T H E S I S.

"SCARLET FEVER IN LIVERPOOL".

by

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C O N T E N T S.

P R E F A C E.

In the following pages I have made an attempt to gather together and utilise the large amount of material presented by the records of the Public Health Department of Liverpool in relation to some of the wider aspects of scarlet fever.

The authorities on which the results detailed in the following pages are based, are the Annual Reports of the Medical Officer of Health over the past thirty years: the Notification Registers of Infectious Diseases: and original records preserved in the Public Health Office which date back to the year 1848. Up to the present there has been no attempt made to classify, or to calculate results from, the mass of figures which have accumulated over the sixty years.

My thanks are due to Dr. Hope, Medical Officer of Health for Liverpool, for permission to use these records, and also for much kind criticism and suggestion; also to Dr. Robertson, Medical Officer of Health for Leith, for permission to examine the records of his burgh.

RORY E. McLAREN.

Liverpool,

April 1910.

I N T R O D U C T O R Y.

The City of Liverpool offers exceptional facilities for a study of the characteristics of an infectious disease, such as scarlet fever. The magnitude of the population, estimated in 1908 at 753,203 protects one against the errors liable to be introduced when dealing with figures obtained from smaller populations. As a further consequence of its size, and the distinctive character of its various districts, Liverpool is very suitable for a study of the local causes which go toward increasing or diminishing the prevalence of the disease. In regard to density of population for instance, the various districts into which the city is divided range from crowded districts with populations of 177 persons per acre, to outlying districts with only 15 per acre.

Moreover, owing to the fact that Liverpool was one of the first cities in the kingdom to establish a sanitary service and appoint a Medical Officer of Health, the records of the Public Health Office date back to exceptionally interesting periods/

periods when scarlet fever was running what may be regarded as its "normal" course, unchecked by any preventitive measures; the energies of the staff of sanitary officials being fully occupied at that time with the control of typhus, and recurring outbreaks of smallpox. In later years however, owing to the almost complete suppression of typhus, and the more efficient control of smallpox, attention has been turned to the minor infectious diseases, amongst which scarlet fever may now be classed. Nevertheless, the ravages caused by scarlet fever some thirty years ago in Liverpool were such as to well merit its inclusion in the category of the more important zymotics. In many years its total mortality reached, and excelled, that of typhus and smallpox as will be seen from the following figures:

Total number of deaths from:

year.	Scarlet Fever	Typhus	Smallpox.
1862	1015	730	
1867	696	656	
1869	1042	475	
1870	1278	218	
1874	1911	172	
1876	251	224	386
1877	225	299	203

As/

As a result of the efforts recently exerted toward combating the spread of the disease, Liverpool is at present peculiarly well equipped for dealing with outbreaks of scarlet fever. The City Hospitals have between them a total of 1160 beds, equal to one bed per 650 of population. Of these beds, between eight and nine hundred are usually reserved for scarlet fever patients, and the public are more and more availing themselves of the facilities so offered. Thus in 1908 there were 3,528 cases of scarlet fever treated in the City Hospitals being 82 per cent of all the cases notified. Under these circumstances it is not surprising to find that the disease at present, in its wider aspects, shows evidence of marked alteration from that which prevailed thirty to sixty years ago.

ON/

ON THE DEATH-RATE IN LIVERPOOL DURING 62 YEARS.

The scarlet fever mortality returns are our main source of information when we turn to study the history and the course of the disease in Liverpool during the years before the introduction of the Infectious Diseases (Notification) Act. These returns of deaths, dating back as far as the year 1848, I have obtained from old records kept in the Public Health Office at Liverpool. In this connexion it may be noted that the Registrar-General's Reports for all England and Wales do not give the mortality returns for scarlet fever previous to 1855; before that year, the deaths from scarlet fever and diptheria are included under one figure. In Liverpool however, the deaths from these two diseases can be obtained separately from 1849.

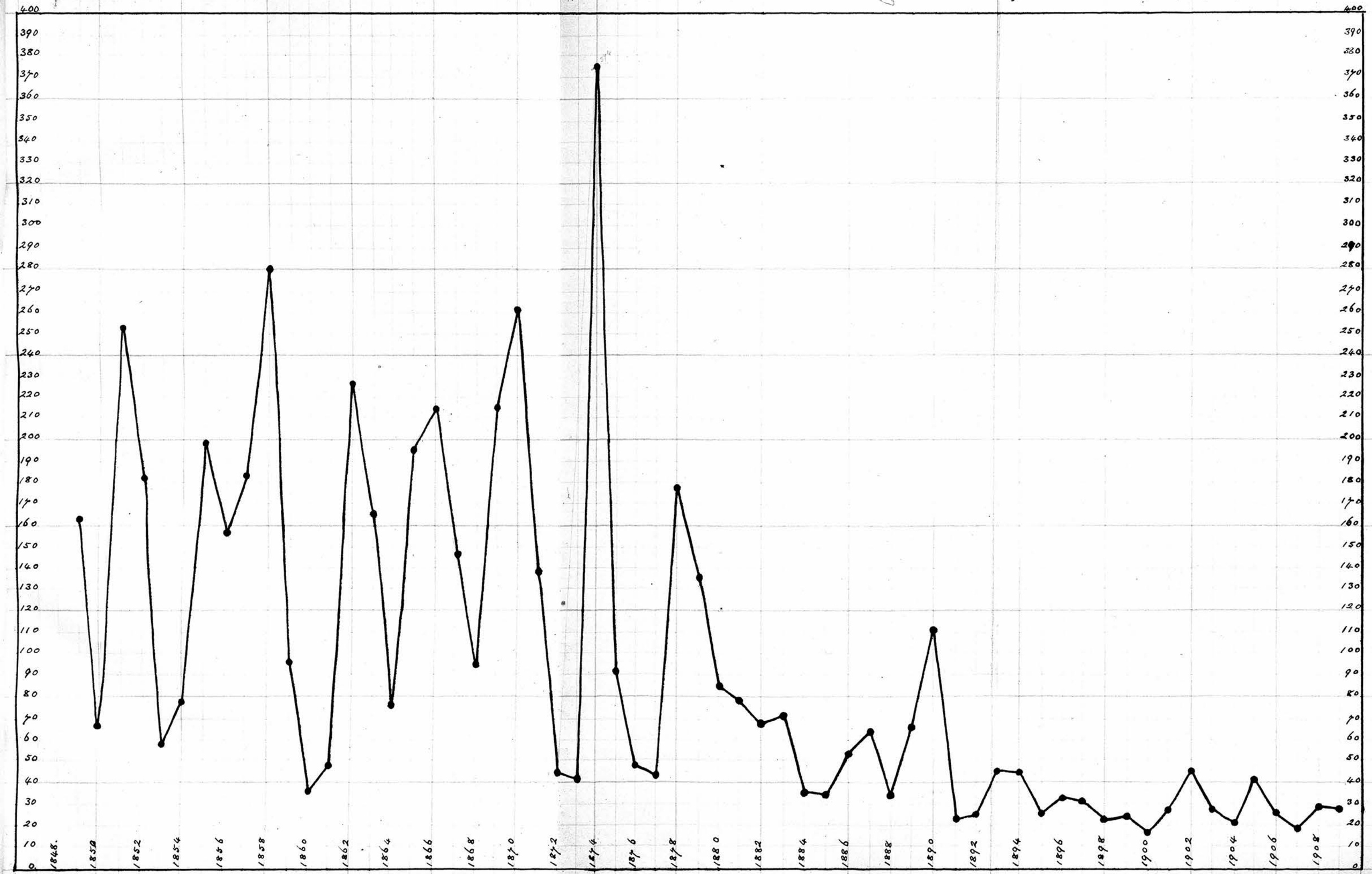
The annexed table and chart shew the crude scarlet fever death rate per 100,000 persons living in Liverpool each year. In all cases I have calculated the death rate upon the estimated population for the respective year.

TABLE/

YEAR	NUMBER of ~~CASES~~ Deaths	DEATH RATE per 100,000 PERSONS LIVING	YEAR	NUMBER of CASES	DEATH RATE per 100,000 PERSONS LIVING
1849	585	163	1871	630	129
1850	240	68	1872	222	44
1851	957	253	1873	205	41
1852	693	181	1874	1911	374
1853	233	59	1875	468	91
1854	314	78	1876	251	48
1855	805	199	1877	225	43
1856	642	158	1878	947	178
1857	761	182	1879	734	136
1858	1186	280	1880	465	85
1859	400	96	1881	435	79
1860	163	37	1882	380	69
1861	216	48	1883	388	71
1862	1015	226	1884	197	36
1863	749	165	1885	190	35
1864	356	77	1886	277	52
1865	506	196	1887	321	65
1866	986	214	1888	187	35
1867	696	147	1889	352	67
1868	456	95	1890	577	111
1869	1042	215	1891	119	23
1870	1278	261	1892	131	25

YEAR	NUMBER of CASES	DEATH RATE per 100,000 PERSONS LIVING.	YEAR	NUMBER of CASES	DEATH RATE per 100,000 PERSONS LIVING.
1893	231	45	1901	195	28
1894	232	44	1902	318	45
1895	169	26	1903	201	28
1896	217	33	1904	149	21
1897	209	31	1905	303	41
1898	145	22	1906	193	26
1899	164	24	1907	140	19
1900	113	17	1908	217	29
			1909	210	28

Crude Scarlet Fever Death Rate per 100,000 persons living: Liverpool 1848–1909.



As these are the only definite records we possess for judging of the behaviour of the disease throughout the middle of last century they are of great value; nevertheless it is only admissable to draw the most general deductions upon the prevalence of a zymotic disease in any city from its mortality returns owing to the presence of two disturbing factors.

The first of these two factors is the variation in the age composition of a population during a period of sixty years. Owing to the steadily decreasing birth-rate*, there has been a change in the age composition of the population with the result that there is now a smaller percentage of children. I have unfortunately not been able to obtain the data to make the necessary corrections in this respect; but the scarlet fever death rate corrected to the present age composition would shew somewhat lower figures in the earlier years on this account.

The main reason however, for our inability to judge of the prevalence of scarlet fever from its death rate per number of persons living is the variation/

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* 38·4 per 1000 in the decade 1861-71;
32·8 per 1000 in the eight years 1901-08.

variation on the type and severity of the disease ~~in~~ which occurs from time to time. The question of case mortality and variations in type will be discussed in detail in the next chapter: suffice it to say that, whilst during the past seventeen years the type in Liverpool has been mild with a mortality ranging from five to eight per 100 cases, in years previous to 1892, the type was undoubtedly much more severe.

Yet notwithstanding these limitations, the crude scarlet fever death rate offers many points of interest. Especially interesting is the period previous to 1890, during which time it may be said no serious attempt was made to control or modify the cause of epidemics. On glancing at the chart it will be seen that this period again falls naturally into two divisions, viz., that prior, and that subsequent to, the year 1880. Prior to this year 1880, we find a very regular series of waves of increased and decreased number of deaths. The absolute height of these waves is not a matter of the first importance, for the reason given above; their importance really lies in the relative positions to one another. Thus we find that the years in which scarlet fever claimed the greatest number/

number of victims are the following:-
1851 - 55 - 58 - 62 - 66 - 70 - 74 - 78.

That is to say, with the greatest regularity, the crests of the waves occur at four yearly intervals. In the entire series, there is only one slight departure through a three years interval, (1855-58). It must be conceded that the regularity of these eight rises during thirty years is a most remarkable feature.

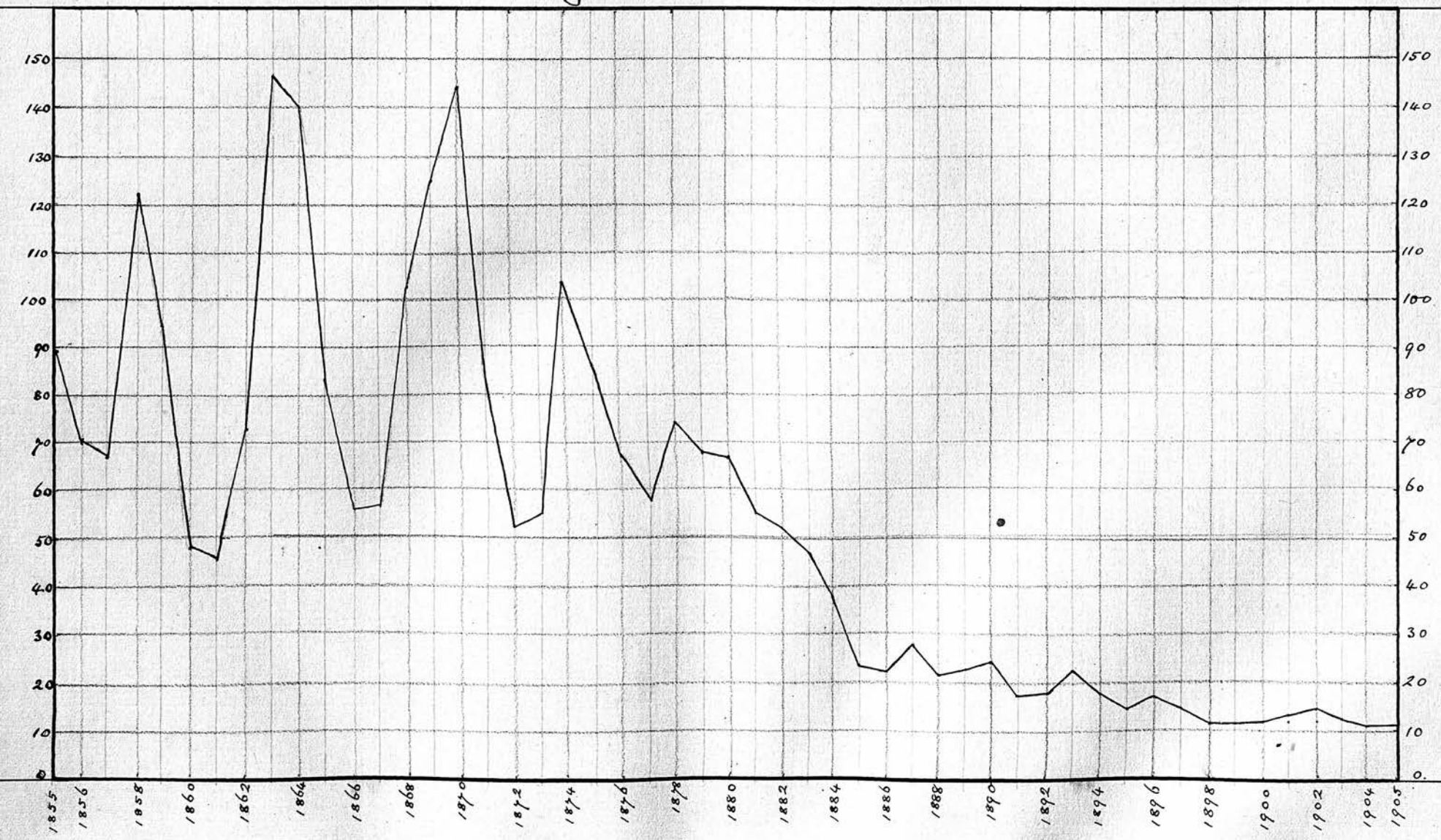
But subsequent to the year 1880 there is a distinct change in the course of the disease; a marked and steady diminution occurs in the number of deaths, the epidemic waves are less easy to recognise, and at no subsequent period has the death rate risen to anything approaching the high figures of the previous years. Nor was this a mere temporary feature dependant on altered local conditions in Liverpool; but rather there was some radical alteration of the characteristics of the disease which was felt more or less simultaneously throughout the entire country. The annexed chart of the corrected scarlet fever death rate per 100,000 persons living in all England and Wales, from the figures published by the Registrar General will shew how marked this change was. Had it occurred/

Chart.

(taken from the figures of the Registrar-General)

Corrected Scarlet Fever Death-Rate per 100,000 persons living:

All England and Wales



occurred ten years later - 1890 - we might have claimed it as a result of the preventative measures exerted by the Public Health authorities; but as it happens, there was practically no hospital isolation of scarlet fever practised in Liverpool at that time.

Thus the records for the past sixty years suggest that the ordinary period for the epidemic/

Corrected Scarlet Fever Death Rate per 100,000 persons living, for all England and Wales.

(Registrar Generals figures) *

1855	89·4	1896	17·7
1860	48·5	1897	14·7
1865	83·7	1898	11·3
1870	144·6	1899	11·7
1875	85·1	1900	11·9
1880	67·5	1901	13·3
1885	23·3	1902	14·8
1890	24·3	1903	12·5
1895	14·9	1904	11·1
		1905	11·2
		1906	10·1
		1907	9·2

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* See Table 27 of Registrar-General's Annual Report for 1907, Cd. 4464. 1908.

epidemic rise of scarlet fever is about four years; whilst at the same time there are liable to be long periods extending over two or three decades, during which the prevalence and malignancy may be either increased or diminished. In this, the experience of Liverpool corroborates the statements of other observers. Ransome for instance, from a study of the course of scarlet fever in Sweden, says: "that not only a short cycle of from four to six years may be traced, but also a long undulation of fifteen or twenty years or more." It will be of interest to note if any change occurs within the next decade in either the prevalence or the type of the disease from that which at present obtains.

What may be the cause of these alternating rises and falls in Liverpool and elsewhere over twenty or thirty years is at present quite unknown: but their correspondence with the period of alternate generations is suggestive. It is very probable that the well marked four yearly epidemics prior to 1880 were due to accumulation of susceptible material in the intervening years. On the other hand the rise and fall of any particular epidemic (excluding those specially spread through a milk agency) or even the rise and fall noted each October/

October to January cannot be explained merely by the "using-up" of susceptible children, but as a recent writer has pointed out,* is possibly due to an alternate exaltation and attenuation of the infecting organisms in their passage through a series of persons. Epidemic forms of many other infectious diseases shew this gradual attenuation more markedly; as for instance in the scattered cases of mild meningitis which are encountered in the year or two subsequent upon an epidemic visitation of cerebro-spinal meningitis.

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* Crookshank "The Control of Scarlet Fever" Lancet No. VII, 1910.

ON/

ON CASE MORTALITY, AND VARIATIONS IN TYPE.

The study of the case mortality in scarlet fever over the past twenty or thirty years is full of interest owing to the evidence it yields of remarkable changes that have occurred in the type and severity of the disease from time to time. The records available in Liverpool are based, as far back as 1890, on the number of deaths occurring amongst the notified cases. As the average number of scarlet fever cases notified per annum during the past twenty years has been over 3000, the figures so obtained may be taken as indicating the severity with a considerable degree of accuracy. Previous to the date when the Notification Act came into force we are obliged to turn to hospital statistics for our figures, and the results arrived at from these data with regard to case mortality are liable to be less accurate for one or two reasons. The paucity of data available introduces the liability to greater error: hence in the subjoined tables on the case mortality in Liverpool I have in all cases given the figures from which the results were obtained that their relative value may be estimated.

There/

There is also the possibility that specially severe cases, or cases at some special age period, may have had preference in admission to hospital treatment. As a matter of fact however, we find, if we compare the published figures for the case mortality amongst hospital treated cases in later years with the case mortality amongst the total notified cases for the respective years, that the disparity is not so very great. The subjoined table will serve to shew the difference that was found to exist between the two in the years following on the adoption of Infectious Diseases (Notification) Act.

NUMBER OF DEATHS OCCURRING PER 100 CASES, AMONGST:

Year.	Hospital Cases.*	Total Notified Cases.
1891	6·0	10·1
1892	5·6	8·0
1893	5·3	6·5
1894	5·4	5·9
1895	6·9	6·2
1896	6·0	6·0
1897	7·1	7·0

These/

* For the figures on hospital-treated cases, v. Annual Report of M.O.H. for Liverpool (1897) p.132.

These figures shew that the case mortality amongst the patients admitted to hospital gave a very fair indication of the type of disease prevalent in the City. Hence, whilst we must for these reasons only accept the figures on case mortality previous to 1890 as approximate, they will at least serve to give a general indication of the malignancy which characterised scarlet fever in Liverpool thirty years ago.

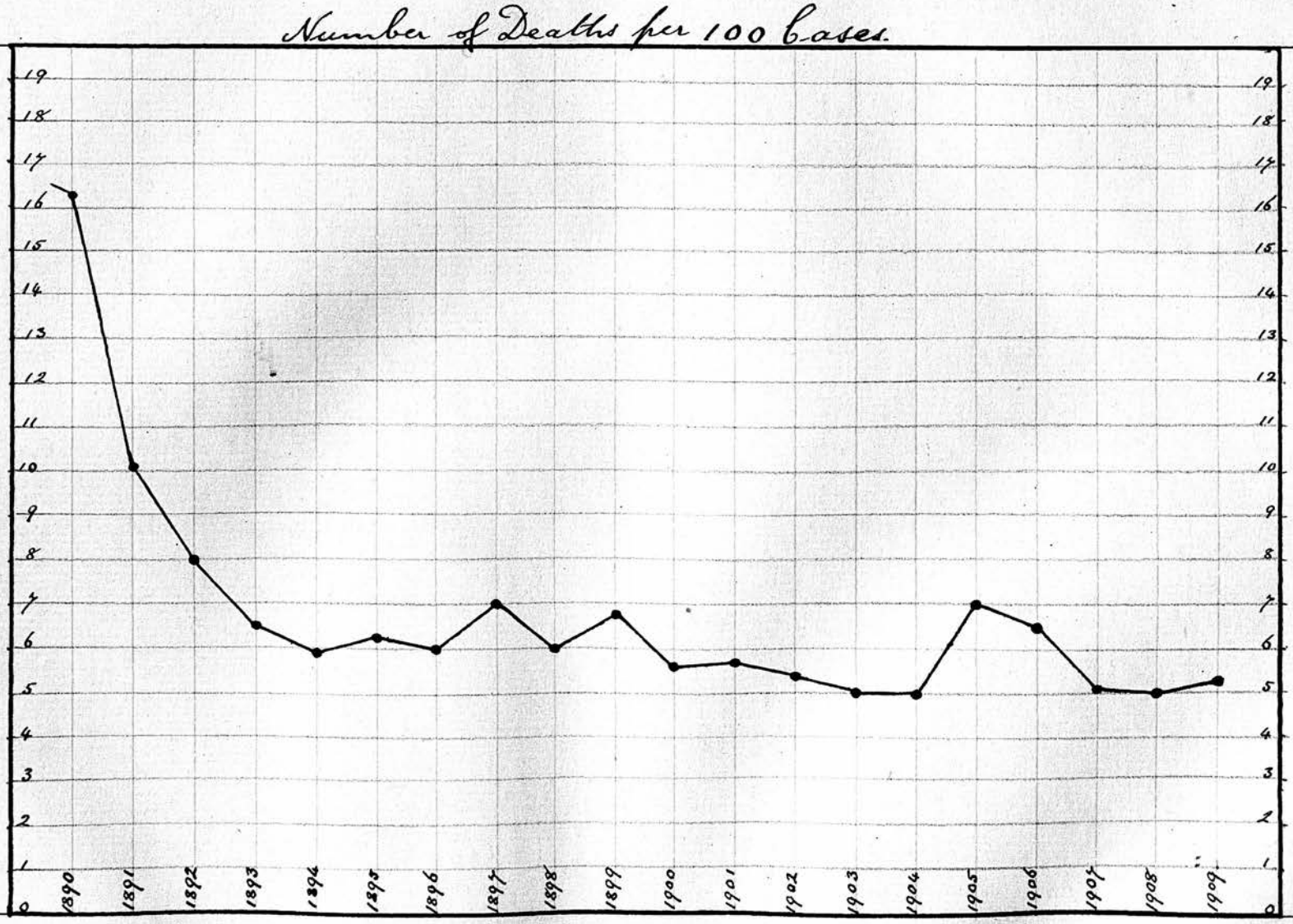
TABLE/

Year	Number of Cases	Number of Deaths	Case Mortality.	Source.
1909	4031	210	5·2	Notified Cases
1908	4295	217	5·0	"
1907	2741	140	5·1	"
1906	2959	193	6·5	"
1905	4308	303	7·0	"
1904	2988	149	5·0	"
1903	4053	201	5·0	"
1902	5914	318	5·4	"
1901	3310	195	5·8	"
1900	1968	113	5·7	"
1899	2416	164	6·8	"
1898	2424	145	6·0	"
1897	3001	209	7·0	"
1896	3584	217	6·0	"
1895	2710	169	6·2	"
1894	3963	232	5·9	"
1893	3538	231	6·5	"
1892	1554	131	8·0	"
1891	1176	119	10·1	"
1890	3520	577	16·3	"
1889	–	–	–	–
1888	115	13	11·2	Parish Hospital Cases.
1887	283	28	9·9	"

Year	Number of Cases	Number of Deaths	Case Mortality	Source
1886	266	20	7·5	Parish Hospital Cases.
1885	116	9	7·8	"
1884	95	19	18·3	"
1883	-	-	-	"
1882	163	22	12·1	"
1881	175	34	17·8	"
1880	144	26	16·9	"
1879	138	37	25·3	"
1878	143	20	14·1	"
1877	52	6	11·5	"
1876	43	5	11·4	"

A/

Case Mortality
amongst the notified scarlet fever cases: Liverpool 1890-1909.



A study of the foregoing table and chart will shew that for the past sixteen years the case mortality has steadily been maintained at a comparatively low figure, varying roughly from 5 to 7 per cent of the total number of cases. During the three years 1891-94 we find evidence of a rapid mitigation of the severe type of the disease prevalent in 1890, when the case mortality amongst the 3520 total notified cases was as high as 16·3 per cent. And the mortality occurring amongst the hospital-treated cases in the years previous to this shew that the disease must have been of a much severe type than that which at present prevails.

This modification that has taken place in recent years has been very generally felt over the whole country, and similar experience has been reported from all the large cities. Hunter, on an analysis of the statistics of the London Fever Hospital over the past sixty years shows,* in the cases of scarlet fever treated in that hospital "that the mortality in certain years has been as high as 20 per cent; the highest quinquennial period (1860-64) being 14 per cent". And the records/

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* Hunter "The Complications of Scarlet Fever" Practitioner, Jan. 1909.

records of all the large fever hospitals bear witness to the fact of the mild form which the disease now assumes.

It is well known that certain of the infective fevers show a tendency to variation in type[+] from time to time; and few afford such well marked evidences of this as scarlet fever. Haemorrhagic scarlet fever has almost disappeared at present, and it is now very uncommon to meet the "toxic" or "malignant" type which used to be the most fatal form of the disease. Moreover at the present day there exist slight variations in the severity of the disease as found in various districts throughout Great Britain. Thus the case mortality in Liverpool over the past fifteen years has lain between 5 to 7 per cent; but this is higher than that found in many localities, when it often falls considerably lower. Thus in Leith I found that the case mortality on the notified cases over the past ten years only averaged 2·0 per cent. And some towns have shewn even lower figures than this. Even in the same district, minor variations will occur from year to year, the percentage incidence of complications changing/

+ v. Whitelegge "Changes of Type in Epidemic Disease" B.M.J. Vol I. 1893; and Hamer, Milroy Lecture 1906; etc.,

changing considerably from time to time.

From a consideration of these facts a point of great interest arises, viz: is it probable that the present amelioration of type will prove permanent, or have we to face the possibility of a reversion to a more malignant form?

Unfortunately it seems we have no grounds for adopting the more sanguine view. For the lowered case mortality cannot be claimed as the result of any radical change of treatment such, as may be instanced in the case of diptheria. In this connexion it may be of interest to note that whilst in 1894 when 33·7 per cent of the notified cases were treated in the Liverpool City Hospitals the ratio of deaths to total cases was 5·9 per cent, in 1908 when 82 per cent were under hospital care the mortality was still at 5 per cent. It is thus very evident that the most modern treatment under all favourable conditions, failed to produce any marked effect in the matter of reducing the mortality amongst the cases. On the other hand this cannot be urged in any way as an argument against hospital isolation, for it must be remembered that the importance of scarlet fever nowadays lies, not so much in the actual mortality as in the severe complications which so often are its sequel.

Nor/

Nor can it be claimed that the mildness of the present average attack is due to a growing immunity on the part of the population. Beyond doubt there do exist relative degrees of immunity toward infectious disease amongst different races owing to long exposure to those diseases - one may instance the terrible ravages caused by smallpox when introduced to America in the XVIth. century the prevalence of measles when first brought to the Fiji Islands, and many other examples; but such immunity is acquired with extreme slowness. Obviously, the sudden change in the severity of scarlet fever is not due to such a cause.

Finally, it has been shewn by Graves and others that there have often been experienced similar prolonged periods when the type was mild, followed again by periods of greater malignancy. These in scarlet fever average on the whole about thirty years. If that be the case, then it is highly probable that within the next decade we shall witness a return to a more malignant type. It is not without significance that in Liverpool there have occurred during the past thirteen months a series of cases which are quite unique in the experience of its fever hospitals./

hospitals. These cases - 14 in all-have been characterised by acute uraemia, as evidenced both by clinical symptoms and post mortem examination, setting in simultaneously with the onset of the fever. With one exception, all these cases proved fatal within two or three days; in some cases within a few hours. After witnessing such cases, one realises what latent potentialities there are for evil in scarlet fever even yet.

ON THE DISEASE INCIDENCE AND INFLUENCE OF HOSPITAL ISOLATION.

It was owing to the application of the Infectious Diseases (Notification) Act of 1889 that the first reliable figures were able to be obtained in connexion with the prevalence of the disease in the City. For some years previous to this, there had been a system of voluntary notification of scarlet fever practised in Liverpool with a considerable degree of success; but such figures, though of great practical use to the Public Health authorities at the time, are of no value for statistical purposes.

From the notification returns subsequent to 1889 it is possible to work out with a fair degree of accuracy the disease incidence (attack rate) per 10,000 of the population: errors in diagnosis have been found to be too slight to vitiate the statistics. The Liverpool City Hospitals find the error to be only 2·3 per cent of the total admissions.

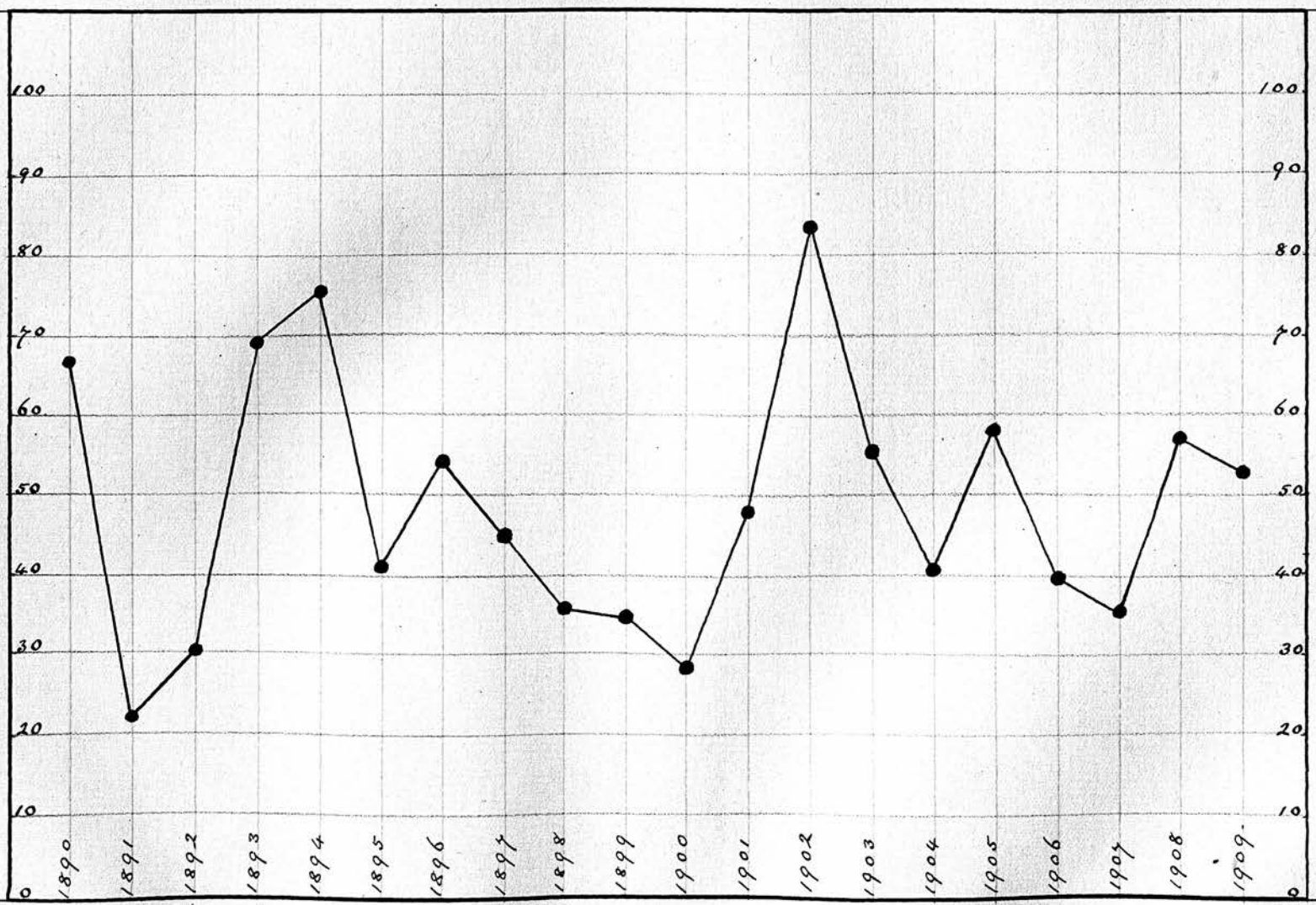
The annexed table shews the attack rate per 10,000 during the past twenty years; also the percentate of the cases which were removed to hospital:

TABLE/

Year	Number of Cases	Disease Incidence per 10,000	Percentage of the cases, Removed to hospital.
1909	4031	53·0	-
1908	4295	57·0	82·1
1907	2741	36·7	78·2
1906	2959	39·9	74·0
1905	4308	58·7	73·0
1904	2988	41·0	74·6
1903	4053	56·5	52·9
1902	5914	83·3	53·4
1901	3310	48·2	54·8
1900	1968	28·9	60·8
1899	2416	35·8	63·6
1898	2424	36·2	60·5
1897	3001	45·2	54·6
1896	3584	54·5	44·3
1895	2710	41·5	38·3
1894	3963	75·9	35·7
1893	3538	69·3	39·1
1892	1554	30·2	38·9
1891	1176	22·7	38·1
1890	3520	67·7	26·6

Scarlet Fever

Disease Incidence per 10,000 : Liverpool 1890–1909.



It will be seen from the foregoing table and chart that, notwithstanding the fact that the percentage of cases removed to hospital has more than trebled, it has been found impossible to reduce the incidence of the disease below a certain level. On the other hand we have no means of knowing what would have occurred in the absence of the present precautionary measures; and it is only fair to assume that their absence would have meant a far higher prevalence. It is probable that the continued low incidence between the epidemics of 1894 and 1902 was due to the increasing efficiency in the control of the cases; but the natural result of a continuously low incidence is to increase the proportion of susceptible children, and to correspondingly increase the liability to an epidemic. Nevertheless by our present precautions both epidemic and inter-epidemic years are probably kept at a lower level than would otherwise be the case.

Scarlet fever is a disease which owes its propogation mainly to its attacking several members of each family: and our main concern in hospital isolation is the protection of the other susceptible children in any family in which a case occurs. Where all the children in a family are simultaneously affected,/

affected, our main object in hospital isolation has been defeated; and the same holds good when a case occurs in a household which contains no other susceptible children provided that one can ensure that ordinary care is taken.

As an illustration of the value of hospital isolation, I may give the results I obtained from an investigation which I recently made upon the cases of 110 families in which scarlet fever occurred, all of which families had other susceptible children under ten years of age. The original case was removed to hospital as soon after notification as possible, and disinfection* of the room and all infected articles was performed by the Public Health officials. Any case occurring within six months of the primary one I considered to have been due to that one. Of the 110 families, I found that in 83 no further infection occurred; in 27, other children contracted the disease (three of these being due to "return" cases.) That is to say, 75 per cent of the families with susceptible children escaped further infection. With regard to the number of children in these families, in all 242 were exposed to infection, of whom

.38/

* Walls sprayed down with a solution of formalin, 6 ozs. to the gallon; sheets, clothing, etc., in a modified Washington Lyon Disinfector, saturated steam at 10 lbs pressure to square inch.

38 contracted it: i.e. 84·3 per cent of those exposed escaped infection, whilst 15·7 per cent contracted it. Such results must be regarded as satisfactory, in their bearing on the control of the disease by present day methods of hospital isolation.

FAMILIES EXPOSED, 110

Further infection in 27; or 25 per cent.
Infection avoided in 83; or 75 per cent.

CHILDREN EXPOSED 242

Number contracting disease 38; or 15·7 per cent.
Number escaping disease 204; or 84·3 per cent.

ON THE ATTACK-RATE IN VARIOUS DISTRICTS, WITH CORRECTION FOR AGE.

Seeing that the incidence of scarlet fever falls so markedly upon the young, it is of the first importance when comparing various localities with one another to ascertain whether the age composition of the populations of those districts is identical and, if they are not, to reduce them to the same standard. It would be obviously incorrect for example to compare an artisan district with a high birth-rate and a large percentage of children against a more fashionable suburb in which the percentage of children is low. For example in Everton, the population of which mainly belongs to the artisan class, the number of children under fifteen years of age at the last census was 3816 per 10,000; whilst in Sefton Park, the residential district, the corresponding figure was only 2732 per 10,000.

The following tables, giving the factor for age correction in the various districts of Liverpool, I have calculated upon the census returns of 1901. It will be seen that the tables are somewhat modified from the ordinary age correction tables by only making correction for the percentage of children of fifteen/

fifteen years and under. The reason for this simplification is, that seeing that by far the majority of cases of scarlet fever occur in children under fifteen years, any variation in the composition of populations over the age of fifteen could have but a fractional influence on the scarlet fever returns. Thus I found that of a total of 17,321 cases of scarlet fever occurring in Liverpool over the past five years, only 6·7 per cent of the cases occurred in persons at all ages above fifteen. Hence slight differences in the age composition of populations over fifteen will have quite an immaterial effect on scarlet fever statistics.

The standard age composition for the districts has been taken as that of all Liverpool at the Census of 1901.

No correction needs to be made for sex distribution when dealing with scarlet fever returns, as the difference of the incidence on the two sexes is so slight that variations in populations in this respect have no effect on scarlet fever statistics.

A word or two may be added upon the characteristics of some of the Liverpool districts in explanation of the following tables.

The/

The low percentage of children in Sefton Park is due to this district being a residential suburb of the better-class amongst whom the birth-rate is low;* also to the fact of there being a large proportion of domestic employés in this part..

In Exchange and Abercrombie, the business quarters of the city, the low percentage is probably due to the large numbers of inmates of registered lodging houses.

Scotland Road and Everton are densely populated districts (populations respectively 177 and 134 per acre)+ of the artisan class.

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* 17·8 per 1000 (1907).

\+ Birth-rate respectively 39·9 and 34·7 per 1000 (1907).

District	Population (Census, 1901.)	Percentage of Population in 0–15 Age Group	Factor for Age correction.
Liverpool	702247	34·915	1·000
Everton	121469	38·16	0·915
Kirkdale	69386	36·69	0·952
Walton	54616	34·66	1·007
Sefton Park	30187	27·32	1·278
Exchange	41994	30·98	1·127
Abercrombie	52440	27·56	1·267
Toxteth	106043	35·28	0·989
Scotland Road	52966	37·51	0·931
Wavertree	25303	35·12	0·968

Having thus obtained the factor for age correction, the subjoined tables shewing the attack rate per 10,000 in various districts of Liverpool have been obtained by calculating the crude attack rate on the estimated population of each district for the respective year, and then multiplying this by the factor for age correction. We thus obtain the Corrected Attack Rate per 10,000, that is to say, the attack rate that would exist in the districts were all the populations of the same age composition. Such figures are strictly comparable.

It may be objected that, in any district, the same factor, based on the Census of 1901, has been applied over a series of several years. As a matter of fact, however, the age composition of districts is extremely slow in altering. According to Newsholme * "In Populations whose chief occupations remain the same, ~~and~~ the age and sex distribution do not alter greatly in a single decennium".

A common difficulty in enquiries dealing with the local prevalence of a zymotic in a town or district, is that the subdivision necessary for the purpose introduces errors due to paucity of date. Owing however to the size of Liverpool, its component districts are in themselves as large as many provincial towns; their populations varying from 40,000 to 120,000. The subjoined tables can thus claim to be free from this defect.

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* Newsholme "Vital Statistics" p.110 Ed 3rd.

Corrected Scarlet Fever Attack Rate per 10,000 in various Districts of Liverpool.

Year	Liverpool.	Everton	Scotland Road	Exchange	Abercrombie	Kirkdale	Toxteth	Walton	Sefton Park	Waverbee
Population 1908.	455203	122940	52478	40445	50242	70536	104905	64053	37408	39150
Density per Acre 1908.	45.1	177	134	86	74	100	121	34	29	21
1908	57.0	77.1	46.1	43.1	25.7	51.6	57.9	83.7	36.2	41.0
1907	36.7	31.4	31.7	39.3	35.9	36.1	34.0	46.6	46.0	26.3
1906	39.9	38.2	21.0	18.1	21.9	34.2	34.3	45.9	63.0	47.2
1905	58.7	53.9	49.6	52.9	36.4	37.8	65.6	70.3	51.5	49.1
1904	41.0	48.0	19.9	25.9	37.1	31.7	43.7	63.1	38.2	37.1
1903	56.5	53.9	34.2	49.9	44.7	67.6	45.2	88.8	65.7	47.7
1902	83.3	90.0	80.3	81.0	65.6	73.6	65.6	121.9	134.3	55.9
1901	48.2	46.4	31.5	29.2	48.2	37.9	54.2	67.3	70.5	33.1
1900	28.9	30.7	13.6	20.9	13.9	26.9	28.7	33.7	42.0	27.9

Figures above the mean of the year are printed in red: those below, in black.

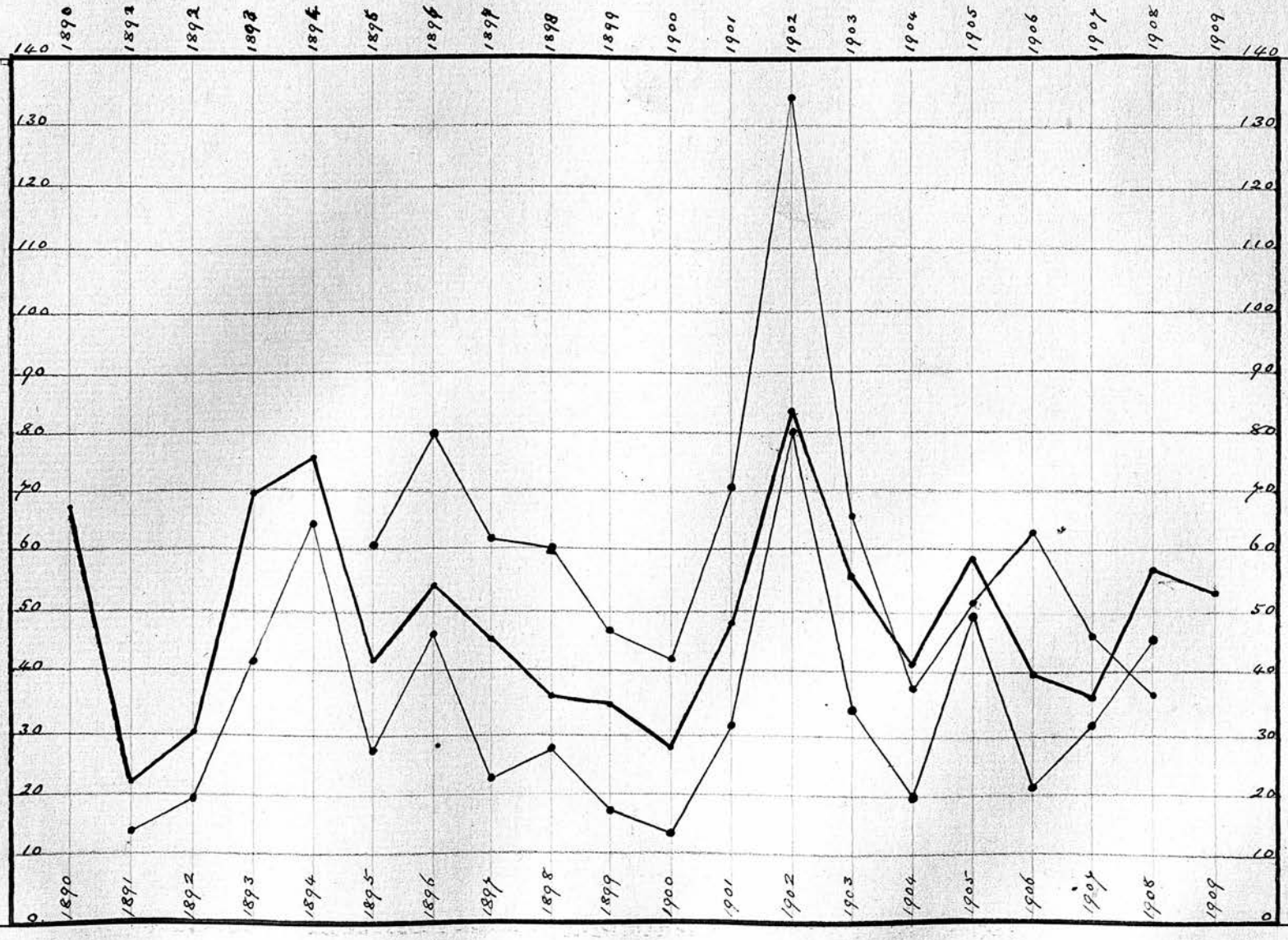
Corrected Scarlet Fever Attack Rate per 10,000 in Various Districts of Liverpool. (continued.)

Year	Liverpool.	Everton	Scotland Road	Exchange	Abercrombie	Kirkdale	Toxteth	Walton	Sefton Park	Wavertree
1899	35.8	39.5	18.1	26.7	33.7	34.0	31.8	43.1	47.8	25.9
1898	36.2	28.1	28.7	18.5	41.1	30.9	38.6	30.9	60.3	22.2
1897	45.2	32.4	22.9	20.9	48.0	32.6	77.4	48.7	61.1	31.2
1896	54.5	52.5	46.9	30.8	41.7	43.5	66.6	33.2	79.8	74.5
1895	41.5	52.3	28.6	29.4	37.1	59.8	31.0	35.9	60.4	33.1
1894	75.9	84.5	64.6			108.1	67.4			
1893	69.3	63.2	41.7			74.4 ~~73.4~~	73.4			
1892	30.2	35.6	19.6			29.8	21.6			
1891	22.7	25.4	14.5			25.4	16.4			
Average Attack Rate (decenniums 1899 - 1908)										
Decenniums 1899 - 1908	48.8	51.0	34.7	38.5	36.1	44.6	45.9	66.7	58.9	39.1

Figures above the mean of the year, printed in red: those below, in black.

corrected Scarlet Fever
Disease Incidence per 10,000

in { All Liverpool — Black
Sefton Park — Red
Scotland Road — Violet.

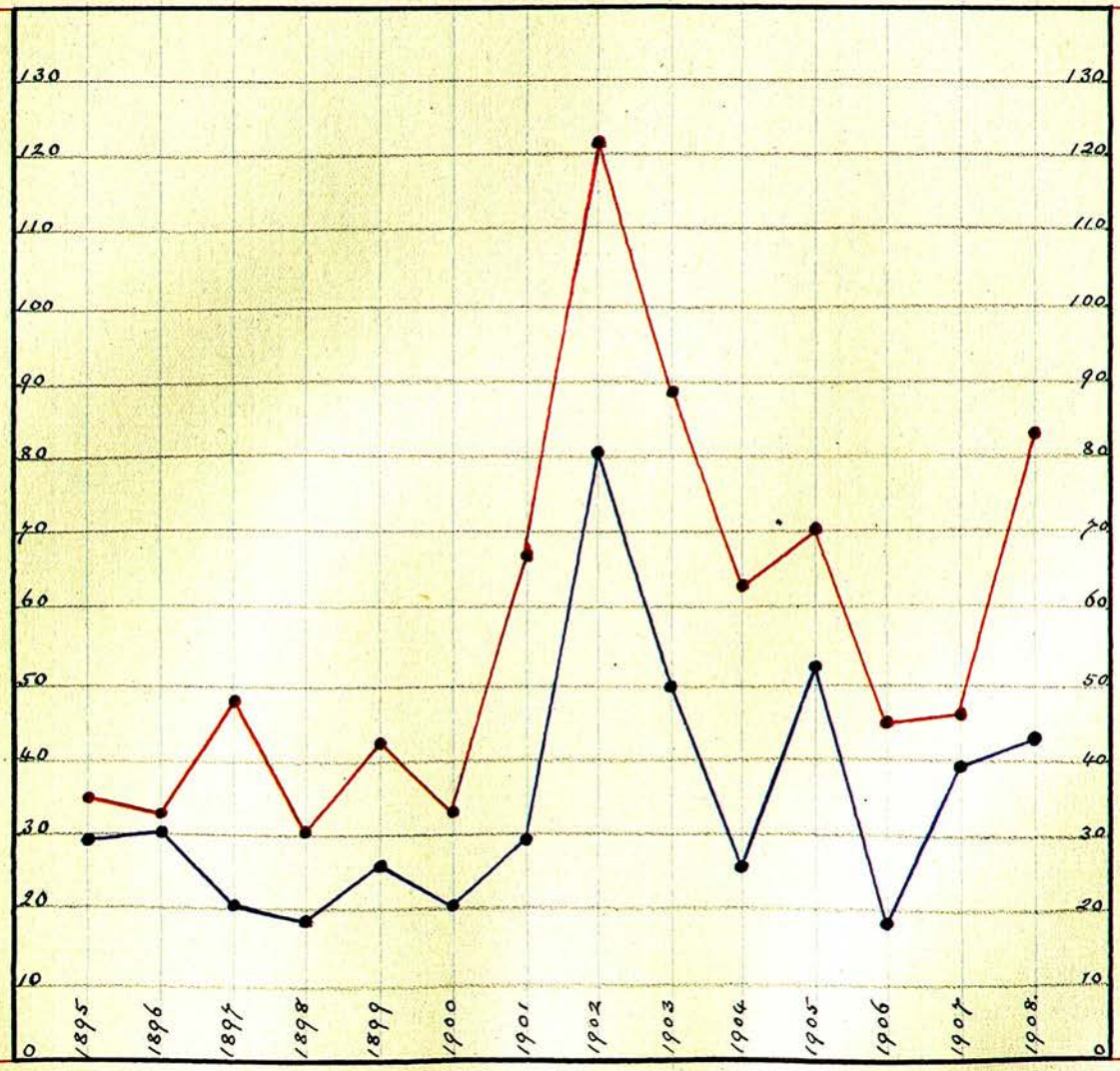


shewing the high incidence in Sefton Park district, a low incidence in Scotland

Corrected Scarlet Fever

Disease Incidence per 10,000:

in { Walton — Red
Exchange — Violet.



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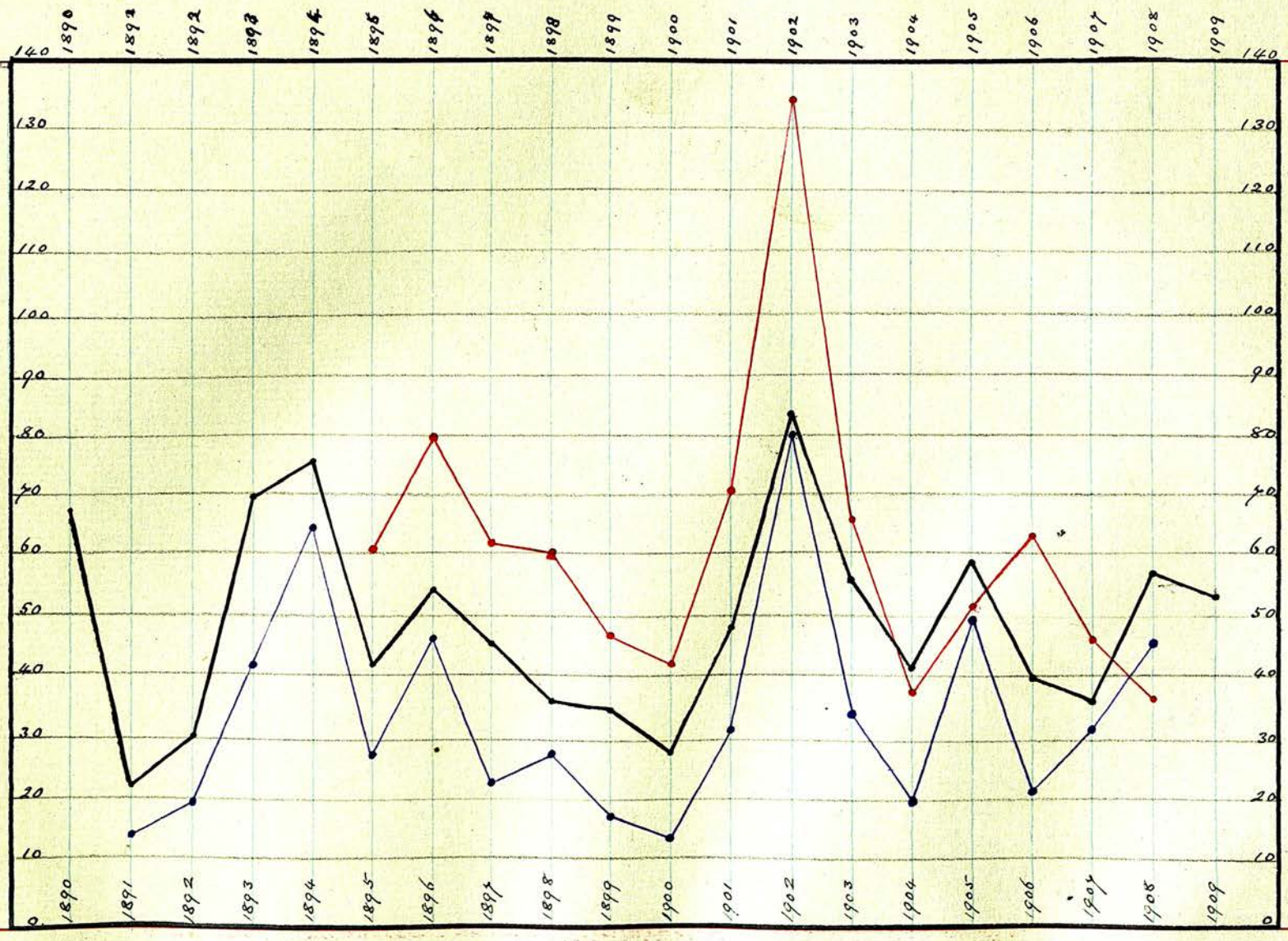


shewing the high incidence in Sefton Park district, a low incidence in Scotland

On examining the foregoing tables we may at once dismiss the four districts of Everton, Kirkdale, Toxteth and Wavertree as approximating so closely to the general disease incidence of all Liverpool as to present no features worthy of special study. The interest rather centres around those districts which present the widest divergence from the mean; Sefton Park and Walton on the one hand shewing a persistently high attack rate: Exchange, Abercrombie and Scotland Road shewing a persistently low one.

What renders these results of peculiar interest however, is that these two groups of districts lie at opposite extremes in the social scale of Liverpool. Sefton Park is the residential suburb, the home of the "well-to-do" portion of the population; Walton a thriving prosperous district of the better class tradesman; whilst the three districts in which scarlet fever is relatively lowest, are populated by some of the poorest in the City. This applies with especial force to Scotland Road, a district which contains many insanitary areas, some of which are the subject of improvement schemes at the present moment.

It had very generally been assumed that

the/

the reverse state of affairs in regard to scarlet fever held good, namely that Walton and Sefton Park were relatively free. Yet even on the shewing of the Crude Attack Rates alone, the opposite is proved to be the case. Nor is the difference due to the intervention of any temporary local factor, such as a well marked "milk" epidemic; but the difference between the districts has been maintained over a period of fifteen years with fair persistency.

It is well known that "overcrowding", per se, tends to facilitate the spread of scarlet fever, though not to a very great extent. Thus in the case of the 110.families previously alluded to, in which a case of scarlet fever occurred and was removed from a household containing children, I found that there was a larger incidence of further infection in those families living in two-roomed houses than in those dwelling in larger houses. Thus of 46 families living in two-roomed houses, 13 yielded further cases (27 per cent;) whilst of 51 families living in three rooms or over there were only 9 which yielded further cases (18 per cent.) Now the density of population per acre in the districts under question is as follows

District/

District	Population per acre (1908)
Scotland Road	134·2
Exchange	86·4
Abercrombie	74·5
Walton	33·6
Sefton Park	29·1

And though we unfortunately do not possess the data to give us the number of persons per occupied room-the true test of "overcrowding" - yet there is no doubt that the first three districts would shew the greatest density in this respect also.

It follows that there must be factors at work with regard to the spread of scarlet fever in these districts so potent that they can easily over ride the effects of density of population, and of the better care and supervision of the children. What these factors are, I must confess I have not as yet been able to elucidate. Dr. Hope of Liverpool, has suggested to me that the increased incidence in the better-class districts is due to a relatively increased consumption of milk; shewing itself, not in any well-marked epidemic, but in an all-round raising of the incidence. If this be so-and the suggestion is worthy of further investigation-then our conceptions/

conceptions with regard to the spread of this disease will require considerable modification.

ON THE SEASONAL VARIATION

Scarlet fever in Liverpool shews the well marked seasonal range of incidence that occurs throughout the rest of Great Britain, being lowest in the spring and summer months, and rapidly rising to its maximum in October. The following figures for Liverpool I have gathered from a series of 43,971 cases extending over a period of thirteen years; the subjoined tables give the total number of cases occurring during each month over the entire period (1896-1908.) To make these figures more readily comparable, I have followed Newsholme's plan of obtaining the monthly average of cases: and, expressing this as 100, have calculated the proportionate number of cases occurring in each month. Thus:

Total Number of Cases in the 13 years = 43971.

Therefore Monthly Average $= \frac{43971}{13 \times 12}$

$= 281 \cdot 8.$

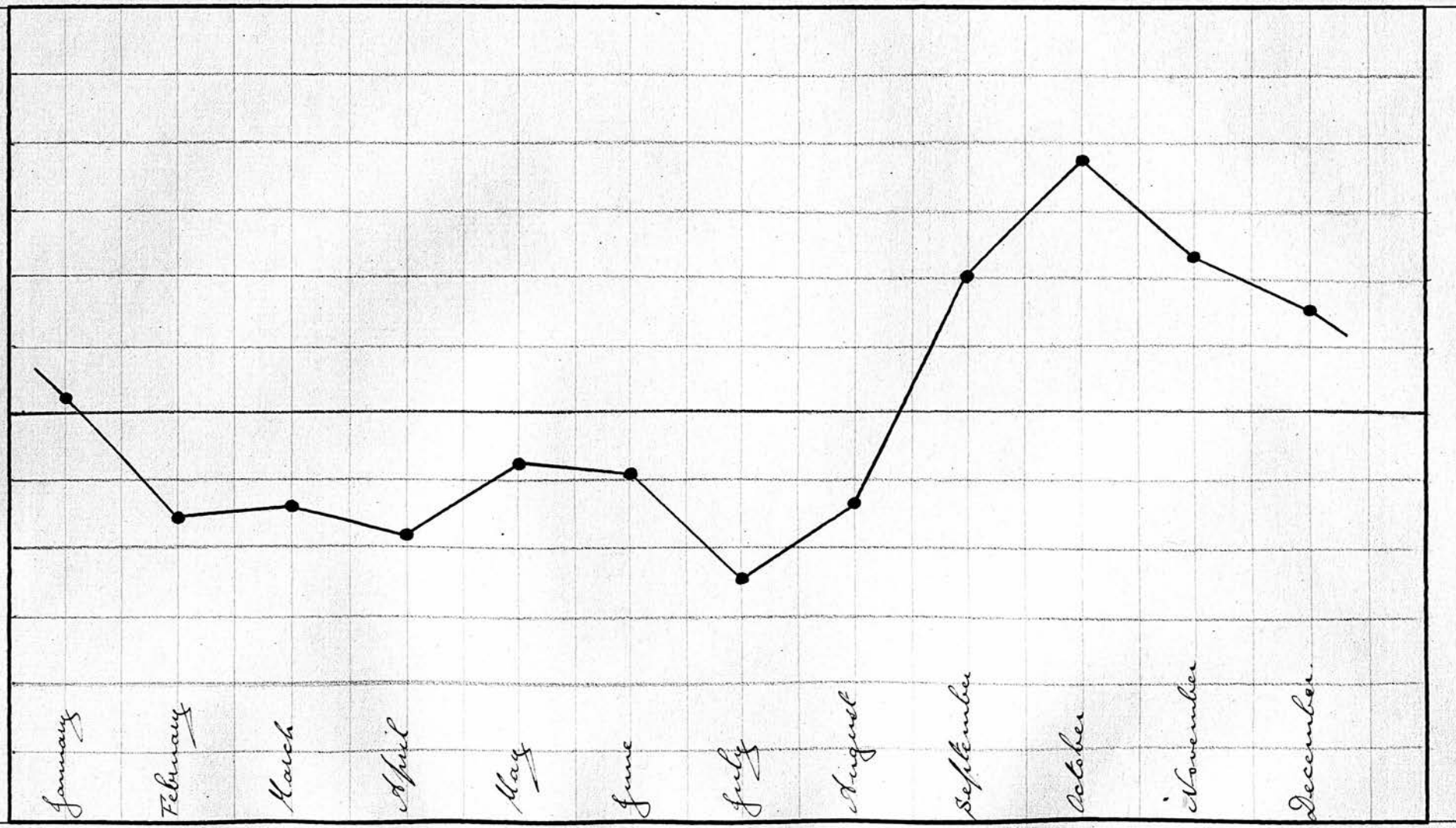
If one then expresses this monthly average as 100, the corresponding figure for each month is obtained by dividing the total number of cases occurring in that month during the thirteen years by $13 \times 2 \cdot 818$.

TABLE/

Month	Total Number of Cases in 13 years	Number when reduced to a monthly average of 100.
January	3749	102·3
February	3102	84·7
March	3171	86·5
April	3000	81·8
May	3379	92·2
June	3333	91·0
July	2806	76·6
August	3188	87·0
September	4411	120·4
October	5062	138·1
November	4534	123·7
December	4236	116·2
	43,971	

Monthly Average 281·8.

Seasonal Incidence of Scarlet Fever in Liverpool 1896–1908.



Each division represents a deviation of 10% above or below the mean monthly average

In the main these figures agree with those obtaining in other large English cities. Thus from February to August the notifications are below the monthly average: from September to January (inclusive) they are above. Owing probably to its more equable climate the range of variation is not so great as that found on many of the cities on the eastern coast. The difference between the figures for the maximum and minimum months in Liverpool is 61; in London 78; and Leith 104. The following table will illustrate this:

City	Minimum	Maximum
Liverpool	July 77	138 October
London *	March 76	154 October
Leith +	June 72	176 October

* On 40 years Mortality Returns: v. Whitelegge and Newman, "Hygiene and Public Health" 1908 Chap. XXI

\+ The Leith figures I have calculated from the Notification Returns (8 years)

ON AGE: IN ITS BEARING ON
INCIDENCE AND MORTALITY.

The following tables are an analysis of 17,321 cases of scarlet fever which occurred in Liverpool during the five years 1904-08. They shew well the marked susceptibility of the young to the disease; the first five years of life giving no less than 45 per cent of the total number of cases. The next ten years are responsible for another 48 per cent of the cases; 16,153, or 93·3 per cent of all the cases occurring below the age of fifteen years. The following is the table shewing the percentage in the various age groups:

Age Group	Number of Cases	Percentage of Total.
0-1	410	2·37
1-5	7399	42·72
5-15	8344	48·17
15-25	769	4·44
25 upward	399	2·30
Total	17,321	100·0

These/

These figures, it may be stated, have been derived from notified cases. Hospital statistics are untrustworthy in this matter, owing to children of certain ages being permitted by their parents to go to hospital with more freedom than are those of other ages. For instance, of the above 17,321 cases, which represent the total number of cases notified over the five years, children under five form a percentage of 45. But of the 12,000 of these cases treated in hospital during the same five years the percentage of children under five forms only 37. This will serve to shew the difference that may exist between figures derived from the two sources.

Hospital statistics, if dealing with a sufficiently large number of cases, are quite admissable for shewing the influence of age on the severity of attack. I have collected the figures for the scarlet fever patients treated during the same five years in the seven principal City Hospitals of Liverpool. These shew the steady decline of the mortality amongst cases from infancy till about the twentieth year, after which it maintains much the same level, or even rises slightly:

TABLE/

Age Group	Number of Cases	Number of Deaths	Percentage Mortality
0-5	4778	505	10·57
5-10	5152	152	2·95
10-20	2353	38	1·61
20-30	378	4	1·06
30-40	123	2	1·62
45-50	20	0	-
50 upwards	3	0	-
All Ages.	12,807	701	5·47

Although the severity of an average attack is greater during the first year of life and thereafter steadily declines, the actual number of deaths rises to a maximum about the third or fourth year of life, as is shewn by the subjoined figures:

DEATHS/

DEATHS FROM SCARLET FEVER OCCURRING IN LIVERPOOL DURING THE FIVE YEARS 1904-08

Age Group	Number of Deaths
0-1	50
1-2	128
2-3	183
3-4	182
4-5	123
All Ages.	1002

This phenomenon is of course, almost entirely accounted for by the mere interaction of the decreasing severity of attack with the increasing susceptibility to attack, during the first six years of life.

APPENDIX/

A P P E N D I X.

It is becoming very generally acknowledged that the long periods of isolation hitherto enforced in cases suffering from scarlet fever are not necessary in the majority of cases. The opinion is steadily growing and evidence is rapidly accumulating, that the later stages of desquamation are not in themselves infective, but only so by virtue of their previous contamination with infected material; in much the same manner as clothing and other fomites are infective. The Liverpool City Hospitals have between two and three thousand cases of scarlet fever under their care annually; and the average period of detention is still maintained between eight to nine weeks. In contradistinction to this, certain fever hospitals are commencing to discharge their scarlet fever patients on the 35th day of the disease if considered in a fit condition: even in some cases as early as the 28th. and it is alleged that there is no corresponding increase in the number of "return cases".

In this connexion, I would give the results which I lately obtained from the discharge of a series of 500, cases of scarlet fever from hospital, all/

all of whom were dismissed as soon after the 35th.day of the disease as was considered advisable.

My practice was to have all cases "shewn up" for examination on the 34th. day of their disease; those that were considered suitable were discharged on the following day. I considered it inadvisable to discharge cases from hospital earlier than the 35th. day, not so much on account of possible infectivity, as on account of the possibility of "relapses", nephritis, or other complications occurring at home after dismissal. Cases shewing evidence of otorrhoea, rhinitis, or vaginitis were, of course, detained; as also were cases with an obvious lesion such as a cracked lip, onychia etc.

Under these conditions I found that I was able to discharge 303 cases or 62 per cent, before the 42nd. day of disease; the remaining 38 per cent were detained for periods over six weeks, as shewn in the table. No "special" measures were employed at the time of the child's dismissal, such as giving the final bath the day before discharge and then keeping in a non-infected ward over-night; but the child received its final bath on the morning of leaving hospital, the parents usually calling for it early in the afternoon. The subjoined table gives the number of cases discharged at each day of disease, and the resultant "return cases".

TABLE/

Day of Disease.	Number Discharged	Number of "Returns"	Percentage of "Returns".
35th.	52	2	
36	56	0	
37	51	1	
38	37	0	
39	32	1	
40	28	0	
41	30	2	
42	17	1	
Before 42nd.day	303	7	2·31
43rd. - 49th.	102	4	
50th. - 56th	39	0	
57th. - 63rd.	20	1	
64th. - 70th	7	0	
Over 70th	19	0	
After 42nd.day	187	5	2·67
Total	490	12	2·45

Thus the percentage of "return cases" on the total 500 was 2·4 - a very usual figure; yet the average stay of these patients in hospital was reduced to 39 days. Moreover it will be seen that in the 300 cases discharged before the 42nd. day of disease the percentage of "returns" (2·3) rose no higher than in the cases whose detention was more prolonged (2·6.) Three hundred cases are not sufficient in themselves upon which to base very accurate results; but they are amply sufficient to shew that suitable cases are no more infective on the 35th. day than they are on the 42nd. In view of results such as these, I would submit that the prolonged periods of detention still practised in many hospitals exceeds that which is necessary for safety; and that suitable cases are quite as ready for discharge on the 35th. day of the disease as on the 42nd, from the point of view of infection. There is no need to point out the saving such a routine entails in the expenses of Infectious Diseases Hospitals.

SUMMARY/

S U M M A R Y.

CHAPTER I.

Calculation of crude Death Rate from Scarlet Fever per 100,000 persons living in Liverpool since 1848.- Source of figures - Limitations in use of Crude Death Rates.- Evidence of four yearly epidemics and thirty year undulations, as recognised by other observers.- Marked reduction of deaths from scarlet fever about the year 1880, previous to introduction of effective measures of control.

CHAPTER II.

Calculation of Case Mortality since the year 1876.- Source of figures between 1876 and 1890: of figures subsequent to 1890.- Their relative value. Recent mitigation of type. Variations in scarlet fever at the present day, both local and temporary. Possibility of return to a more malignant form. Reasons for this view. Recent cases of a "new type" of scarlet fever.

CHAPTER III.

Calculation of Disease Incidence per 10,000 of population.- No evidence of marked reduction through more efficient control.- Main factor in/

in spread of scarlet fever. Object of hospital isolation. Results obtained in a series of cases removed to hospital.

CHAPTER IV.

Effect of age composition of populations upon scarlet fever statistics. Calculation of age composition of various districts of Liverpool, based on Census of 1901. High incidence of scarlet fever in the better-class districts; lowest in the poorest. Effect of density of population, per se.

CHAPTER V.

Calculation of Seasonal Incidence over thirteen years. Methods employed. Effect of equable climate.

CHAPTER VI.

Age in relation to susceptibility. Analysis of cases. Importance of correct source of figures. Age in relation to mortality. Analysis of cases.

APPENDIX/

A P P E N D I X.

Earlier discharge of scarlet fever patients from hospital, as now practised. Results obtained from the discharge of a series of cases, as soon after the 35th. day of disease as possible.