

A Critical Evaluation of Influenza Surveillance

ALEXANDER D. LANGMUIR¹ & JERE HOUSWORTH²

The present system of global surveillance of influenza worked effectively in identifying the importance and character of the Hong Kong variant and informing the world of new developments as they occurred. Many deficiencies still exist in the surveillance system that require attention if it is to serve effectively in guiding future control of influenza. More quantitative data are needed regarding incidence of clinical disease, age- and sex-specific attack rates, character and severity of complications, socio-economic factors influencing mortality and distribution and utilization of influenza vaccines.

The most valuable index for global surveillance of influenza is excess mortality due to respiratory causes. A comparison of the mortality experience in England and Wales with that in the USA reveals that sharply defined epidemics of influenza A recurred in both countries at intervals of 2-3 years. Mortality rates in England and Wales were considerably greater than in the USA and excess mortality during influenza epidemics was markedly higher in the former country with a notable exception in 1968-69, when the pandemic due to the Hong Kong variant was much more severe in the USA and the mortality in England and Wales was only slightly increased. Mortality data from many other parts of the world could be made available and would materially enhance the effectiveness of the global influenza surveillance programme.

The papers and discussions presented at this Conference vividly demonstrate the extent to which surveillance of influenza has become a global reality. The rapidity with which the epidemic in Hong Kong was recognized and the new strain of virus isolated and characterized confirms the wisdom and leadership of Dr C. H. Andrewes and the group that conceived and organized the World Influenza Programme at the end of the Second World War. This programme set the pattern for expanded surveillance activities now being undertaken by the World Health Organization. It is worthy of note, however, that the World Influenza Programme was in operation years before even the term "surveillance" with its present connotation was in general use.

WHO, largely through timely releases published in the *Weekly Epidemiological Record*, has kept the

world informed of the status and movement of influenza. Of particular value is the detailed summary *Influenza in the World* published in January 1969.

In the face of this impressive array of current and relevant data, it is difficult to discharge our assigned task; namely, to be critical of influenza surveillance. Patently the present system is a highly effective communications network with hundreds of competent participants working jointly towards a common goal. Clearly also the prompt availability of increasingly sophisticated surveillance data has led health authorities in many nations to plan and attempt to carry out major control efforts.

But as epidemiologists we have insatiable appetites for even more relevant data and, in spite of the glut that has been provided during the past year, we are still hungry. Good surveillance requires more than simple descriptive epidemiology and precise virology and serology. The objective of surveillance must be the provision of sufficiently accurate and current information to guide the effective application of control measures. Our goal should be the elimination of epidemics, if not the eradication of the disease.

¹ Director, Epidemiology Program, National Communicable Disease Center, Health Services and Mental Health Administration, Public Health Service, US Department of Health, Education, and Welfare, Atlanta, Ga., USA.

² Chief, Statistical Services Activity, Epidemiology Program, National Communicable Disease Center, Health Services and Mental Health Administration, Public Health Service, US Department of Health, Education, and Welfare, Atlanta, Ga., USA.

As contributors to this Conference, we should like first to examine some of the deficiencies that we are acutely aware of in the surveillance procedures now being followed in the United States of America. Secondly, we shall compare excess respiratory disease mortality in the USA with that in England and Wales. This simple statistical procedure provides an accurate and quantitative measure of the extent and severity of influenza epidemics in large populations. In our opinion, it deserves far wider application than it has received to date.

INFLUENZA SURVEILLANCE IN THE USA

Dr R. G. Sharrar has described¹ the introduction of Hong Kong influenza to the USA—its pre-epidemic seeding and the extent and severity of the epidemic as it developed during the early winter. A very large amount of data was collected, evaluated, and promptly disseminated to the health profession and the public in the spirit of modern surveillance.

Yet, in spite of all these data, neither can we account for the unusual severity of our epidemic, nor do we have the essential facts to formulate logical alternative possibilities.

Our information regarding the occurrence of influenza is largely qualitative. Schools close, absenteeism increases, medical services become taxed, virus isolations and serological identifications are made in great numbers, and daily accounts appear in our newspapers and on television. We know we have an epidemic and we know its specific cause, but we have few quantitative measures of incidence, age- and sex-specific attack rates, and character and severity of complications. Furthermore, we have only crude data regarding mortality. We do not know what proportion of excess deaths occurs among reasonably active and productive citizens in contrast to deaths among persons who are already invalids suffering from severely debilitating pre-existing disease. Despite this serious deficiency we base our recommendations for vaccine use largely on mortality experience. We undertake major efforts to produce influenza vaccine in large amounts, but we have no meaningful information regarding its actual distribution. We do not know to what extent it actually reaches persons at highest risk.

These deficiencies in essential surveillance data are not impossible to correct. Much of the information exists in the records of our medical centres, labora-

tories, and health services. Well designed surveys could provide the rest. These deficiencies must be corrected if surveillance is to serve its function of guiding the control of influenza epidemics in the future.

RESPIRATORY MORTALITY AS AN INDEX OF INFLUENZA

In studying influenza surveillance reports from many countries, one is immediately aware of a serious limitation in the comparability of data. The methods of reporting, the fashions of nosology, the systems of medical care, and the availability and use of laboratory diagnostic services vary so widely that it is difficult to compare the extent and severity of epidemics in different countries. For example, it is claimed that the recent epidemic in the USA was unusually severe. We know this to be true in relation to our own past experience, and clearly our epidemic was more severe in terms of mortality than the epidemics in England and Wales and in Czechoslovakia, as has been shown in earlier papers, but there are few data with which to compare our experience in a quantitative way with that in most other countries.

Sharp increases in mortality have long been recognized as the most dramatic and awesome characteristic of influenza epidemics. William Farr (1848) described this in vivid detail in the epidemic in London in 1847. He introduced the concept of "excess mortality", defining it as the number of deaths over and above the expected number for the particular season and place where the epidemic occurred. He showed that the excess of deaths was ascribed not only to influenza, but also to pneumonia, bronchitis, other respiratory diseases, and, in addition, to many non-respiratory diseases.

The use of mortality statistics has been the most widely applicable tool for the characterization of influenza epidemics on a world-wide basis since the pandemic of 1889-91. Frost (1919) and Collins et al. (1930) applied Farr's concept of excess mortality for detailed studies of the 1918 pandemic of influenza and for the many milder epidemics that occurred from 1910 to 1930. They used both weekly and monthly mortality data from 50 cities in the USA. Since then, assessment of current weekly mortality in selected representative cities has become a routine statistical function of the US Public Health Service (Collins & Lehmann, 1951). McDonald (1967) has used this method effectively in Canada, but the practice has not been followed extensively elsewhere.

¹ See the paper on page 361 of this issue.

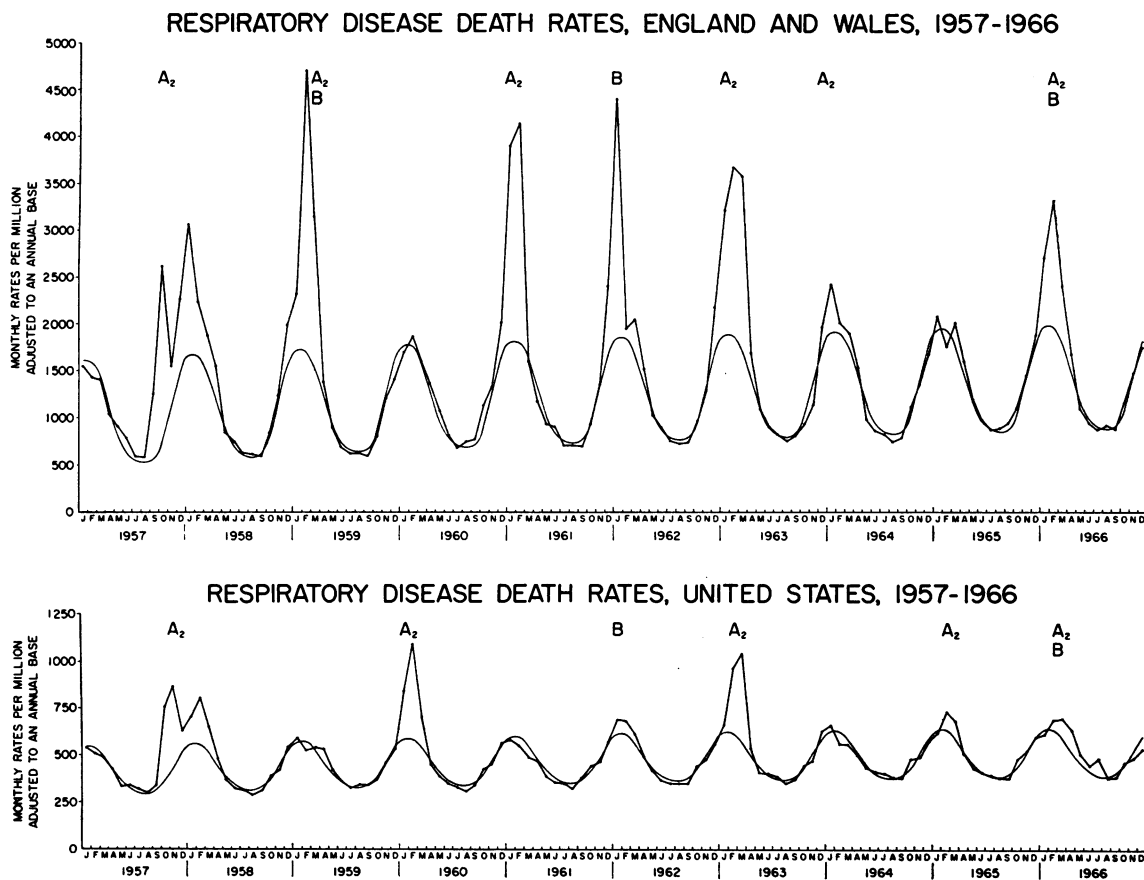
For the comparative study of epidemics over a period of years, monthly mortality data are most useful and practical. Deaths are usually ascribed to residence, thus permitting the determination of meaningful rates. Excess total mortality provides the most accurate measure of the impact of the influenza epidemic on the population. However, often in mild and moderate epidemics the deviations above the base-line of expected deaths are proportionately slight and statistical procedures become complex. A more practical and generally useful index of influenza epidemics in the USA has been found to be excess mortality from total respiratory causes.

Fig. 1 presents monthly death rates for total respiratory diseases in England and Wales and in the

USA from July 1957 to June 1966. The rhythmic base-line or expectancy curve was calculated by the method of Serfling (1963). This consists in fitting a curve with seasonal variation and long-term trend to the monthly observations in which epidemic deviants have been replaced by normal or expected values in the calculations. Other and simpler procedures for estimating expected values are available, such as the one used by McDonald (1967).

Respiratory mortality rates in England and Wales are materially higher than those in the USA, and there is a greater seasonal swing in the normal or expected mortality in England and Wales. The epidemics of influenza A and B are clearly discernible in both countries. The long-known tendency of influenza A epidemics to recur periodically at

FIG. 1
MONTHLY DEATH RATES FOR ALL RESPIRATORY DISEASES IN ENGLAND AND WALES AND THE USA, JULY 1957 TO JUNE 1966



intervals of 2–3 years is apparent. In England and Wales a 2-year period was more manifest; in the USA a 3-year period was more evident. In 1965 and 1966 the influenza epidemic in the USA was split over a 2-year period, the East and Midwest being most heavily involved in 1965 and the Pacific coastal states in 1966.

Influenza B was epidemic in both countries in the winter of 1961–62 and this virus was also prevalent in 1966 when A2 influenza was also epidemic.

The 3-month period January to March 1963 was chosen for a more detailed comparison of mortality for specific causes between the USA and England and Wales because synchronous epidemics of influenza A2 occurred. The results are shown in Table 1. The well known differences in diagnostic terminology and classification of causes of death are illustrated. Bronchitis was the most frequently listed respiratory cause of death in England and Wales, while this term rarely appeared as a cause of death in the USA. Conversely, pulmonary emphysema was recorded with moderate frequency in the USA, but was not listed in monthly figures in England and Wales.

Table 2 presents the excess mortality rates for each of the epidemics from 1957 to 1966. The markedly higher excess rates accompanying most epidemics in England and Wales are again evident. The relative frequency with which the three common

diagnostic terms, pneumonia, influenza, and bronchitis, appear as causes of death varies widely from epidemic to epidemic in the same country and between the two countries. For this reason it is suggested that the most practical index for making international comparisons of monthly mortality over a period of years is total respiratory diseases (Section VIII of the International Classification of Diseases).

For surveillance of ongoing epidemics of influenza, monthly mortality data are not usually available on a current basis in most countries. Weekly figures have long been available in England and Wales and special reporting systems such as the one established in the USA since 1918 are practical and well adapted for studying influenza. In Fig. 2 the experience during the past 4 years in England and Wales and in the USA is shown, using these weekly data. Only numbers of deaths are given because valid weekly rates in the USA are not obtainable.

Epidemics of moderate severity appeared in both countries in the winter of 1965–66. Both were associated with type A2 and B influenza viruses. The next year was free of measurable excess mortality and isolations of influenza viruses were notably rare. In fact the mortality experience in England and Wales was remarkably low. In 1967–68 epidemics again appeared synchronously, 2 years after the last one.

TABLE 1
COMPARATIVE MORTALITY BY SELECTED CAUSES DURING INFLUENZA EPIDEMICS
IN ENGLAND AND WALES AND THE USA, JANUARY–MARCH 1963

Cause of death	Numbers of deaths		3-monthly rates ^a	
	England & Wales	USA	England & Wales	USA
All causes	197 234	503 229	4 194	2 667
Cardiovascular diseases (Section VII of ICD)	73 672	221 129	1 567	1 172
Respiratory diseases (Section VIII of ICD)	40 456	41 537	860	220
Pneumonia	17 281	24 758	367	131
Influenza	2 613	5 648	56	30
Bronchitis	18 308	1 967	389	10
Emphysema (527.1) ^b	—	4 669	—	25
All other	2 254	4 495	48	24

^a Rates per million based on mid-year resident populations: England and Wales, 47 027 700; USA, 188 658 000.

^b Emphysema not listed separately for England and Wales.

FIG. 2

WEEKLY DEATHS FROM PNEUMONIA, INFLUENZA AND BRONCHITIS IN ENGLAND AND WALES AND FROM PNEUMONIA AND INFLUENZA IN THE USA, 1965-69

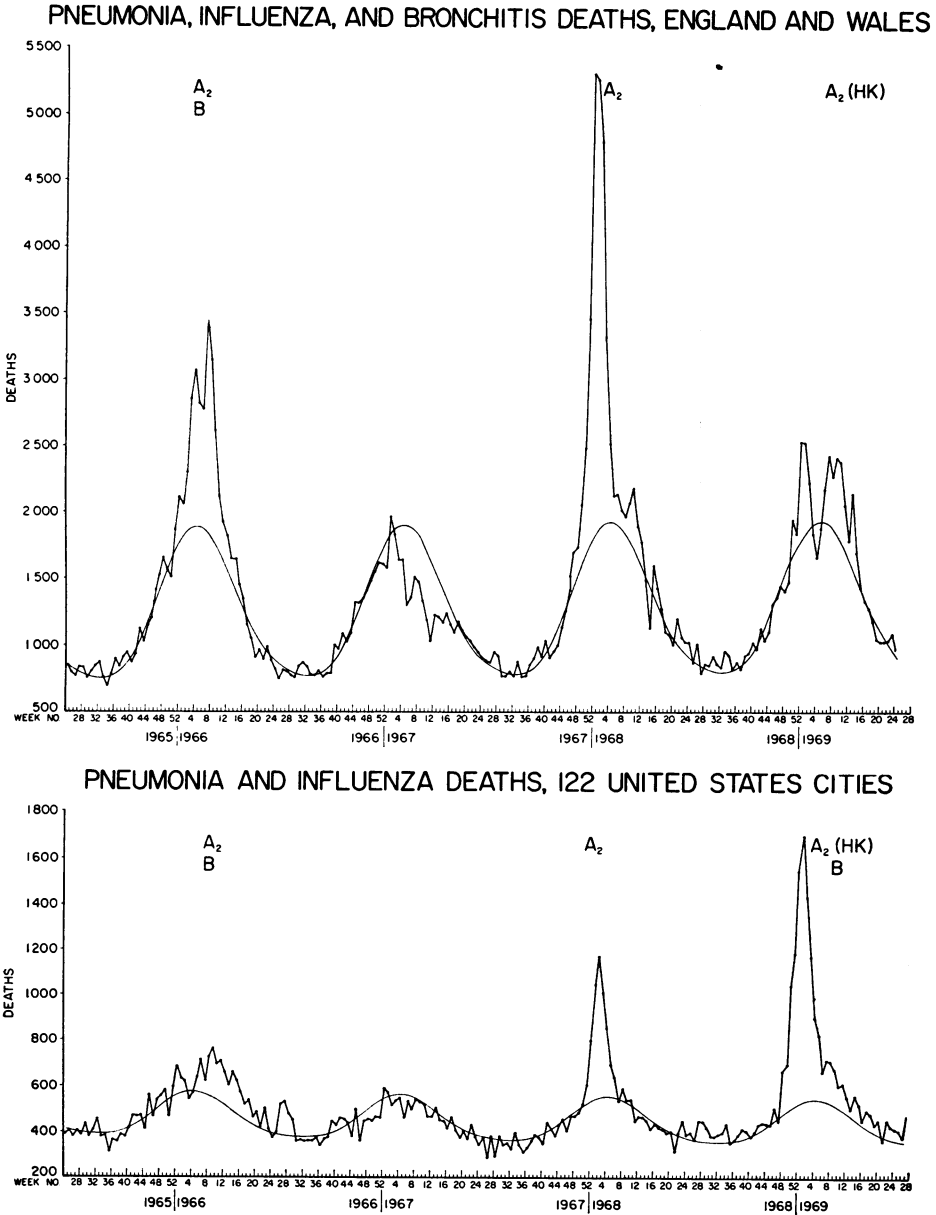


TABLE 2
EXCESS MORTALITY RATES PER MILLION BY CAUSE DURING SPECIFIED INFLUENZA EPIDEMICS,
ENGLAND AND WALES AND USA

Epidemic period	Pneumonia	Influenza	Bronchitis	Total respiratory diseases (Section VIII of ICD)	Prevailing virus types
England and Wales					
September 1957–April 1958	172.67	167.10	225.85	543.11	A2
January 1959–March 1959	116.29	144.59	145.84	419.48	A2, B
December 1960–February 1961	112.10	123.26	138.85	390.98	A2
December 1961–April 1962	116.48	57.02	144.34	331.40	B
January 1963–April 1963	185.34	50.13	184.58	435.39	A2
December 1963–January 1964	27.52	2.36	30.50	62.99	A2
March 1965	12.04	1.14	7.46	21.60	A2
January 1966–April 1966	97.49	60.64	70.94	235.74	A2, B
USA					
October 1957–March 1958	66.22	38.94	3.77	122.57	A2
April 1959	4.29	1.32	0.07	6.43	A2
January 1960–March 1960	37.55	29.67	1.32	75.63	A2
January 1962–March 1962	9.10	5.55	0.17	16.57	B
February 1963–March 1963	33.28	23.57	2.24	67.18	A2
February 1965–March 1965	8.85	2.35	0.91	16.12	A2
February 1966–April 1966	10.57	5.36	1.44	21.65	A2, B

The differing mortality experience during the influenza pandemic due to the Hong Kong variant is clearly shown. In England and Wales mortality exceeds the normal expectancy, but only irregularly and to slight degree. In the USA, however, a sharp, high, and broadly based peak of excess mortality occurred.

This comparison of respiratory mortality in two

countries demonstrates that influenza epidemics can be measured with quantitative precision, and therefore this relatively simple statistical procedure has great value for the surveillance of influenza. It is applicable in all areas of the world where deaths are registered on a current basis. The wider use of this procedure would enhance the value of the global surveillance of influenza.

REFERENCES¹

- Collins, S. D., Frost, W. H., Gover, M. & Sydenstricker, E. (1930) *Publ. Hlth Rep. (Wash.)*, **45**, 2277-2328
 Collins, S. D. & Lehmann, J., Jr (1951) *Publ. Hlth Rep. (Wash.)*, **66**, 1487-1516
 Farr, W. (1848) In: *Vital statistics*, 1885, London, Office of the Sanitary Institute, pp. 330-333
 Frost, W. H. (1919) *Publ. Hlth Rep. (Wash.)*, **34**, 1823-1836
 McDonald, J. C. (1967) *Canad. med. Ass. J.*, **97**, 522-527
 Serfling, R. E. (1963) *Publ. Hlth Rep. (Wash.)*, **78**, 494-506

¹ The statistical data in this paper have been taken from *The Registrar General's Statistical Review of England and Wales* for the years 1957-66; *The Registrar General's Weekly Return for England and Wales*, 1966-69, London, Her Majesty's Stationery Office; *Vital Statistics of the United States*, 1957-66, Washington, D.C., US Department of Health, Education, and Welfare; *Morbidity and Mortality Weekly Report*, 1966-69, Atlanta, Georgia, National Communicable Disease Center, and *Current Population Reports, Population Estimates and Projections*, 1957-66, Washington, D.C., US Department of Commerce, Bureau of the Census.