LOOKING BACK

Decline and fall of the tubercle bacillus: the Newcastle story 1882–1988

F J W Miller, Mary D Thompson

In 1882, when Koch isolated and cultured the turbercle bacillus, Newcastle upon Tyne was a city of 160 000 people. A century earlier the population had been about 30 000 and in that time prosperity founded upon the export of coal, the manufacture of glass and chemicals, the production of armaments, and the building of ships for both peace and war had encouraged immigration not only from the surrounding countryside and other parts of England but also from Scotland and Ireland. Work was plentiful and rapid growth had produced areas of great contrasts and poor property.

Newcastle 1882–1913

By then the first medical officer of health, Dr H E Armstrong, who had come to that appointment from six years as the resident medical officer of the Newcastle dispensary had been in office nine years. His years at the dispensary had certainly given him intimate experience of the disease patterns and the conditions of life for many families and their children. Not only a tough Northumbrian he was also long lived and from 1873 to his retirement in 1913, while he waged war against disease, he also produced a series of annual reports revealing how Newcastle with other industrial cities suffered death rates well above those for the country as a whole and that infant and child mortalities were particularly high. Fortunately his reports were continued by his successors until 1972 and today make fascinating reading.

Using these reports we have tried to trace the toll which *Mycobacterium tuberculosis* exacted during that time. Dr Armstrong had many difficulties. Statutory notification of tuberculosis was still 30 years in the future and information came chiefly from death certification and the tables produced by the Office of the Registrar General. Deaths from tuberculosis were then noted under the heads of phthisis, tabes mesenterica, scrofula, in addition to tuberculosis. Before 1882 there could not have been any bacteriological evidence and after that date it must have come slowly. Even so the numbers of deaths returned as due to phthisis were probably understated for there was considerable family opposition to the term as tuberculosis was widely thought to be a hereditary trait. But we show in table 1 the deaths from tuberculosis as recorded in Dr Armstrong's reports covering a period of 30 years before notification.

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During that time although Henry Armstrong became more and more concerned about tuberculosis, he could not measure its prevalence and, as he lacked access to the community, he could not mount a study. But, in 1895, he arranged for the examination of samples of the milk entering the city or produced within it. Some 10% of those examined contained viable tubercle bacilli and he encountered great difficulty in getting any effective action in respect of the cattle concerned. Yet he knew that most deaths were due to pulmonary tuberculosis and the chief spread was from person to person. In 1907 he made tuberculosis the subject of a special report to the sanitary committee discussing its causes, its toll, and its control.[1] In his annual report for the same year he pleaded for a scheme of local and national treatment and prevention asking for: (1) compulsory notification of tuberculosis. (2) The provision of sanatoria, hospitals, and dispensaries. (3) Methods to prevent infection of the lungs and abdominal tract. (4) The education of public opinion. (5) That legal powers should be granted to sanitary authorities to carry out the above four measures. (6) The establishment of a national health authority.

Four years later in 1911, when the first National Insurance Act created the 'panel' for the medical care of employed men, a duty was placed on local health authorities to establish a tuberculosis dispensary and to keep a register of notified cases (partial notification had started in 1909). For the first time also a specific disease, tuberculosis, was named in a general act of parliament and the sum of sixpence (2·5p) per insured person was set aside for treatment. No provision was made for wives or families. Notification was not obligatory for all types of tuberculosis until 1 January 1913. In that year despite the reluctance of many doctors in practice, no fewer than 972 cases of pulmonary tuberculosis were notified in Newcastle, 326 persons were certified as dying from phthisis, and 153 from other forms of tuberculosis, a death rate of 1·76 per 1000 inhabitants, half the

Table 1 Newcastle upon Tyne 1875–1905

	Deaths from tuberculosis			
	1875	*1878*	*1901*	*1905*
Total	491	539	596	608
Rate/1000 population	3·6	3·7	2·8	2·3
Age <1 year	73	56	34	54
Age <5 years	120	128	115	139

rate of 35 years earlier. Dr Armstrong's last report before retirement also concentrated on tuberculosis and the measures required under the 1911 National Insurance Act and he was quite explicit that the local resources were not sufficient for local requirements. The city had arranged for the use of 30 beds at a sanatorium for adult patients and also for the same number of beds at a children's sanatorium. Both institutions were controlled by voluntary associations.

Treatment 1913–45

Dr Armstrong was succeeded by his friend and colleague Dr Harold Kerr who was equally keen to implement the 1911 act. In 1913 a doctor was appointed to organise the tuberculosis dispensary and to compile the register of notified cases. The beds at both the sanatoria were already filled and in addition 14 beds for 'advanced cases' had been made available and 60 more planned at the large City Hospital for Infectious Diseases. The belief was that rest, fresh air, and good food produced the best conditions for healing. Although the amount of sanatorium and hospital treatment increased steadily, that in essence was the treatment available for the next 30 years. But natural healing in tuberculosis is slow and for many the time was all too short.

Attempts were certainly made to simulate sanatorium conditions at home but were impossible to attain on any scale. Public understanding of tuberculosis was limited and many believed it was a family constitutional disease. Many people lived in poor overcrowded houses, illness meant loss of employment and difficulty for re-employment. Families could not be supported by husbands or cared for by mothers. Support available through voluntary aid was variable. Although tuberculosis of the lungs claimed most attention, many people young and old had other forms of the disease affecting bones or joints, lymph nodes, or the central nervous system. Healing often left permanent deformity and handicapped 'hunchbacks' were familiar sights.

Many of the large cities, including Newcastle, had death rates greater than the country as a whole and in the 1920s and 1930s the Tyneside boroughs including Newcastle had the highest death rates in the country. Within Newcastle the poorer wards had much higher death rates than the more fortunate areas.[2] During those years Newcastle had increased the number of beds available to more than 100 for pulmonary disease and 60 for other types and still maintained the 30 beds in the children's sanatorium. Children were also admitted to the various hospitals in the city. Those levels of provision continued until the mid 1940s.

Table 2 Newcastle upon Tyne 1885–1972. Deaths and deaths rates from tuberculosis/1000 population

	Pulmonary		*Other (central nervous system, etc)*		*Total*		*Population*
	Deaths	*Death rate*	*Deaths*	*Death rate*	*Deaths*	*Death rate*	
1885	368	2·28	138	0·86	506	3·13	161 526
1895	406	2·05	218	1·10	624	3·15	198 141
1905	397	1·56	211	0·83	608	2·38	255 160
1913	326	1·20	153	0·56	479	1·76	271 295
1915	380	1·37	162	0·58	542	1·95	278 107
1925	343	1·20	101	0·35	444	1·55	286 300
1935	240	0·82	63	0·22	303	1·04	292 700
1940	251	0·98	51	0·20	302	1·18	255 900
1945	227	0·85	47	0·18	274	1·03	265 990
1950	183	0·62	25	0·08	208	0·70	294 800
1955	48	0·17	4	0·01	52	0·18	281 000
1960	24	0·09	4	0·015	28	0·10	268 970
1965	19	0·07	6	0·023	25	0·10	257 460
1970	9	0·04	3	0·013	12	0·05	236 730
1972	10	0·045	2	0·009	12	0·05	217 220

Table 3 Notifications of tuberculosis in Newcastle upon Tyne 1915–75

	Notifications of tuberculosis			
	Pulmonary cases	*Other types*	*Total*	*Attack rate/ 1000 population*
1915	612	352	964	3·46
1925	546	303	849	2·9
1935	464	176	640	2·2
1945	580	115	695	3·0
1955	373	68	441	1·57
1965	142	32	174	0·67
1970	82	17	99	0·42
1975	61	17	78	0·35

The pathogenesis and epidemiology of tuberculosis in Newcastle

The numbers of deaths from tuberculosis were recorded each year in the medical officer of health's reports and notifications since 1913 (tables 2 and 3). The phenomenon of tuberculin sensitivity had been demonstrated by Koch and Mantoux but the natural history of the complex relationship between man and the tubercle bacillus had not been established despite Marfan's acute clinical observation in 1886 that persons with well healed scars from tuberculosis of the cervical lymph nodes were not likely to suffer from pulmonary tuberculosis.[3] In 1912 Anton Gohn had described calcified well healed pulmonary foci and their related nodes but that was a pathological rather than an epidemiological observation.[4] In 1929 and later Rich and McCordock studied tuberculin sensitivity and its effects,[5] and their studies were soon followed by Blacklock's report on the pathological findings of tuberculosis in children.[6] But there was no agreement concerning the relationship between primary infection and disease in adults and regrettably there was a tendency to regard primary infection as both inevitable and innocuous.

Studies to ascertain the prevalence of tuberculous infection at different ages using the tuberculin test seemed long in coming and as far as we can tell the first study for that purpose in this country was in 1929 when Hart tested children and young adults attending the outpatient department of the London Hospital.[7] Those tested had no signs of tuberculosis and were attending for other reasons. That study showed the incidence of primary infection rose steadily with age and that, by 21 years 95% of those examined gave positive results (table 4). Twenty years later the Medical Research Council survey showed that two of every three people aged 19–20 tested in northern urban areas were tuberculin positive and that the annual infection rate appeared to be about 3%.[8] In Newcastle, in the 1000 family study, which began in 1947, 7·2% of children were tuberculin

Table 4 The incidence (%) of positive tuberculin sensitivity at ages to 21 years

The London Hospital		*Northern urban areas*	
Ages	*Hart (1929)*[7]	*Ages*	*Medical Research Council (1949–50)*[8]
0–2	6·5	5–6	15·2
3–5	18	7–8	21·3
6–10	38	9–10	29·5
11–20	70	11–12	36·5
21	95	13–14	42·5
		15–16	51·0
		17–18	59·0
		19–20	67·5

positive at 5 years in 1952 and 12·3% at 13 years in 1960.[9]

In tables 2 and 3 we have shown the mortality from tuberculosis as given in the medical officers of health's reports from 1885–1972 and notifications from 1915–75. The period relating to death, covering almost a century, can be divided into three phases. During the years 1885–95, although the numbers of deaths increased, the death rate did not change as the population increased. Then, from 1905, the death rate, except for the years 1914–18, slowly decreased until 1945. During that period the great majority of children had experienced a primary infection before 20 years of age and there must have been plenty of opportunities for reinfection. The capacity of the individual to withstand the development or to heal clinical disease depended upon their own powers of resistance which in turn depended upon nutrition, the frequency of other infections and illnesses, and their habit and conditions of life. So despite years of economic depression, unemployment, much poor housing, ignorance of or failure to take reasonable health care, the conditions of life for many or most of the people must have slowly improved. In the 35 years from 1905–40 the death rate from pulmonary tuberculosis fell by a third and for other forms of tuberculosis by three quarters.

But it was between 1945 and 1950 that the 'decline' became the 'fall', which was even more headlong between 1950 and 1955 and thereafter. Notifications of new cases showed the same general pattern although the rate was not so great. Figure 1 shows the rates of fall of death rates from tuberculosis of all types, from pulmonary tuberculosis and from other forms. Figure 2 shows the changes in attack rates from 1915 to 72. The data are those given in tables 2 and 3. The non-respiratory tuberculosis comprised abdominal tuberculosis (tabes mesenterica), tuberculous meningitis, and generalised or miliary tuberculosis; bone tuberculosis was not often given as a cause of death apart from a general spread. Although pulmonary tuberculosis or phthisis was sometimes given as a cause of death in young children, those terms represented, by and large, the deaths of adolescents and adults. Deaths in the pulmonary groups could have been the result of a progressive primary infection particularly in adolescents and young adults but later would have been due either to reinfection at a time of lowered resistance or to reactivation of an old primary lesion.

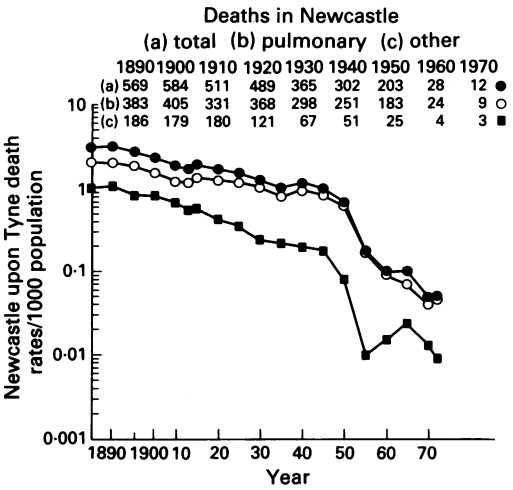

Figure 1 Death rates/1000 population for tuberculosis in Newcastle upon Tyne, 1885–1975. (Total deaths from all causes 1885–1952 was 28 515.)

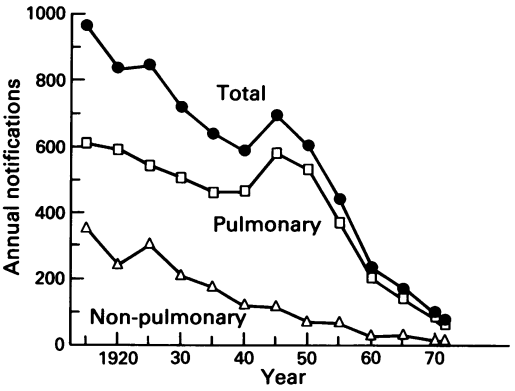

Figure 2 Notification of tuberculosis in Newcastle upon Tyne in 1915–72.

Reference to table 1 and fig 1 will show that the death rate from pulmonary disease fell more slowly than that from non-pulmonary disease. We know that the majority of children were still getting primary infections. Certainly the numbers of children in the population were diminishing and death rates from infective causes were declining but the average heights and weights of children in maintained schools were increasing both in girls and boys.[10] These trends give some support to an overall improvement in health and therefore of resistance to primary infection. To examine that possibility further we have tried to calculate the fall in death rates for children up to 15 years of age compared with the older population from 1885–1960 (table 5). From these figures it would seem that the death rates in children certainly improved faster than those over the age of 15 years and would support the impression gained from fig 1. By 1960 deaths of children from tuberculosis had ceased to occur in Newcastle. During the war years 1939–45 notifications of pulmonary tuberculosis increased but that was at least partly due to the work of the mass miniature *x* ray units. Deaths from pulmonary tuberculosis continued to decline as did notifications and death rates of non-pulmonary disease.

That long period of decline was to be

Table 5 Newcastle upon Tyne 1891–1961. Deaths from tuberculosis in children to 15 years and people thereafter

	Population (1000s)		Deaths from tuberculosis		Rate/1000	
	≤15	>15	≤15	>15	≤15	>15
1891–1900	73·8	139·7	211	415	2·85	2·96
1901–10	80·0	174·3	190	378	2·3	2·16
1911	86·0	181·2	154	353	1·79	1·95
1921	83·8	194·6	111	340	1·32	1·74
1931	85·7	197·3	73	324	0·85	1·64
1941	64·0	190·9	31	259	0·48	1·35
1951	66·2	226·0	4	120	0·06	0·53
1961	63·4	206·0	0	28	—	0·13

Population data and deaths from tuberculosis are annual averages taken from the Registrar General's decennial reports of 1891–1990 and 1901–10.
Population data 1911–61 from census returns and deaths from tuberculosis from the annual reports of the medical officer of health.

succeeded by the near miracle of the fall. The success of the sulphonamides and penicillin had stimulated research and by 1944 Waksman working in Ann Arbor had prepared streptomycin sulphate and found it active against tubercle bacilli. Some years earlier Lehmann in Sweden had shown paraminosalicylic acid also had an effect on tubercle bacilli. Together these preparations were the agents which brought the initial changes and reinforced by isonicotinic hydrazide in 1950 made an effective cure available. Although there were many lessons to be learned and new drugs were required, the whole attitude to tuberculosis was changed and the possibility of its elimination from the community became a realistic objective.

Tuberculosis in children

We have shown the death rate from tuberculosis in children had been declining. But, in 1945 the bacillus was still an important cause of death accounting for 15% of deaths of children aged 1–15 years in England and Wales and between 1939 and 1947 in Newcastle it killed more children of that age than any other cause (table 6). Also in Newcastle children formed a higher proportion of all deaths from tuberculosis than those in at least one London borough (table 7). Those deaths were certainly associated with primary infection although its risks had not been quantified and sometimes hardly admitted.

In 1941, in an attempt both to help families and to obtain data a 'clinic' was organised where young children who had been or were in contact with notified cases of tuberculosis could be seen and examined.[11] It was held in the children's department of Newcastle General Hospital because it was felt that children would be brought there more readily than to a tuberculosis dispensary. The parents or relatives bringing the children were counselled and their anxieties met as far as possible, the children were examined, tuberculin tested, and thereafter seen at intervals or when parents wished. In that way general advice could be given, tuberculosis could be explained, and data gradually accumulated. Information regarding all young children in contact with new notifications of tuberculosis was sent to the child welfare department of the city whence the clinic was organised and the families visited.

Fortunately the beginning of the National Health Service and the advent of chemotherapy occurred at almost the same time and in Newcastle the University Department of Child Health had been established in 1942. The work of the chest physicians at the two chest clinics was later related to the hospitals where their patients were treated and came into the hospital service. But the home visiting of contacts and others remained a function of the local health authority. There was also great interest regarding tuberculosis in children in the university department, members of which were on the staff of all the children's hospitals and units in the city, the maternity hospitals and, after 1947, the children's sanatorium. The possibility of BCG vaccination for non-infected contacts and the extension of vaccination to school leavers were also matters of importance requiring detailed organisation and recording.

In 1952 therefore the children's contact service was made a separate section of the city health department and a children's tuberculosis officer (MDT) appointed. She had had special experience of paediatrics and tuberculosis in children and worked closely with the physicians at the chest clinics, the paediatricians in the children's hospitals, and later with the staff of the school health service. The work was described in detail in 1963 but must be indicated here.[3] It was associated with the children's services of the city in hospitals or child health clinics. There were contact clinics for children under 5 years. Older children had a special clinic on a Saturday morning or after school hours. All children admitted to any hospital were given a tuberculin test, those positive were investigated further, and a register of tuberculin positive children was compiled from all sources. From 1954 school leavers were tuberculin tested and those negative were offered BCG; at first this operated only in maintained schools but after 1958 in all schools within the city. All the testing was done by members of the school health service.

From 1955 a tuberculin test became part of the routine school medical inspection of 10 year old children and in 1956 the test was offered to children in their first school year. All children found positive and their families were investigated. In that way we were able to supervise tuberculin positive children and at the same time observe the decline in the numbers of children positive at the various ages. After the

Table 6 Newcastle upon Tyne 1939–47. Deaths of children 1–15 years

	Age (years)	Acute respiratory disease, measles, pertussis	Tuberculosis	Diphtheria	Total (all causes)
	1–5	187	106	68	497
	>5–15	30	136	59	523
Total	1–15	217	242	127	1020

Table 7 Deaths from tuberculosis 1942–45

Place	Population	Deaths from tuberculosis			
		All ages	0–5	>5–15	0–15
Ealing and Acton	212 000	450	13	5	18
Newcastle	270 000	1177	58	72	130

Table 8 Newcastle upon Tyne 1973–88 (inclusive). Tuberculosis deaths at all ages (years)

	<15	15–24	25–34	35–44	45–54	55–65	>65	Total
1973–79	0	1	0	1	13	21	43	79
1980–88	0	0	2	3	2	13	39	62

introduction of isoniazid it was possible to treat primary infection without injections and without admission to hospital, and after 1953 we treated all tuberculin positive children under 5 years of age, and since 1960 no Newcastle child has died from tuberculosis.

Our story concerning Newcastle children and tuberculosis is ended. New notifications of adult tuberculosis are now very few but the contact work and BCG vaccination continue. In 1972, 12 deaths of adults were recorded (table 2) and, in table 8 the deaths from 1973 to 1988 have been brought together in two groups divided into age groups. The striking and welcome fact is that no child died and only one person under 25 years. More than half the deaths were in people age 65 years or more; two thirds were men. A more detailed study was not possible but the figures suggest that these deaths are the result of the breakdown of old lesions or respiratory failure associated with fibrotic or other changes.

Thus the decline from the beginning to the mid-point of this century was succeeded by the fall over the next 25 years and deaths from tuberculosis are disappearing from our society—but we need to keep our defences for another generation and protect everyone from natural primary infection.

Throughout this paper use has been made of the reports of the medical officers of health of Newcastle from 1874–1972 held in the Robinson Library, the University of Newcastle upon Tyne.

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Dr Florence Siebert (1897–1991): she gave us PPD

It is given to few people to know that they have given to the world something of immense value but such a person must have been Dr Florence Siebert who died in Florida on 23 August 1991 at the age of 93 (Obituary in *The Times* on 3 September 1991).

She was born in Eaton, Pennsylvania, in 1897. At the age of 3 she contracted polio and thereafter needed to wear leg calipers. She took a PhD in chemistry at Yale but it was as a Guggenheim fellow at the University of Uppsala in Sweden that she isolated purified protein derivative (PPD) in 1934 and in 1941 a single large batch was deposited as an international standard. Thus tuberculin testing was standardised for the first time. Robert Koch had produced crude tuberculin from a boiled culture of tubercle bacilli in 1880[1] but had proposed it as of therapeutic rather than diagnostic use. Dr Charles Mantoux (1877–1947) of Cannes described the intradermal tuberculin test in 1908[2] but, interestingly, the idea of using tuberculin as a diagnostic agent has been attributed to Sir Arthur Conan Doyle.[3]

Florence Siebert is a name previously unsung in my ears but in future whenever I ask for a tuberculin test I shall think of her.

ARCHIVIST

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