23. *De morbo sacro*, 1-2 Grensemann.
24. Su Dioniso in generale, rimando a H. Jeanmarie, *Dionysos*, Paris 1951 (Trad. it. *Dioniso. Religione e cultura in Grecia*, Torino 1972).
25. Per un ulteriore approfondimento dell'argomento, si consultino i seguenti testi:
ABEL K., *Plato und die Medizin seiner Zeit*, Gesnerus 14 (1957) 94-118.
CASERTANO G., *Pazzia, poesia e politica in Platone*, AION, Sez. filol.-lett., 6, (1984) 19-35.
DI BENEDETTO V., *Il medico e la malattia. La scienza di Ippocrate*, Torino 1986, pp. 35-69.
FLASHAR H., *Melancholie und Melancholiker in der medizinischen Theorien der Antike*, Berlin 1966.
FOUCAULT M., *Storia della follia nell'età classica*, Milano 1992, 231-251
JACKSON S.W., *Melancholia and depression: from Hippocratic times to modern times*, Yale University Press, New Haven-London 1986.
JOLY R., *Platon et la médecine*, Bull. Ass. G. Budé 1961, pp. 435-451.
KUCHARSKI P., *La méthode d'Hippocrate dans le Phèdre*, Revue des ét. gr. 52 (1939) 301-357.
LLOYD G.E.R., *Plato as a Natural Scientist*, Journ. of Hell. St. 88 (1968) 78-92.
MANULI P. - VEGETTI M., *Cuore, sangue e cervello. Biologia ed antropologia nel pensiero antico*, Milano 1977.
PIGEAUD J., *La maladie et l'âme. Ètude sur la relation de l'âme et du corps dans la tradition médico-philosophique antique*, Paris 1981.
IDEM, *Folie et cures de la folie chez les médecins de l'antiquité gréco-romaine. La manie*, Paris 1987.
ROY L., *Le concept de χολή, la bile dans le corpus hippocratique*, Laval 1981.
SIMON B., *Mind and Madness in Ancient Greece*, Ithaca-London 1978.
THIVEL H., *Cnide et Cnos? Essai sur les doctrines médicales dans la collection hippocratique*, Paris 1981.
VEGETTI M., *La medicina in Platone* I, Riv. crit. st. filos. 21 (1966) 3-39; II, *ibid.* 22 (1967) 251-270; III, *ibid.* 23 (1968) 251-267; IV, *ibid.* 24 (1969) 3-22.

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Articoli/*Articles*

THE CHANGE IN THE CAUSES OF MORTALITY IN ENGLAND AND WALES DURING THE LAST 150 YEARS.

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RIASSUNTO

Tra gli anni 1750 e 1975, si è verificata in Inghilterra e Galles la transizione demografica da livelli di mortalità e fecondità simili e di entità elevata a livelli bassi. Il tasso di mortalità per malattie non infettive non è diminuito molto e rimane ancora pari circa al 12 per 1000, mentre per le malattie infettive il tasso è diminuito da circa 11 a meno di 1 per 1000. Il cambio dei livelli di mortalità per le più importanti malattie infettive è descritto in questo articolo. È proposto che lo sviluppo dei trasporti, in particolare la costruzione dei canali, abbia favorito un aumento della disponibilità del cibo e del carbone e che la rivoluzione industriale abbia migliorato la qualità generale della vita della gente con conseguente calo della mortalità. Le scoperte scientifiche ed i passi avanti nella medicina non sono stati i maggiori responsabili del ribasso del livello di mortalità per le malattie infettive ed il calo del livello della fecondità si è verificato prima della disponibilità su larga scala di mezzi tecnici efficaci.

SUMMARY

Between about 1750 and 1975 England and Wales experienced the demographic transition from high, but approximately equal levels of mortality and fertility to low levels. The death rate from causes other than infectious diseases which was 12 per 1000 in 1850 has not declined markedly, whereas for infectious diseases, it has fallen from about 11 per 1000 to less than 1 per 1000. The changes

Parole chiave/key words: Demographic transition mortality infectious disease

in mortality from important infectious diseases is described. It is suggested that the agricultural revolution and the development of transport, initiated by the construction of canals, led to the greater availability of food and coal, and enabled the industrial revolution to improve the standard of living of the people. Scientific discoveries and medical break-throughs did not in general, contribute importantly to the early major decline in infectious disease mortality and the decline in fertility occurred before efficient contraception became available.

1. INTRODUCTION

There is no doubt that during the last 150 years there has been a large reduction, without precedent, in the level of mortality in Europe. The purpose of this paper is to describe and illustrate this reduction using data from England and Wales, and to try to explain why it occurred.

2. POPULATION STRUCTURE, MORTALITY AND FERTILITY.

The health of a population determines and is determined by its age and sex structure. Ignoring the effect of immigration and emigration, the size of the population increases if the birth rate is larger than the death rate. A population with a high level of mortality must have a high birth rate in order to survive, and in consequence there will be a relatively high proportion of young people in the population. After a major reduction in the level of mortality, the age structure of the population changes and the proportions in the older age groups increase, and chronic diseases become the major causes of mortality.

As shown in figure 1, the population of England and Wales has increased continuously and rapidly during the last thousand years with the period of the epidemic of plague in the fourteenth century being the only exception. Although the level of mortality was high, the level of fertility was even higher.

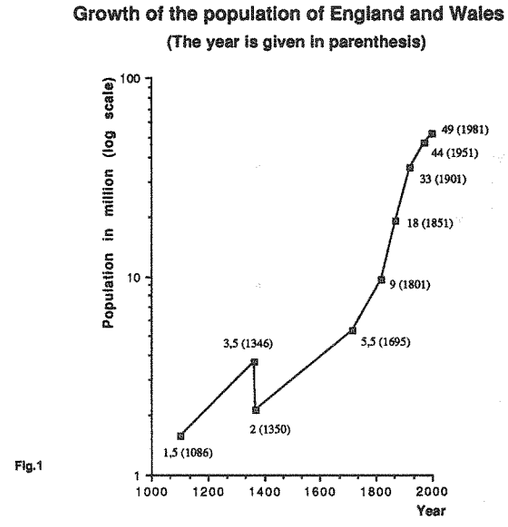


Figure 1. The growth of the population of England and Wales.

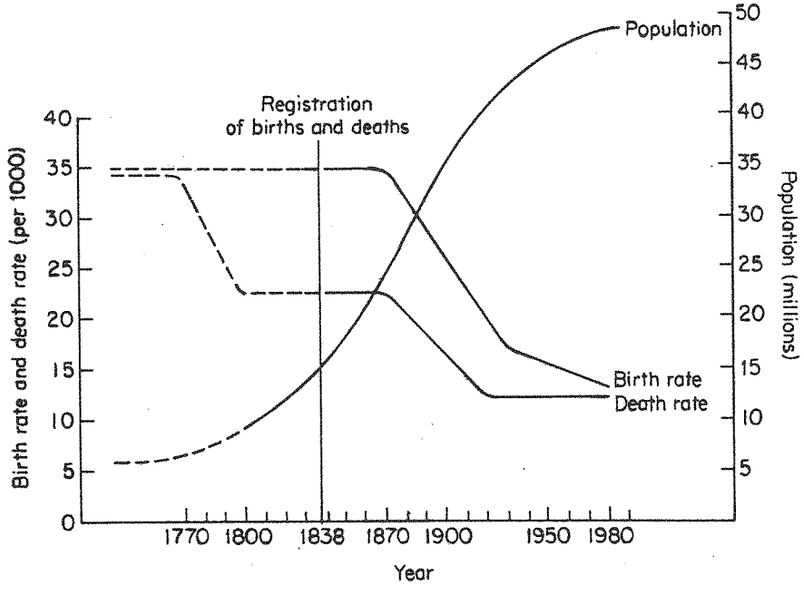


Figure 2. The demographic transition in England and Wales.

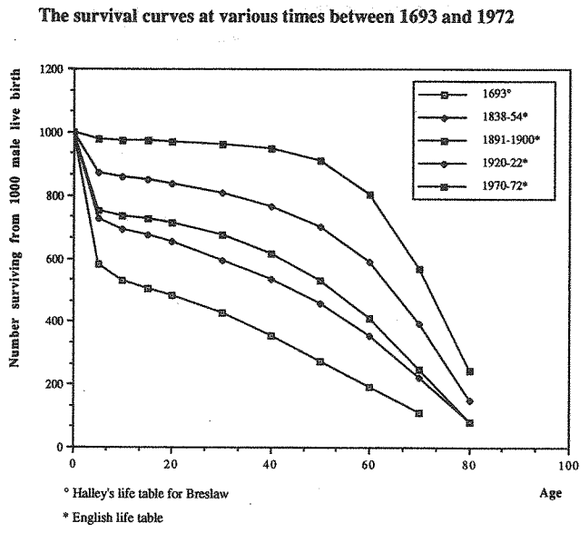


Figure 3. Number of survivors from 1000 live births at each age.

During the last 150 years, the population of England and Wales has tripled. Figure 2 is a simplification of the pattern of the change in the levels of mortality and fertility during this period. Until 1750, the level of fertility was generally just a little higher than the level of mortality and the population grew relatively slowly. However, while in about 1750 the level of mortality started to decline, fertility remained at its previous high level until about 1880 before it too started to fall. This large difference between the two rates in the intervening years led to a very rapid growth in the population. About 25 years ago, the two rates had again become similar and population growth has subsided. This change from high levels of fertility and mortality to low values is called the demographic transition and it is the most important cause of population growth in third world countries nowadays. In figure 2 it should be borne in mind that the registration of births and deaths became mandatory in 1838

and values of the rates for the years prior to this date are estimates.

Another method for displaying the reduction in mortality is to plot graphs of the survivorship columns of life tables for successive periods of time. The survivorship column of the life table shows the number of survivors from a cohort of 1000 live births at each age. Figure 3 shows graphs of the numbers surviving for various years between 1838 and 1970. Also in this figure there is the same type of curve for the city of Breslau in 1693, which is the first example of the use of the life table to describe the pattern of mortality of a population. The median age at death (that is the age at which one half of the original 1000 babies is dead) was about 15 years in 1693, about 45 during the years 1838-54, but by 1980 had risen to 70 for males and more than 75 years for women. Also it is possible to see that the important reduction in mortality has occurred for babies, children and young adults. Table 1 shows the reduction in the mortality rates between 1845 and 1980. Childhood mortality and death among young adults have been practically eradicated (apart from accidents). The infant mortality rate has declined from about 150 per 1000 live births to about 8 per thousand nowadays.

Table 1. The percentage change in mortality rates between 1841-50 and 1980 for various age groups in England and Wales.

Age group	Percentage reduction in mortality between 1841—50 and 1980
0 —	92.0%
1 —	4 not known
5 —	14 98.6%
15 —	44 92.8%
45 —	64 59.1%
65 +	34.1%
all ages	46.4%

Adapted from Acheson RM and Hagard S (1984).

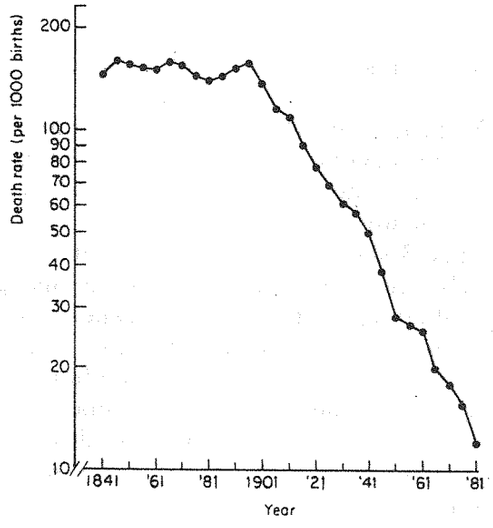


Figure 4. The change in the infant mortality rate in England and Wales between 1841 and 1986. Note logarithmic vertical scale.

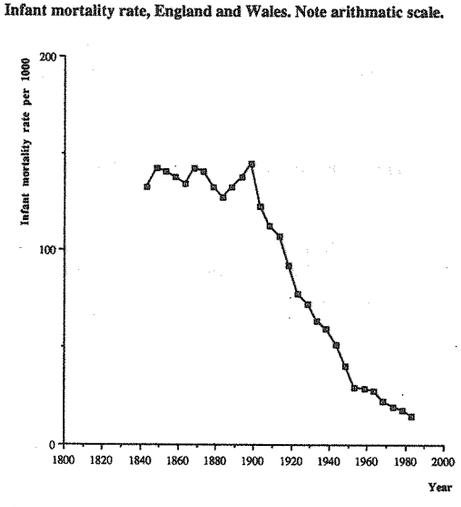


Figure 5. The change in the infant mortality rate in England and Wales between 1841 and 1986. Note arithmetic vertical scale.

The decline in infant mortality is also shown in figure 4. It is important to note that the vertical axis of this graph has a logarithmic scale. Logarithmic scales are often used to display time series of rates because such graphs show proportionate changes in the rates. If the graph is a straight line it implies that the rate has changed by a constant proportion in each year. In this example, in 1900 the infant mortality rate was about 125 per 1000 and after 80 years it had fallen to 10. This is an average reduction of about 1% per annum. The fact that the graph is approximately a straight line implies that the reduction has been constant at about 1% every year during this period.

The same graph has been drawn with an arithmetic vertical axis in figure 5, and it can be seen that the decline was greatest absolutely when the rate was high and less in the later years when the rate was low. Also, because of the arithmetic scaling it is difficult to see the trend in the later years.

Thus there has certainly been a decline in the rate of mortality. However, what were the causes of the decline and, in particular, why did it occur among children and adults? Figure 6 shows graphs of the rates of mortality for infectious and non-

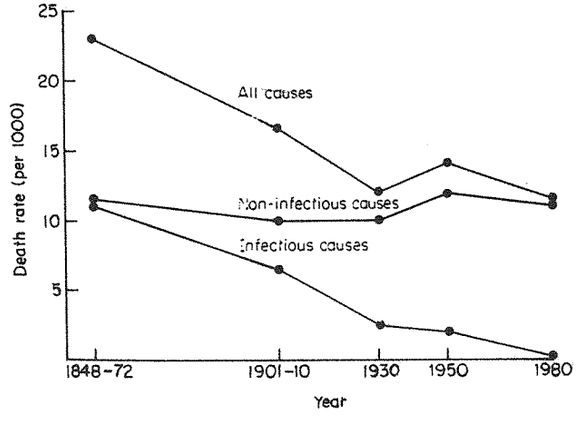


Figure 6. The change in infectious and non-infectious disease mortality rates in England and Wales 1850-1980.

Table 2. Standardised mortality rates in England and Wales 1851-60 by cause.

Cause of death	Mortality rate per million
Respiratory TB	2772
TB other forms	706
Typhoid	891
Scarlet fever	779
Diarrhoeal diseases	990
Smallpox	202
Whooping cough	433
Measles	357
Diptheria	99
All other causes	13980
All causes	21209

Adapted from Acheson RM and Hagard S (1984)

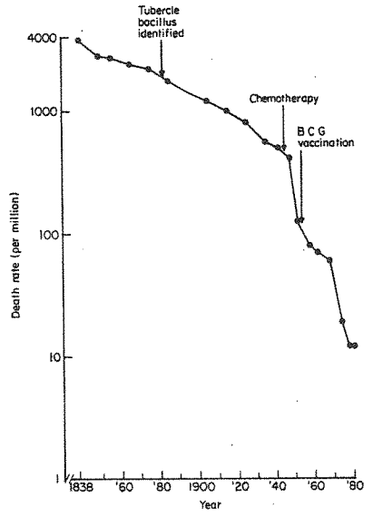
infectious diseases separately, and it is clear that while the rate for chronic, non-infectious diseases has remained almost constant, the rate for infectious diseases has declined dramatically and is now near zero. The infectious diseases which continue to cause death, for example influenza and AIDS, have miniscule mortality rates compared with the burden of infectious disease mortality sufferred by the population 150 years ago.

3. THE REDUCTION IN MORTALITY FROM INFECTIOUS DISEASES

Table 2 shows the rates of mortality from the important infectious diseases in 1855, and the successive figures show the pattern of the decline for each of these causes of death.

3.1. Tuberculosis

In 1850, tuberculosis was the most important infectious disease. Figure 7 shows the reduction in the mortality rate from



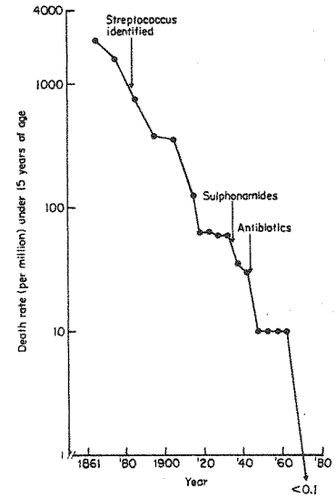


Figure 7. Respiratory tuberculosis: mortality rates per million population.

Figure 8. Scarlet fever: mortality rates per million children aged under 15 years.

this cause from about 4000 per million in 1840 to about 2000 in 1882 when Robert Koch identified *Micobacterium Tuberculosis*. After the second World War when chemotherapy became available, the rate had already declined to about 500 per million and, when vaccination started to be used on a large scale in 1955, the rate was only about 100. Nowadays the rate is practically zero. By the time chemotherapy had become available, the rate had already decreased by about 90% from its 1840 level.

3.2. Scarlet fever

As shown in figure 8, by 1860 the mortality rate from scarlet fever had fallen to about 2250 per million children aged under 15 and when in 1879 Louis Pasteur identified *Streptococcus Haemolyticus* the rate was already less than 1000. When

suphonamide drugs became available the rate had fallen to 65 and before the arrival of antibiotics such as penicillin, the rate was only 30 per million. Nowadays the rate is almost zero. However it is interesting to note that the reduction in the rate of mortality has not been constant. There have been three periods, around the turn of the century and after the two World Wars when the rate remained stable for up to 30 years.

3.3. Whooping cough

Figure 9 shows that the rate of mortality from whooping cough has followed much the same pattern as that for tuberculosis and scarlet fever. It had declined from 1300 per million children aged under 15 to 800 by the time *Bordetella pertussis* was identified in 1906. Immunisation began to be used after the

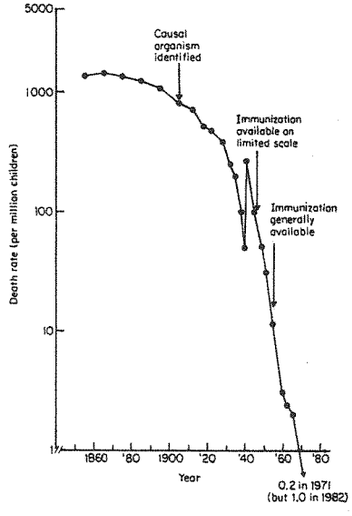


Figure 9. Whooping cough: mortality rates per million children aged under 15 years.

second World War when the rate was about 100 per million, and when the immunisation became generally available in 1955, the rate was only 10 per million.

3.4. Poliomylitis

Poliomylitis has never been a very important cause of death in England and Wales when compared with other infectious diseases and the mortality rate has never been more than about 35 per million children aged under 15. This disease was only recognised as such in 1909 and so there is no evidence of the pattern of the change in mortality during the nineteenth century. After the introduction of immunisation in the mid 1950s the rate declined rapidly and mortality from this cause is almost non-existent now.

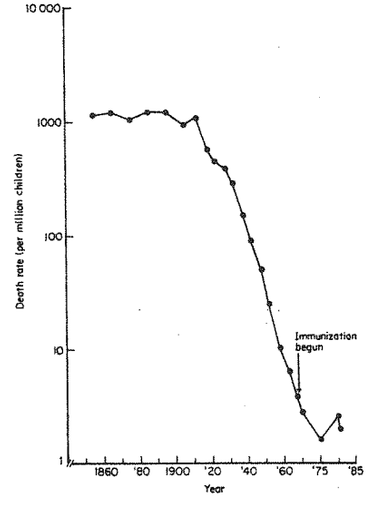


Figure 10. Measles: mortality rates per million children aged under 15 years.

3.5. Measles

Measles was a common and dangerous disease until the beginning of this century with a mortality rate of over 1000 per million children aged under 15. However, as shown in figure 10, the rate has declined during the last 75 years to about 2 per million. Immunisation became available about 30 years ago when the rate was about 4 per million. It is to be hoped that with the widespread use of immunisation this disease will be eradicated even in those countries where today measles epidemics still take a huge toll in children's lives. The world-wide eradication of smallpox announced in 1980 is an exemplary precedent.

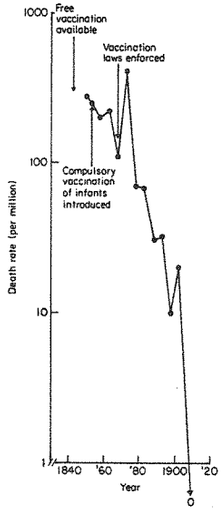


Figure 11. Smallpox: mortality rates per million population.

3.6. Smallpox

About 200 years ago, smallpox was a common disease with a high case fatality rate. The London Bills of Mortality show the existence of very large epidemics and, for example, in 1796 about 20% of all deaths were caused by smallpox. In 1852 vaccination of children became mandatory and the rate diminished as is shown in figure 11. In 1965 the World Health Organisation announced the goal of world wide eradication which, thanks to extraordinary international collaboration, was achieved in only 15 years. This is the only example in recorded history of humans ridding themselves of a major infectious disease. However, in England and Wales, although vaccination played an important role, it is difficult to be sure of the extent of its contribution to the reduction in incidence and mortality. Other diseases declined without vaccination, but smallpox vaccination was introduced much earlier than other vaccines.

3.7. Diptheria

Before 1900 the mortality rate for diptheria was high, about 800-1000 per million children aged less than 15. Immunisation was introduced in the second World War when the rate was about 150, and now the disease is virtually eradicated in England and Wales. After 1890 antitoxin was used for the treatment of diptheria and this probably reduced the case fatality rate.

3.8. Typhus enteric fever

Typhus is a louse borne disease and the major decline in mortality observed between 1870 and 1900 was probably a consequence of improved hygienic conditions especially the improvement in the public supply of water resulting in greater personal cleanliness. Also, around the turn of the century, the people tend-

ed to change clothes more regularly thus impeding the transmission of the disease.

3.9. Cholera

Cholera has never been endemic in England and Wales, but epidemics occurred frequently. One of the classic epidemiological studies was by Dr John Snow, of an epidemic of this disease which occurred in London in August and September 1854. Snow drew a map of the district of Soho and St. James and made a mark on it at the address of every case of the disease. He also marked the position of every public water pump. He noticed that the cases seemed to cluster around one particular water pump, the infamous pump at Broad Street. This observation induced him to prohibit the use of this pump and the epidemic subsided. Only two years after the report of the epidemic written by John Snow, in 1857, a law was passed which required that all water supplied for public consumption should be filtered. However, it was necessary to wait nearly 30 years before Robert Koch identified the causal organism of the disease. This is another example of a public health intervention which led to a reduction in mortality without a complete understanding of the aetiology of the disease.

4. EXPLAINING THE REDUCTION IN MORTALITY FROM INFECTIOUS DISEASES

There have been many reasons speculated to explain the reduction in mortality from infectious diseases which occurred in England and Wales and in other European countries in the last 150 years. There can be no simple explanation applicable to all diseases at all times but they can be grouped together as follows:

a) interventions as a result of medical or technological discoveries or innovations;

b) a spontaneous reduction or a change in the virulence of the causal micro-organisms;

c) a general improvement in the environment.

4.1. Medical or technological discoveries or innovations

Medical or technological discoveries and innovations are an intuitively appealing explanation of the virtual eradication of the formerly important infectious diseases. In particular the scientific knowledge and understanding of these diseases has improved enormously; there have been major improvements in the availability and quality of hospital services; there have been major advances in the therapy of infectious diseases; maternity services, both ante-natal and post-natal have improved; the education and training of health professionals have improved and there have been important advances in physiology and pathology.

However, there is not much concrete evidence that these improvements have had a direct and general influence on the reduction in mortality from all infectious diseases nationally. There are exceptions; for example, the growing tendency to isolate tuberculosis cases and the increase in the use of smallpox vaccination. This latter practice certainly became so widespread that it is inconceivable that it had no effect on the mortality from this disease. Similarly, the use of antitoxin for the treatment of diptheria improved the survival of cases with this disease. However, generally, the development of hospital services, of therapies, maternity services etc. have occurred too recently to have had an important effect on the major decline in the rates of mortality observed in the last century.

4.2. A spontaneous decline or a change in virulence

The mortality from infectious diseases can fluctuate in the absence of specific medical interventions or deliberate changes

in the environment. Sometimes a rise may be observed in the mortality from one disease whilst simultaneously there may be a reduction in another. For example, mortality from scarlet fever stayed constant for three periods each of 30 years while other diseases continued to decline. The mortality rate from poliomylitis showed very strong oscillations from year to year before the start of its decline. This variability from year to year, also observed for example in measles incidence, is also related to the size of the epidemics and the consequential numbers of persons remaining at risk of infection in the community. However, the hypothesis that the enormous simultaneous reduction in all the infectious diseases at the same time arose as a result of haphazard fluctuations is implausible.

4.3. General improvement in the environment

Although hygiene did improve during the course of the nineteenth century, the major advance came after 1880 when mortality from intestinal infections started to decline as a result of improved water supply and waste disposal.

Probably the most important contribution to improved health arose as a result of the increase in production and better distribution of food during the eighteenth and nineteenth centuries. This was possible as a result of the industrial revolution and the associated development of transport, in particular the canal system and later the railways and roads. At first, the increase in the production of food was achieved by improving traditional methods of cultivation, for example by introducing crop rotation. Later, fertilizers and other technical innovations enabled yields to be increased. The construction of the canal system in the eighteenth and nineteenth centuries, together with the control of the flow of water in the rivers, revolutionised the transport of bulky goods, not only of food but also, for example, coal. At the height of the development of water transport at the turn of the twentieth century, practically all important

towns were connected, and food, coal, raw materials and manufactured goods were distributed more cheaply, more efficiently and more extensively. Coal was important not only because it was used by the people to heat their houses and provide domestic hot water, but also because it was the main source of energy which fired the industrial revolution.

During the nineteenth century, there was large scale construction of houses in the cities and towns to provide accommodation for the new workers who had moved in from the countryside to find employment in the new industries. If this programme had the effect of reducing overcrowding, it would also have had the effect of impeding the transmission of some infectious diseases, for example tuberculosis and scarlet fever. The industrial revolution provided an improvement in the general standard of living and was associated with the development of the "work house" for the relief of poverty. A consequence of the institution of work houses was the development of work house infirmaries and the isolation of cases of infectious disease, in particular tuberculosis. After 1880, the discoveries of Koch, Pasteur and others of the organisms responsible for the infectious diseases enabled their aetiology to be better understood and strategies to prevent infection and control its spread could be developed.

Even now, 100 years after the start of the decline in the mortality caused by infectious disease, there is little consensus about the precise factors which were responsible for it. There can be little doubt that the individuals in a population better fed, better clothed and better housed would have an improved chance of survival if they contracted an infectious disease. Likewise, house building and a strategy for the isolation of cases, would reduce the extent of the diffusion of the diseases among the people. Although there can be many hypotheses about the particular single factors responsible for the decline in mortality, it is unlikely that any one factor, on its own, could occur in the absense of others, or that its effect could be as great as that of many factors all together. Even so, Wilson (1990) argues forcibly

that the practice of isolation of cases was the prime cause for the decline in tuberculosis mortality and dismisses the opinion of McKeown (1988) who argues equally strongly in favour of the hypothesis that food is the key cause of the decline.

After 1880 the vast improvement in the supply and quality of domestic water and the development of efficient systems of waste disposal paved the way for the advances of the twentieth century notably in prevention, therapy and the control of pain. However, a necessary condition for the continued improvement in the quality of life is the control of fertility. If the birth rate had not fallen from its levels of 100 years ago, the population of England and Wales would be more than three times as high as it is now and there would be insufficient resources to maintain the standard of living that has been achieved this century. It is also noteworthy that the population managed to control its fertility well before the advent of efficient techniques of contraception.

5. CONCLUSION

It is most likely that the decline in the levels of mortality from infectious diseases during the last 150 years has been the result of a general improvement in the standard of living, which was brought about by the agricultural revolution, the development of transport and the industrial revolution. While the introduction of public health strategies, such as isolation of cases and later, the control of public water supply certainly contributed to the decline, they probably would not have occurred without the contemporary and preceding economic and social changes. Certainly the control of infectious disease became more efficient as a result of the discoveries of Koch and Pasteur. Perhaps, even more important for the future, the advance of science, and in particular the development of means of communication, has guaranteed that the improvements achieved during the last 150 years will not be lost, as occurred at other times in history, for example after the fall of the Roman empire.

REFERENCES

ACHESON R.M. and HAGARD S. *Health, Society and medicine, an introduction to community medicine.* Blackwell Scientific Publications, Oxford 1984.

McKEOWN T. *The origins of human disease.* Blackwell, Oxford 1988.

WILSON O.G. *The historical decline of tuberculosis in Europe and America.* Its causes and significance. J. Hist. Med. all. sci. 45:366-396 1990.

CREIGHTON C. *A history of epidemics in Britain.* Frank Cass & Co.Ltd., London 1965.

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