

Epidemiology of influenza during 1957-75 in the Union of Soviet Socialist Republics and the German Democratic Republic

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Analysis of clinical data collected by the epidemiological services in both countries showed that each shift or drift in the antigenic structure of the influenza virus resulted in epidemics in both countries. Depending on the degree of antigenic change, both shifts and drifts influenced the speed of epidemic spread and the time of occurrence and the intensity of the epidemics. However, the analyses did not reveal a direct relation between degree of antigenic variation and the attack rate or the severity of the epidemic. The mean attack rate in both countries was about 13% depending on the pathogenicity of the circulating virus. The severity of the epidemics varied in the two countries but the fourth epidemic after each shift was severe in both countries. The reasons for this and other features of the epidemiology are discussed.

Investigations of the antigenic composition of influenza viruses type A of both human and animal origin have shown that two antigens—haemagglutinin and neuraminidase—are involved in the emergence of new variants of the virus. Taking the definitions of antigenic “shift” and “drift” given by Laver & Webster (1) as the basis for describing such antigenic changes in the period between 1957 and 1975, two shifts occurred during this period and each was associated with several epidemics. Some special epidemiological features related to antigenic shifts and drifts are the subject of this study based on data obtained in the Union of Soviet Socialist Republics (USSR) and the German Democratic Republic (GDR).

MATERIALS AND METHODS

The study is based on clinical data collected by the District Epidemiological Departments of both countries and analysed in the National Influenza Centres. Also, data presented by the Statistical Centre of the GDR were employed for calculation of monthly mortality rates from all causes. The following definitions were used in the analysis.

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Start of epidemic—the month when a twofold or higher rise in morbidity occurred compared with the interepidemic period.

Peak of epidemic—the month of the highest morbidity.

End of epidemic—the month when the morbidity decreased to the level typical for that time of the year.

Epidemic distribution—geographical distribution of the epidemic.

Attack rate—incidence of morbidity per 10 000 during the whole epidemic period.

Peak incidence—incidence of morbidity per 10 000 for the month of the peak of the epidemic.

Intensity of epidemic—number of people that experienced the disease during the peak month expressed as a percentage of the total attack rate during the whole epidemic.

Severity of epidemic—was judged by the general mortality, mortality from influenza and pneumonia, and by morbidity.

RESULTS

The study covers a period of 19 years. The data from both countries are summarized in Table 1. The effects of antigenic shift and drift on influenza morbidity are considered separately.

Table 1. Data on epidemics of influenza in the USSR and GDR, 1957-75

Country	Year	Epidemic			Attack rate ^b	Peak incidence ^b	Intensity
		Start ^a	Peak ^a	End ^a			
USSR	1957	IV	V	VI	1216.8	860.7	70.7
GDR		IX	X	XI	321.0	282.0	87.8
		X	X	XII			
USSR	1958	—	—	—			
GDR		I	II	III	44.2	43.7	98.6
USSR	1959	I	II	III	1203.7	615.4	51.1
GDR		III	IV	V	23.6	16.1	68.2
USSR	1960	—	—	—	—	—	—
GDR		I	III	IV	0.558	0.288	51.5
USSR	1962	I	I	III	1217.0	804.8	66.1
GDR		I	IV	IV	0.535	0.182	34.0
USSR	1965	I	II	III	1026.3	615.6	60.0
GDR		I	II	III	360.5	177.2	49.0
USSR	1967	XII-66	II	III	1185.2	472.0	39.8
GDR		—	—	—	—	—	—
USSR	1968	—	—	—	—	—	—
GDR		I	III	III	523.2	258.2	49.4
USSR	1969	I	II	III	1106.5	535.0	48.3
GDR		III	IV	V	935.8	468.8	50.0
USSR	1970	I	II	III	1388.1	683.6	49.2
GDR		XII-69	I	II	II	1333.5	825.4
USSR	1971-72	XI-71	XII-71	II-72	1177.7	490.7	41.7
GDR		XII-71	II-72	II-72	1358.4	501.2	36.8
USSR	1973	XII-72	I	III	1360.2	762.8	56.1
GDR		I	II	II	1321.1	845.6	64.2
USSR	1975	XI-74	I	II	1292.1	613.5	47.5
GDR		XII-74	I	II	1705.0	764.0	45.0

^a Roman numerals indicate the month.

^b Calculated per 10 000 inhabitants.

Effect of shift

Antigenic shift in the influenza virus type A was observed in 1957 and in 1968. In 1957 both the haemagglutinin and the neuraminidase changed (H1N1→H2N2), whereas in 1968 only the haemagglutinin changed (H2N2→H3N2). These two shifts led to epidemics in the USSR and the GDR in the same years—1957 and 1969 respectively.

In 1957 the antigenic shift in both haemagglutinin and neuraminidase led to a pandemic, which reached the USSR first. A considerable increase in influenza morbidity in some parts of central Asia, Transcaucasus, and the Baltic region was recorded as early as April 1957. In the summer, the spread of influenza almost ceased; in September it started again, and in October of 1957 all cities in the USSR were affected. In the GDR the pandemic of 1957 erupted and reached a peak in October; after an interval of one month the epidemic recurred.

The epidemic induced by the second antigenic shift started in the USSR in January 1969, reached its peak in February and subsided in March. A second wave occurred a year later, in January 1970. In the GDR, the epidemic of influenza H3N2 started in March 1969, reached its peak in April and May and was over in early summer. A second wave occurred in December 1969.

The subtype H2N2 induced epidemics every 2-3 years. The subtype H3N2 demonstrated a different periodicity—two successive epidemic years being followed by a year without an epidemic. Thus in each country six epidemics occurred during the 12 years that the subtype H2N2 was circulating and five epidemics occurred during the 7 years that the subtype H3N2 was reported. All epidemics except those in 1962, 1965 and 1970 affected the USSR first and the GDR later, with intervals varying from 1 month to 1 year. Intervals of 1 year

were recorded only during the H2N2 era: in 1960, 1967, and 1968.

In 1960, the epidemic occurred only in the GDR and it could be considered as a continuation of the epidemic of 1959. There was a similar occurrence with the first epidemic of the subtype H3N2. The epidemic of 1959 affected the population of the GDR in March, the peak being recorded in April followed by a decrease in May. Transmission was quiescent during the summer. In January of 1960, morbidity from influenza again reached epidemic level and the peak was recorded in March; in April the epidemic was over.

In the USSR, the epidemic of 1959 took place from January to March, its course being normal and the following two years were free of epidemics. The last epidemic of the H2N2 subtype in the USSR started in January 1967, the peak was recorded in February, and after that the epidemic receded. In the GDR, 1967 was not an epidemic year, although morbidity was above the usual seasonal level. One year later, in January 1968, the last epidemic of influenza of the H2N2 subtype in the GDR occurred. It developed gradually and reached a peak in March 1968.

Intervals. Analysing the intervals between the onset of epidemics in the USSR and the GDR, we found that during the period 1970-75 the interval was 1 month. In 1959, the interval was 2 months and in 1962 and 1965 there was no interval between the start of epidemics in the USSR and the GDR. The epidemics of 1962 started simultaneously in both countries; in the USSR the peak was recorded in the same month and in the GDR 4 months later. The start, peak, and end of the epidemics in 1965 coincided in both countries.

Duration. Generally, the average duration of epidemics caused by both subtypes was 3 months, except for 1960 and 1962 in the GDR, and for 1973 and 1975 in the USSR. Those epidemics lasted 4 months. The epidemics of 1967 and 1972 in the USSR also lasted 4 months but influenza B was also involved. A very short epidemic was observed in the GDR in 1973. It lasted only 2 months, the peak and the end occurring in the same month. The occurrence of the onset and the peak in the same month, as happened in the GDR in 1957 and in the USSR in 1962, has not been observed during the era of the subtype H3N2 up to 1976. During the majority of epidemics the interval between the start and the peak was 1 month. Exceptions were noted in 1972 in the GDR and in 1975 in the USSR

when the epidemics reached their peak 2 months after the start.

Morbidity. In the USSR, the attack rate associated with the introduction of new subtypes in 1957 and 1969 was nearly the same as in other epidemic years. The values differed by 10% only.

Peak incidence and intensity. The peak incidence after the introduction of the new subtype differed greatly between epidemics caused by H2N2 and H3N2. In 1957 the peak incidence was 860.7 compared with only 535 in 1969. In the GDR the 1969 value was 12.4% lower still, indicating that the peak incidence of influenza when both the haemagglutinin and the neuraminidase had changed was about 38% higher than when only the haemagglutinin had changed. The difference between the intensities of the first epidemic of the H2N2 subtype and the first epidemic of the subtype H3N2 was 22.4%. These data show the importance of the extent of antigenic shift of influenza virus.

Effect of drift

Analysis of epidemics caused by antigenic drifts of the H2N2 subtype could be undertaken only for the USSR. During the era of the H2N2 subtype, the attack rate of epidemics varied within a range of 1000 to 1200. The peak incidence varied from 472 to 804. During the H3N2 era, the attack rates were higher than during the H2N2 era in the USSR, varying between 1100 and 1400. Comparing the attack rates for this period between countries, we found almost equal values for the epidemics in 1970 and 1973. In 1972 the attack rate in the GDR was 13% higher, and in 1975 it was 24% higher than in the USSR. Comparing the peak incidence we found that it was higher in the GDR in 1970 by 17% and in 1975 by 20%. On the other hand, the attack rates in the two countries in 1972 and 1973 were only slightly different. More intensive epidemics in the GDR compared with the USSR were observed in 1970 and in 1973, the differences being 16% and 8% respectively.

Severity. A further point to consider is to what extent antigenic shift and drift influenced the severity of epidemics. The severity of an epidemic may be judged by different criteria. No criterion is free from error due to incorrect registration, but mortality seems to be the most reliable indicator. Mortality is registered differently in the USSR and GDR. In the USSR influenza mortality is determined, as a rule, on the basis of clinical and pathological features,

Table 2. Mortality in the GDR and USSR for influenza epidemics of 1957-75 ^a

Epidemic period in:	GDR				USSR
	All causes		Influenza & ARD		Influenza & pneumonia ^b
	Reported	Expected	Calculated ^c	Reported	Reported
1	2	3	4	5	6
1957	3718	3402	+ 316	4.25	
1958	3733	3786	- 53	1.20	
1959	3785	3610	+ 175	1.24	
1960	5402	4955	+ 447	0.59	
1962	5548	4955	+ 593	0.40	
1965	3893	3786	+ 107	0.27	•
1967 ^d	3594	3786	- 192	0.11	12.4
1968 ^d	4273	3786	+ 487	0.90	9.8
1969	4058	3610	+ 448	2.39	12.4
1970	4351	3700	+ 651	4.77	12.5
1972	3988	3700	+ 288	2.47	13.8
1973	2741	2480	+ 261	3.95	15.8
1975	4209	3700	+ 509	14.49	16.3

^a Per 100 000 inhabitants; for the epidemic period + 1 month.

^b For a selected number of localities.

^c Difference between column 2 and column 3.

^d Nonepidemic years: GDR—1967; USSR—1968.

whereas in the GDR it is determined mainly on the clinical picture. Therefore rates of mortality from influenza and its complications in the USSR are considered more accurate. To determine the severity of influenza epidemics in the GDR we compared mortality from all causes with that reported for influenza and acute respiratory disease (ARD).

As seen in Table 2, there is wide disagreement between the calculated and reported mortality from influenza and ARD for the GDR. As comparable mortality data are not available for the years 1957-65, we were able to compare the indices of mortality of the two countries only for the period of circulation of the subtype H3N2. For the same reason, comparison of mortality due to the subtype H2N2 with that due to H3N2 was possible only for the GDR. The calculated mortality from influenza and ARD for the period of the H3N2 subtype was generally higher than that for the period of the subtype H2N2, and may be seen for the epidemics that occurred in the years after the antigenic shifts: it increased during the second epidemic of the subtype H3N2 (in 1970) to the highest level found during

the whole period of the study. A high rate of mortality was found for both subtypes in the fifth epidemic after the antigenic shift—593 in 1962 and 509 in 1975.

Classifying epidemics according to mortality from influenza and ARD from these data, it is possible to make the following recommendations for the definition of mild, moderate, and severe influenza epidemics in the GDR: mild 0<200, moderate 200-500, severe >500 deaths per 100 000 inhabitants during the epidemic period plus one month.

In the GDR severe epidemics occurred in 1962, 1970, and 1975; moderate epidemics in 1957, 1960, 1968, 1969, 1972, and 1973; and mild epidemics in 1958, 1959, and 1965. Thus half the epidemics of influenza and ARD in the GDR were of moderate severity. Mild epidemics occurred mainly during prevalence of the subtype H2N2, and severe epidemics were more often connected with the subtype H3N2. Comparing the degrees of severity of epidemics with morbidity, we found that epidemics with nearly identical attack rates (1970, 1973) had very different degrees of severity. In 1969 and 1970 in the USSR the reported mortality rate remained

around 12.5 whereas in the GDR mortality was higher in 1970 in comparison with that of 1969. In subsequent years mortality in the USSR gradually increased. On the contrary in 1972 and 1973, the GDR experienced epidemics of moderate to mild severity. In 1975, mortality in the GDR increased significantly and the epidemic reached the severe level. The epidemic was also severe in the USSR in 1975.

This analysis shows that the severity of the epidemics in different years in the two countries was not identical. This observation corresponds to the results of mortality calculations done by Assaad et al. (2), which included analysis of mortality for a number of countries, and from 1966 to 1973 for the USSR.

DISCUSSION

Following the higher peak incidence in the first epidemics caused by the H2N2 viruses, the peak incidence levels in the subsequent epidemics were lower. The more moderate peak incidence of the first epidemics with the H3N2 viruses was followed by higher levels of peak incidence in the subsequent epidemics and the epidemic periodicity was different for the two subtypes. We explain these special patterns of peak incidence as being due to different degrees of variation in the influenza viruses. The greater the variation, the higher the peak incidence.

A difference in the duration of the epidemics between the USSR and GDR was noted more often during the era of the H2N2 subtype. However,

the frequency of epidemics was always the same. This is evidence of uniform development of epidemic variants depending partly on the relative uniformity of the immune status of the population. The attack rates associated with shifts and drifts were practically the same if calculated for each epidemic period. Even the difference in the attack rates between the USSR and the GDR was usually not significant. According to official statistics, about 13% of the population usually experienced the disease during an epidemic of influenza A. Generally the peak incidence was attained within 3–4 weeks, but there were exceptions in both countries. In 1957 this period was shorter in both countries and in 1962 it was shorter only in the USSR. In 1962 the time until peak incidence was extremely prolonged in the GDR.

Studying the intensity of single epidemics, we found no regularity during the era of the subtype H2N2. In the era of the H3N2 subtype intensive epidemics were followed by less intensive epidemics. This is seen in the data for the GDR, and from 1971/72 onwards also for the USSR. These observations are in conformity with the hypothesis mentioned above.

Analysing the severity of the different influenza epidemics using the indices of mortality, no direct relation to the processes of antigenic shift or drift was detected. The severity of epidemics caused by the influenza virus depended not only on its special antigenic composition (haemagglutinin and neuramidase) but also on the factors responsible for the pathogenicity of the virus.

RÉSUMÉ

ÉPIDÉMIOLOGIE DE LA GRIPPE, DE 1957 À 1975, EN UNION DES RÉPUBLIQUES SOCIALISTES SOVIÉTIQUES ET EN RÉPUBLIQUE DÉMOCRATIQUE ALLEMANDE

L'analyse des données cliniques rassemblées par les services épidémiologiques des deux pays a montré que chaque cassure ou glissement dans la structure antigénique du virus de la grippe a eu pour résultat des épidémies dans les deux pays. En fonction du degré de l'altération antigénique, aussi bien les cassures que les glissements ont influencé la rapidité de la propagation des épidémies ainsi que le moment de leur apparition et leur intensité. Les analyses effectuées n'ont cependant pas révélé de relation directe entre le degré de la variation

antigénique d'une part et le taux d'attaque ou la gravité de l'épidémie de l'autre. Le taux d'attaque moyen, dépendant de la pathogénicité du virus circulant, était dans les deux pays de l'ordre de 13%. La gravité des épidémies a varié dans les deux pays, mais la quatrième épidémie suivant chaque cassure a été plus grave dans chacun d'eux. Les raisons de ce phénomène et d'autres caractéristiques épidémiologiques sont étudiées dans l'article.

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