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Mr. W. H. Power's Report to the Local Government Board
on Prevalence of Diphtheria and other Throat Illness at
Radwinter, in the Saffron Walden Rural Sanitary District.

Inspected, May 1877.

EDWARD C. SEATON, M.D.,
Medical Department,
August 3, 1877.

Four deaths from diphtheria in each of the two last quarters of 1876, and five from the same disease in the first quarter of 1877, were registered in the Radwinter sub-district, Saffron Walden. These data in the Returns of the Registrar-General gave occasion for the following inquiry.

On arriving in the district and upon examination of the local registrar's books, it was soon evident that the 13 deaths above enumerated by no means represented the whole prevalence of fatal throat illness in the six parishes constituting the sub-district. From these books it appeared that a fatal case of diphtheria occurred so far back as July 1875, and that towards the close of that year, and in the early part of 1876, "croup" proved fatal in three instances. In all, from July 1875 to the present time, there have occurred in the six parishes no less than 20 fatal cases of throat illness. In view of the lapse of time since the first occurrence of fatal throat illness in the sub-district, and of a still earlier prevalence of diphtheria ascertained to have occurred in neighbouring places, inquiry respecting circumstances of diphtheria *origin* could not, it was thought, usefully be made. Accordingly, attention has been mainly given to examination of the circumstances under which extension of the disease has taken place, and to this end Radwinter parish, in which 12 of the 20 fatal cases have occurred, has been selected for investigation.

Radwinter parish, acres 3,802, population (in 1871) 986, is situated five miles east of Saffron Walden, upon high undulating country formed of gravel and Boulder clay overlying the Chalk formation. Its population, in number about the same now as in 1871, is almost wholly agricultural, and is much scattered. Except a considerable aggregation of dwellings about the church and school the parish has no village, but consists of a series of cottages distributed in smaller or larger groups over a very wide area. Some of these groups of dwellings are much isolated, and have but limited relation with other parts of the parish. The chief of them with the distance in each instance from the "village," are: Chapel End with Sampford Road, 2-4 furlongs; Maple Lane, 5 furlongs; Water Lane, 3-6 furlongs; Stocking Green, 1-1½ miles; Tilekilm, 1-1½ miles; and Radwinter End, 2 miles and upwards.

Dwellings.—Cottages are most of them of lath and plaster, with bricked floors and thatched roofs. A few are built wholly of wood. Some of the newer ones are of brick, with tiled or slated roofs. Almost all have gardens. Old dwellings are many of them dilapidated, and generally they are ill-ventilated; their windows commonly being small and frequently not made to open. As regards sleeping accommodation in dwellings, a survey was made in 1874 by the officers of the sanitary authority in respect of 194 houses in the parish; and from this survey it appeared that 16 per cent. had but one bedroom; 60 per cent. had two; and 24 per cent. had three or more bedrooms. As regards density of occupation it was found that in 33 instances (17 per cent. of the houses) four or more inmates occupied one bedroom, and 230 persons (31 per cent. of the population whose dwellings were inspected) were judged to be more or less overcrowded by night. Overcrowding of this sort has been in some cases dealt with by the sanitary authority as a nuisance, and abatement procured. Also dwellings unfit for habitation have been closed.

Water supply.—For drinking purposes, water of the superficial soil is mainly in use; only a few persons store and use rain-water. In the gravel districts water is obtained from wells, which, except in very dry seasons, rarely wholly fail in their supply. On the confines of the gravel area springs are not uncommon. Upon the high clay lands water is stored in ponds, which even in ordinary summers soon become dry, as also do many of the watercourses, here fed solely by land water. Thus many persons are put to great inconvenience in obtaining water, which has to be carried long distances from the few accessible wells or springs.

Drainage.—No drainage fulfilling any sanitary purpose at present exists in the parish. Slop and refuse water is cast on the ground or into pits dug in the gardens for the reception of solid and liquid refuse.

Excrement disposal is wholly by pit privies. These are commonly set in gardens at a distance from dwellings. Cottage property of the older sort is not always sufficiently provided

with privy accommodation, one convenience not unfrequently serving for two or three dwellings. In such instances the privy pit is commonly a hole in the ground, unbricked and uncovered; occasionally it has an overflow to a watercourse. New cottages have each a privy, and these have covered pits, bricked, and sometimes lined internally with cement. Such pits are professedly water-tight and are intended to receive ashes as well as excrement. It is contemplated that privies of this sort shall eventually replace structures of the older kind. Emptying of privies is in the hands of occupiers, who apply the produce to their own gardens.

Previous Health History of the Parish.—Radwinter is regarded, and apparently justly regarded, as a healthy place. No tradition exists of previous epidemic prevalence in it of diphtheria. The mortality in the parish for the three years 1874-76 is given in Table I.

TABLE I.
RADWINTER PARISH.—Acres, 3802; Houses, 207; Population, 986.

Year.	Deaths from all causes at all ages.	At ages as below.		From the several causes as below.				
		Under one year.	Over 60 years.	Seven infectious diseases.	Consumption.	Other lung diseases.	Heart disease.	All other diseases and injury.
1874	18	4	6	—	2	5	1	10
1875	13	2	5	—	2	1	2	8
1876	13	1	3	5*	2	1	2	3

* All from diphtheria.

The Diphtheria.—The existence of diphtheria in Radwinter first became apparent in July last year. In that month two deaths from throat illness occurred almost simultaneously in different parts of the parish, one (a child aged four) on July 13th, at St. Pris' Well; the other on July 16th, near Maple Lane. These children were attacked on the 6th and 7th of July respectively, and though one only was registered as having died of diphtheria, there can be no doubt that both suffered from this disease. But these were not the first cases in the parish. At least one other household had already suffered, though not fatally, from throat illness extending from one to other members of the family. The history of disease in that household was as follows: Frederick R., aged 11, of Maple Lane, was attacked by sore throat, June 22nd. He was not very ill, and he kept his bed a day or two only. On June 29th, his brother, aged 14, who slept with him, was taken ill and suffered severely for several weeks with throat illness, that appears to have been unquestionably diphtheria. Subsequently, July 17th, the mother and a lodger were also slightly attacked. More than one member of this family has since suffered from nervous disorder of a sort that not unfrequently follows diphtheria. So far as could be ascertained, Frederick R. was the first person attacked in Radwinter by throat illness of the nature of diphtheria, and inquiry in this case failed altogether in tracing connexion with antecedent throat illness of any sort. It is, however, probable that failure of evidence in this direction has been due to imperfection of record rather than to absence of connexion in the sense suspected, for I learn that after July, when attention was first called to the possible significance of throat illness, sore throats became recognised as increasingly prevalent in the parish, and this went on for many months with but slight interruption, so that it may well be believed that affections of the same sort preceded, though without exciting notice, the earliest recorded attack of diphtheria in June.

Passing on to consider the circumstances under which the disease may have become propagated in the parish, it soon became evident that the above-mentioned increasing prevalence of throat illness in the parish had been concurrent with extension of definite diphtheria, and consequently that the method of distribution of the graver disease could not be judged of except with reference to the greater prevalence of what had seemed to be mere sore throat. Indeed, though a large proportion of the throat attacks in the parish have been of comparatively mild nature, there is good ground for believing that some of them, some even of the mildest, have been capable of transmitting to other persons, and more especially to children, true diphtheria. This being the case, I attempted, by house to house inquiry, to get information respecting all households and persons attacked by sore throat since June last. This has not, perhaps, as regards earlier attacks been fully achieved, but there can be no doubt that the main facts of the later incidence of sore throat in the parish have been obtained.

The progress month by month of throat illness in the parish during the year 1876-7 is given in Table II.

TABLE II.
Throat Illness in Radwinter Parish in 12 Months ending May 1877.

Month.	Fresh Cases in Month.	Houses newly attacked.	Deaths.	Month.	Fresh Cases in Month.	Houses newly attacked.	Deaths.
June 1876 -	2	1	—	Dec. 1876 -	19	10	—
July " -	9	4	2	Jan. 1877 -	18	5	2
Aug. " -	4	1	—	Feb. " -	15	6	2
Sept. " -	3	3	—	Mar. " -	3	2	1
Oct. " -	4	2	2	Apr. " -	3	—	2
Nov. " -	16	9	1	May " -	1	—	—

Table III. shows month by month the distribution of the disease in certain localities of the parish, the date at which each locality first became invaded, and its distance from the "village." It gives also for each locality the number of families and of persons resident; the number, as well as time of invasion, of the several households attacked, with the number of cases of throat illness, inclusive of diphtheria, and the deaths from diphtheria.

TABLE III.

Date of first Invasion.	Locality invaded.	Distance from "Village."	Number in Locality		Number of Households attacked in each Month.	Number of Cases of Throat Illness.	Deaths from Diphtheria.
			Of Households.	Of Persons.			
June 22 -	District of Maple Lane -	5 furlongs -	23	104	{ In June, 1 " July, 1 " Dec., 1 " Jan., 1 " Feb., 1 } 5	12	2
July 1 -	" Village " -	- - - -	42	179	{ " July, 2 " Nov., 3 " Feb., 3 } 8	16	1
July 6 -	District of Radwinter End -	2-3 miles -	34	155	{ " July, 1 " Dec., 1 " Jan., 1 " Mar., 1 } 4	6	—
August 1 -	Old Mill House (outlying dwellings)	4 furlongs -	3	19	{ " Aug., 1 " Nov., 1 } 2	6	—
September 15 -	Hempstead Road (outlying dwellings).	1 mile -	2	13	" Sept., 1 1	3	1
" 28	District of Chapel End -	2-4 furlongs -	20	75	{ " Sept., 2 " Oct., 1 " Dec., 1 " Jan., 2 " Feb., 1 } 7	14	5
October 8 -	District of Tile Kiln -	1-1½ miles -	12	56	{ " Oct., 1 " Nov., 1 " Dec., 1 } 3	5	—
November 6 -	District of Water Lane -	3-6 furlongs -	17	78	{ " Nov., 3 " Dec., 3 " Jan., 1 } 7	20	1
" 11 -	District of Stocking Green -	1-1½ miles -	10	43	{ " Nov., 1 " Dec., 2 " Mar., 1 } 4	9	2
December 25 -	Grange Farm (solitary outlying) -	5 furlongs -	1	7	" Dec., 1 1	2	—
February 14 -	Brodditch Farm (outlying) -	2 miles -	6	20	" Feb., 1 1	4	—

As to Propagation of the Diphtheria.—There can be no doubt that to a very large extent diphtheria with its allied throat complaints has spread in Radwinter by infection from person to person. In the 43 houses into which it got entry 56 persons besides the original sufferers were attacked. Between the occurrence of the first case in each house, and succeeding ones, an interval, an "incubation period," of two to four days was commonly apparent. The 43 houses had besides the original sufferers, 208 inmates, and the incidence

of diphtheria or allied throat illness upon them, was largely determined by the age of the persons exposed; one age being more "susceptible" than another; thus

20 were under 3 years, of whom 5 contracted throat illness = 25 per cent.									
25 were between 3 and 6 years, of whom 11 contracted throat illness									
20	"	"	6	"	9	"	"	7	"
14	"	"	9	"	12	"	"	9	"
18	"	"	12	"	15	"	"	5	"
111	"	"	over	15	years,	of	whom	19	contracted throat illness = 17.1 per cent.
									=45.7 per cent.
									=27.7 per cent.

All this accords with the custom of infectious diseases generally, and the special susceptibility of children over 3 years and under 12 years old accords with what has before been observed of diphtheria.

But now arises the question of chief interest for this report; in what ways did the 42 persons* who introduced throat illness into the several households themselves come by the disease? Granted, that is, the existence of diphtheria or allied sore throat in the parish, what were the means of its extension from one person to another, and from one part of the parish to another, antecedent to its extension within the family?

Somewhat lengthy examination of this question has been undertaken, in the hope of getting a better knowledge of the circumstances concerned in the spread of diphtheria generally. It was not at once assumed (as might have been assumed for scarlatina or measles) that infection had operated among the 42 persons primarily attacked in just the same way as it afterwards operated among their housemates. For in previous inquiries it has appeared that direct personal contagion may not be the only way in which diphtheria spreads. Accordingly, at Radwinter, inquiry has been concerned with the water supplies, the drainage, and the privy accommodation of the various houses and localities where throat illness has occurred, and search has been made for any relation of such circumstances to the occurrence of the disease. Again, note has been taken of the sources of milk and other food supplied to the several houses and places. Again, the presence of any form of disease existing among animals simultaneously with the throat illness of the human subject has been sought for. But the result of all such inquiries has been negative. As regards locality, little or no community of any such circumstance as the foregoing could be found between one and another infected house or place, while there was abundant community of these kinds between houses and places that were attacked and houses and places that escaped attack. So too, in regard of time, there was no such sudden outbreak of diphtheria, nor any such rapid sequence of cases as pointed to any common cause producing the 42 primary cases. In brief, the inquiry was thrown back on the probabilities of intercommunication of some sort between one and the other of the 42 persons who were the first to introduce disease into their respective houses; and the following were the results of inquiry as to the opportunities of personal intercourse had by such persons.

These in Radwinter have been of two kinds:—First, houses wherein the disease already existed; and, secondly, places of common resort whereat persons incubating, suffering, or recovering from throat illness have, with other persons, habitually assembled. Of the former no notice is necessary beyond the statement that intercommunication of healthy and infected households has, owing partly to the scattered population, partly to the habits of the people, occurred less commonly, perhaps, than might be expected. But as regards places of common resort, some particulars are necessary. Now, in Radwinter the schools have been the only places whereat habitual mixing of the population has occurred. The Church day-school is a centre at which children, mainly at ages 3–12, from all parts of the parish, assemble daily. In addition, older children, not attending day-school, have attended Sunday school, while for youths there has been held during the winter months a night-school three times in each week. In 1876–77 the day-school was closed during harvest, from August 11th to September 25th, and it was closed again from December 22nd to January 1st. Sunday-school has been attended weekly throughout the year.

As to opportunity at school for contracting sore throat, it is certain that for many weeks after the first appearance in the parish of throat illness, children from infected households freely attended schools of all sorts. But soon after the re-assembly of the day-school at the conclusion of harvest, restriction respecting such attendance was undertaken, and has been exercised up to the present time. It has not, however, been complete, and does not appear to have extended to minor cases of sore throat; for again and again in the course of house to house inquiry, has information been obtained respecting the attendance

* One of these must be held to have infected two households, and thus the number of infected households has come to be 43.

at school of children incubating diphtheria or recovering from throat illness that cannot be dissociated from it. Often, too, have children with slight sore throat continued their school attendance throughout the whole period of their ailment. Clearly, then, the day-school in Radwinter has afforded to healthy children at a particular age special opportunity of coming in contact with other children capable of transmitting throat infection.

Now, upon investigation of the daily doings of the persons who were attacked by throat disease *the first* of their respective households, it was found that, out of 42 such persons 26 were in attendance at the day-school of the village during some part of the week immediately preceding illness, and five of the 26 had only been back at school for a few days before their attack, after a previous absence of several weeks. In none of these cases could any communication with infected persons, unless it were at school, be traced. Then there were four other persons of the 42 who had been in attendance at night or Sunday school in the week preceding attack. As regards the 12 persons remaining out of the 42,—the 12 who had not been to any school in the week before their illness—five are known to have been in personal communication with already infected families, and three others are believed to have been in similar communication. There remain but four persons who got throat illness without (so far as can be learnt) having been in relation with antecedent cases, or without having been in attendance at any school.

There is another piece of evidence however that points somewhat definitely towards the day-school as having been concerned in the distribution of throat disease. Of the 42 persons whose attacks are now in question, most were aged between 3 and 12. This was to be expected, if the special susceptibility of children at these ages be considered. But it would seem that there must have been some further and peculiar influence at work upon the children aged 3–12 out of these 42 beyond that which was at work upon the children of the same ages out of the 56 considered in a previous paragraph. The incidence of the disease according to age, within each group of cases, is shown below.

—	Of the 42 first persons attacked in their respective households, there were	Of the 56 persons subsequently attacked there were
At ages 0–3 - -	One, or 2 per cent. of the 42 -	Five, or 9 per cent. of the 56.
" 3–12 - -	Thirty-two, or 76 per cent. of the 42	Twenty-seven, or 48 per cent. of the 56.
" 12–15 - -	Three, or 7 per cent. of the 42 -	Five, or 9 per cent. of the 56.
" 15 and upwards -	Six, or 14 per cent. of the 42 -	Nineteen, or 34 per cent. of the 56.

The incidence upon age within the 56 cases is the incidence under conditions of exposure alike in people of all ages; and the proportionate incidence on each age of this group may be taken as a standard for examining the incidence according to age in any other group where the conditions of exposure are unknown. Now, in the other group of 42 persons, those who were first to fall ill in their respective families, there is a noteworthy excess beyond the standard in the case of children aged between 3 and 12 years; and it cannot be doubted, I think, (though I admit the inference would be more certain if the actual figures were larger,) that this excess shows the children of these ages to have been specially exposed to infection. In the known circumstances of the village, such special exposure cannot have been anywhere but at the day-school, and accordingly I judge that that school was in effect a means of distributing the infection of diphtheria from one family to another.

Summary.—The main results of inquiry in Radwinter are then as follows:—1. Diphtheria irregularly distributed as regards place and time, has here been found associated with long continued and widespread prevalence of sore throat. 2. The chief incidence of the throat illness has been upon children, especially on children at ages 3–12. 3. Whatever the origin of the disease, its propagation has been mainly by personal intercourse. And 4. The attendance of children at the village day-school has been one important means of distributing the disease throughout the parish.

W. H. POWER.

Local Government Board, June 1877.

at school of children incubating diphtheria or recovering from throat illness that cannot be classified from it. Other, not have children with slight sore throat continued their school attendance throughout the whole period of their illness. Clearly, then, the day-school in this instance has afforded to healthy children a particular opportunity of coming in contact with other children capable of transmitting throat infection.

Now, upon investigation of the daily doings of the persons who were attacked by throat disease the first of their respective households it was found that out of 42 such persons 28 were in attendance at the day-school of the village during some part of the week immediately preceding illness, and five of the 28 had only been back at school for a few days before their attack, after a previous absence of several weeks. In none of these cases could any communication with infected persons, unless it were at school, be traced. Then there were four other persons of the 42 who had been in attendance at night or Sunday school in the week preceding attack. As regards the 12 persons remaining out of the 42—the 12 who had not been to any school in the week before their illness—five are known to have been in personal communication with already infected families, and three others are believed to have been in similar communication. There remain but four persons who got throat illness without (so far as can be learnt) having been in relation with antecedent cases, or without having been in attendance at any school.

There is another piece of evidence however that points emphatically towards the day-school as having been concerned in the distribution of throat disease. Of the 42 persons whose attacks are now in question, most were aged between 5 and 15. This was to be expected if the special susceptibility of children at these ages be considered. But it would seem that there must have been some further and peculiar influence at work upon the children aged 5-15 out of these 42 persons that which was at work upon the children of the same ages out of the 58 remaining in a previous paragraph. The incidence of the disease according to age within each group of cases is shown in the following table.

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At ages 5-15	11 out of 42	26 out of 58
15 and upwards	11 out of 42	12 out of 58
Under 5	2 out of 42	20 out of 58
Total	24 out of 84	38 out of 116

The incidence upon age within the 58 cases is the incidence under conditions of exposure also in people of all ages; and the proportionate incidence on each age of the group may be taken as a standard for examining the incidence according to age in any other group where the conditions of exposure are uniform. Now, in the other group of 42 persons, those who were said to fall ill in their respective families, there is a uniformly even spread of the disease in the case of children aged between 5 and 15 years; and it cannot be doubted, I think, though I admit the inference would be more certain if the actual figures were known, that this evenness shows the children of these ages to have been equally exposed to infection. In the known circumstances of the village, such equal exposure cannot have been anywhere but at the day-school, and accordingly I judge that that school was in effect a means of distributing the infection of diphtheria from one family to another.

Summary.—The main results of inquiry in Backwater are then as follows:—1. Diphtheria is regularly distributed as regards place and time, has been found associated with long continued and widespread prevalence of sore throat. 2. The chief incidence of the illness has been upon children, especially on children at ages 5-15. 3. Whether the spread of the disease, its propagation has been mainly by personal communication. And 4. The attendance of children at the village day-school has been the important means of distributing the disease throughout the parish.

W. H. POWER.

Local Government Board, June 1877.