.6 per cent of the total recorded cases. This is a strikingly small proportion and one which will require further explanation below.

The second mode of spread of whooping cough within a neighborhood is school attendance. In all, sixty-six, or 23.6 per cent of all the cases, attended a school in which there was known to have been an infective case.

As explained above, this does not necessarily mean contact *in* school, but the whole series of relationships into which a child is brought when he goes to school. The specificity of this category may be considered open to grave question in view of the fact pointed out above, that schoolmates are very likely to be playmates, and consequently also subject to vicinal contact. It would be difficult, if not impossible, to differentiate these two factors in any given case; however, there are certain facts which would suggest that school attendance in a community deserves separate mention as a mode of spread. Thus, sixteen of the twenty-nine neighborhood occurrences just discussed began in households where one or more cases attended school. Of these sixteen, eleven gave rise to local outbreaks involving one or more other homes in the immediate neighborhood. Furthermore, the primary case in these other homes was almost invariably a school child. Of the thirteen occurrences noted as beginning in households with no case attending school, on the other hand, only two involved other homes in the immediate vicinity. As none of the four homes with cases of school age but not attending started a local outbreak, there would appear to be some grounds for suspecting school attendance of very materially aiding in the neighborhood dissemination of whooping cough.

The fact that farm children, attacked in the course of attendance at village high schools, usually fail to spread the disease among other homes in their vicinity is an observation which indi-

cates that casual neighborhood or play contact has a relatively minor rôle in disseminating whooping cough on farms. When the dates of onset of such cases, even though on neighboring farms, are compared, it will often be found that they may occur six weeks or more apart. Rather striking also is the low proportion of attacked households without cases attending school in connection with the farm outbreaks. Less than one-fifth of the attacked farm homes belonged in this category, while more than a third of the village homes had no direct relation with school. This observation tends to confirm the general remarks made above on the unimportance of neighborhood contact in regard to the spread of whooping cough in the farm areas and of its somewhat greater importance in the villages.

The relationships discussed above have all been extrafamilial, and the discussion thus far has therefore been limited to primary cases in households. There remains one final relationship to touch upon: household contact. In order to differentiate between primary and secondary cases in households, a minimum interval of only one day has been selected. This was done in part because it was felt that the incubation period of whooping cough could occasionally be as short as forty-eight hours. However, the interval does not, within limits, greatly affect the number of primary cases, as only seven cases would be changed from secondary to primary were the interval four days instead of one.

By the one-day criterion, a total of 142 cases, or 50.7 per cent, were attributed to household contact. There is every reason to believe that, with the single reservation noted in the discussion of the interval selected to differentiate primary from secondary cases, this figure is a very accurate one.

Stocks[24] has used the proportion of secondary household to total cases of whooping cough as an "index of infectivity" for the

[24] Stocks, Percy: On the Epidemiology of Whooping Cough in London. *Journal of Hygiene*, 1932, xxxii, p. 581.

disease. He found that the proportion varied in one of the boroughs of London, England, from about 20 per cent to about 5 per cent, with an average value in the neighborhood of 10 or 12 per cent. If the same limitations are put upon the selection of secondary cases as those used by Stocks (a four-day interval between the primary and secondary cases and the discarding of secondary cases over 15 years of age), the average value of this index for the three years of the survey becomes 45 per cent instead of 51 per cent. The difference between the levels is probably in part related to the difference in average family size in Cattaraugus and in the London borough studied by Stocks and in part to a difference in the manner of collecting the data.

Stocks has pointed out that the actual value of this index varies somewhat with family size, and he therefore concentrates his attention less upon the average figure than upon the fluctuations shown during short intervals of time. These fluctuations he relates to fluctuations in the incidence of whooping cough in the borough, finding that the index falls during an outbreak from levels of 20 to approximately 5, and rises gradually thereafter. These changes, he feels, are probably due "to changes in the specific immunity, active and latent, of the population at risk."

In the present survey data, similar fluctuations in the value of the index are in evidence and they are similarly related to the incidence of whooping cough. However, there are also evident very definite changes in the size of attacked family, which also seem to be related to fluctuations in the index and in the incidence and which may at least in part explain the variations in index figures commented upon by Stocks. Apparently in Cattaraugus the larger families and those with the greater number of individuals with no prior history of whooping cough are more likely to be attacked in the early phases of an epidemic than in the later ones.

Recapitulating briefly the data on contacts up to this point, it

has been shown that 12.1 per cent of all the survey cases were primary cases in their respective neighborhoods and therefore infected by sources and in ways which can only be surmised. Another 13.6 per cent was attributed to casual neighborhood or vicinal contact. The somewhat larger proportion of 23.5 per cent was attributed to school attendance. The balance, or 50.7 per cent, were quite definitely secondary cases in their respective homes and have been attributed to familial contact.

The limitations of the indirect method of reaching these conclusions, particularly as regards the separation of vicinal from school contact, have been emphasized. It is evident that, even in this rural area with quite simple contact possibilities, the relationships among individuals are complex enough to warrant much more intensive studies than could be made by the method of the present survey. Such studies have in fact been made in and near the survey area, and one of them was described by Burroughs.[25] Three small outbreaks were observed and contact records carefully kept by visits made at very short intervals. A total of thirty-seven cases was recorded in these three small outbreaks, of which three, or 8.1 per cent, were infected outside the respective neighborhoods; four, or 10.8 per cent, by vicinal contact; eight, or 21.6 per cent, by school attendance; and twenty-two, or 59.4 per cent, by familial contact. The numbers are small and the regions kept under observation were purely rural areas outside the villages, but the proportions are rather surprisingly similar to those reported for the present survey.

4. *Contact and the Risk of Infection.* The mere enumeration of cases attributable to various forms of contact, while important from the point of view of determining modes of spread, is relatively valueless without some measure of the risk of infection associated with the types of contact under consideration. From

[25] Burroughs, Travis P., M.D.: An Epidemiological Study of a Rural Outbreak of Whooping Cough. The Milbank Memorial Fund *Quarterly Bulletin,* January, 1932, x, No. 1, pp. 41-52.

what has been said above about the complexity of relationships even in the farm sections, it will be evident that only tentative answers at best can be obtained to these questions from the survey data. However, the studies of Burroughs, previously mentioned, offer a very useful check on the accuracy of the conclusions at least as far as the purely farm contacts are concerned.

In one respect, and that is, perhaps, the most important, the survey data yield very valuable information, namely, in determining the secondary attack rate in attacked households. This is given in some detail in Table 12, both because these data are almost unique in their completeness and because frequent reference has been made to them above. The rapid fall in the secondary attack rates in Table 12 for all persons, with advancing age, is, of course, in part a result of the increasing number of immunes in the family in older age groups. The secondary attack rates among "susceptibles" are quite striking in their maintenance of fairly high levels until about the fifteenth year, however. Very little has appeared in the literature which is comparable with these data, and what there is deals primarily with urban centers. The published data do, however, suggest that in urban areas there is a much more rapid fall than is evident here among "susceptibles."[26]

The separate studies of Burroughs, noted above, check quite well the rates for all ages given in Table 12. Twenty-two cases occurred among fifty-three persons exposed familially, a rate of 41.5 per cent. Of these there were seventeen cases and twenty-four exposed

[26] Comparable data for the City of Cleveland are given for the year August, 1925, to July, 1926, by Howard Whipple Green in "Communicable Disease Analysis," Cleveland Health Council, 1929. The percentage of "susceptibles" contracting whooping cough in families as secondary cases falls from 70.7 per cent in the 0-4 age group to 12.3 per cent in the 10-14 age group, the total percentage at all ages being only 36.3. In his "Effect of a Whooping Cough Epidemic upon the Size of the Nonimmune Group in an Urban Community" (The Milbank Memorial Fund *Quarterly Bulletin*, October, 1932, x, No. 4, pp. 302-314), Sydenstricker gives "susceptible" attack rates at ages under 15 years in Hagerstown families. Attack rates are generally 5 to 10 per cent higher than secondary attack rates but show essentially the same trend. The attack rates in this case fell from about 90 per cent at the younger ages to 25 per cent at age 14.

persons without prior history of attack, giving a rate of 70.8 per cent for "susceptibles."

School attendance is another mode of spread upon which very reliable survey data are available. The problem of obtaining secondary attack rates for schools is somewhat less simple than that of obtaining them for households because a certain number of children who attended attacked schools and developed whooping cough were secondary cases not only in their schools but in their own homes. As the home exposure is undoubtedly the most intimate, these cases have been credited to the home rather than to

Table 12. Household secondary attack rates, Cattaraugus County, 1929-1932.

Age[1]	All Persons			"Susceptibles" Only		
	Per Cent Attacked	Secondary Cases	Exposed Population	Per Cent Attacked	Secondary Cases	Exposed Population
All Ages	29.8	142	476	80.1	133	166
0	82.4	14	17	82.4	14	17
1	100.0	10	10	100.0	10	10
2	81.8	9	11	81.8	9	11
3	100.0	12	12	100.0	12	12
4	90.5	19	21	100.0	19	19
0-4	90.1	64	71	92.8	64	69
5	92.3	12	13	92.3	12	13
6	44.4	4	9	80.0	4	5
7	77.8	7	9	100.0	7	7
8	61.1	11	18	90.9	10	11
9	47.0	8	17	75.0	6	8
5-9	63.6	42	66	88.6	39	44
10	66.7	4	6	100.0	4	4
11	28.6	4	14	80.0	4	5
12	40.0	2	5	100.0	2	2
13	33.3	3	9	75.0	3	4
14	—	1	8	—	1	1
10-14	33.3	14	42	87.5	14	16
15-19	16.3	7	43	53.8	7	13
20+	5.9	15	254	37.5	9	24

[1] Ages are computed, as of the last birthday, when whooping cough appeared in the household. For the general morbidity data in previous sections ages were computed as of each survey year.

Age	All Pupils			"Susceptible" Pupils Only		
	Per Cent Attacked	Secondary Cases[1]	Exposed Population[2]	Per Cent Attacked	Secondary Cases[1]	Exposed Population[2]
Under 10 years	22.0	49	223	41.2	47	114
10 years and over	4.5	17	376	14.7	14	95
ALL PUPILS	11.0	66	599	29.2	61	209

[1] Includes only school secondary cases which were primary household cases.

[2] Includes all pupils attending at the time these schools were attacked with the exception of the first cases in the respective schools and with the exception also of any household cases secondary to the primary cases who were at the time attending the same school.

Table 13. Secondary attack rates in attacked schools, including farm grade schools and village grade and high schools, Cattaraugus County, 1929-1932.

the school, but, except for the household secondaries of the primary case in the school, they have been counted in the exposed population of the school.

Table 13 shows the age specific rates for all pupils and for "susceptibles." To one familiar with the large number of pupils attacked by whooping cough in farm grade schools these rates seem quite low. One reason is, of course, that many of the children who were attacked were exposed at home as well as in school, and another is that the larger village schools, included in Table 13, have a somewhat lower attack rate, particularly at the older ages. These differences may be seen in Table 14. Correction for age differences in the farm and in the village schools makes but slight changes in the rates for all ages.

The studies of Burroughs rather closely corroborate the rates in the farm grade schools. Out of fifty-two children known to have been exposed through school attendance, eight were considered to have acquired their infection in this manner, a rate of 15.4 per cent. For "susceptibles" his rate was somewhat but not significantly higher, there having been seventeen exposures and seven cases, the proportion infected being 41.2 per cent.

Because of the lack of contact data, it is impossible to make a similar analysis of the risk of infection for vicinal contact. From

the more detailed data of Burroughs it was found that only 4 cases were attributable to vicinal contact out of 127 known to have been exposed in this way, the incidence being only 3.1 per cent for all persons. Of the 127 only 42 were found to have a negative history of attack, so that the "susceptible" rate was 9.5 per cent. Burroughs' data apply, however, primarily to the farm sections. Possibly the village rates would be somewhat higher. It is also true that if it were possible to exclude from Burroughs' data the persons above the age of 20 who, though giving no history of whooping cough, are relatively immune, the rates would be higher. It does not, however, seem probable that this form of contact can rank even in villages as a serious risk with the two types previously described: household contact and school attendance.

The discussion has thus far centered upon the risks of infection within the neighborhoods in which outbreaks were observed. No data are obtainable either from the survey or from the more intensive studies of Burroughs which will throw light upon the risks of infection to a person of a neighborhood from outside sources. It would appear, however, that relatively few cases are acquired in this way, although the consequences of the importation of whooping cough may be very unfortunate.

Table 14. Secondary attack rates shown separately for attacked farm grade schools and village grade and high schools, Cattaraugus County, 1929-1932.

Age	All Pupils			"Susceptible" Pupils Only		
	Per Cent Attacked	Secondary Cases	Exposed Population	Per Cent Attacked	Secondary Cases	Exposed Population
	FARM GRADE SCHOOLS					
Under 10 years	19.8	17	86	42.5	17	40
10 years and over	12.7	9	71	21.9	7	32
ALL PUPILS	16.6	26	157	33.3	24	72
	VILLAGE GRADE AND HIGH SCHOOLS					
Under 10 years	23.4	32	137	40.5	30	74
10 years and over	2.6	8	305	11.1	7	63
ALL PUPILS	9.0	40	442	27.0	37	137

V. POSSIBLE PREVENTIVE MEASURES

From the above summary of the number of cases attributable to various forms of contact and of the associated risks, it is evident that household contact is the most important factor in the dissemination of the disease. The involved relationships implied in school attendance are next in importance, although, as has been suggested, actual school contact may play a relatively minor part. Finally, vicinal and extravicinal exposures have a small but definite rôle to play, the latter being of importance chiefly because of the effects of the importation of whooping cough into a community.

The bare analysis of cases and risk with respect to contact may, however, be misleading. If the word "spread" be defined as distribution among the households of a community instead of distribution among individuals, there is no doubt about the fact that school attendance is responsible for more cases than any other in the farm sections and possibly also in the villages. If any lesson can be drawn from the observations thus far made upon contacts, it is that whooping cough does not become widely distributed in rural Cattaraugus unless it can do so through school attendance. It should therefore be possible in that area and very probably in many similar rural areas, to apply restrictive measures at the school in order to reduce incidence not only in attacked schools but throughout the neighborhoods in which they are located.

As a first step in controlling whooping cough and perhaps other infectious diseases in rural areas at the school, the communicable disease history of each pupil should be recorded on entering and brought up to date at the beginning of each school year. Such data, if obtained from the parents, are reasonably accurate and in the case of whooping cough a sufficient guarantee against subsequent attack, so that restrictive measures may be somewhat directed thereby. Three possible experimental procedures suggest themselves readily in the particular instance of whooping cough in addition to those already in force in schools. The first is the im-

mediate dismissal for a few days of any "susceptible" child showing a cough of the dry, consecutive variety.

It is recognized that this is somewhat drastic, particularly when, as sometimes occurs, such coughs are shown by a large proportion of the pupils and do not end in whooping cough. However, it seems probable that the time lost, in the long run, would be less than when whooping cough does occur. This measure would be especially useful in the farm grade schools where the contacts outside of school are known to be limited.

Another measure, which could be tried experimentally either as an alternative to dismissal or as a separate project, is that of enforcing the use of gauze masks by all pupils known not to have had whooping cough when they show suspicious symptoms. Such a procedure could be made routine in the small country grade schools and possibly would assist in reducing the incidence of other acute upper respiratory infections as well.

Inoculation against whooping cough is a procedure of doubtful value at present, although recent claims suggest a relatively long-lived immunity. It should be possible under farm school conditions, where the secondary attack rate is known to be fairly high, to set up a controlled experiment which would assist in demonstrating the effectiveness or ineffectiveness of this procedure.

These are three possible approaches to the problem of reducing the community incidence of whooping cough through restrictive measures applied in farm grade schools. Their value may be determined with relatively little expense, but any such experiment would have to be applied on a fairly large scale and over a long period of time, for, as has been shown, a large proportion of the farm grade schools remained unattacked during the three-year period of the Cattaraugus survey. The effectiveness of similar measures could also be tried in village schools, but the less intimate relationships existing there and the possibly greater frequency of infective extra-curricular contact would make them less useful.

Age	Percentage Distribution		Cases	
	Primary	Secondary	Primary	Secondary
ALL AGES	100.0	100.0	81[1]	142
0-4	14.8	45.1	12	64
5-19	82.7	44.3	67	63
20+	2.5	10.6	2	15

[1] Excludes 57 primary cases in families without secondary cases, distributed as follows: 24 cases in the youngest, 30 in the middle, and 3 in the oldest age groups. The ages here are computed as noted under Table 12.

Table 15. Percentage distribution of primary and secondary household cases of whooping cough by age, Cattaraugus County, 1929-1932.

The value of postponing an almost inevitable attack of whooping cough in children of school age might be questioned. It should be remembered, however, that it is not entirely a question of postponing the attack in the pupils themselves. In this area, whooping cough appears to be carried home to younger children by their older brothers and sisters, as the percentage distributions in Table 15 show.

As a further argument for postponing the age of attack even in children of school age, the rapid decline in incidence among older children without history of recognized attack might be cited, although it must be confessed that a certain proportion of these may be attacked in later life if sufficiently exposed.

It cannot be claimed that repressive measures instituted in schools will entirely eliminate whooping cough in rural areas. If, after due experimentation, some effective preventive action were found, it could at best reduce the incidence by about one-half. Had a perfect system of prophylaxis been applied in the schools of Cattaraugus at the time of the survey, it would have eliminated the 66 cases which were secondary to primary cases in the various attacked schools and 75 cases secondary to these in the households where the former lived, in all, 133, or about half of the 280 recorded cases. No readily applicable preventive measure suggests itself as a protection against the chance exposures outside the

neighborhood or within the neighborhood outside the school. The school would appear to offer the best point upon which to focus preventive efforts, if not in the villages at least in the farm sections of rural Cattaraugus.