Acute respiratory diseases/influenza sentinel 2000/2001

Abstract A sentinel surveillance system of the public health service for acute respiratory diseases (ARD), especially influenza, has been realized in the Free State of Saxony of Germany for 25 years. The epidemiological sentinel is based on weekly registration of morbidity and mathematical-statistical calculations. For a microbiological sentinel, a fast diagnosis by nucleic acid amplification techniques and improvements of sample management in connection with the rapid transmission of results have been introduced. In the present report, the ARD/influenza sentinel is demonstrated for the season 2000/2001. The sentinel system provides scientific and practical information for a prophylactic and therapeutic control program. Economic significance has been proved by verifiable numerical data derived from several epidemiological and microbiological investigations. The realized system has been considered superior to the influenza surveillance scheme of the Arbeitsgemeinschaft Influenza (AGI, Marburg, Germany) for all Germany and another system of a pharmaceutical company which is under construction.

Keywords Influenza · Epidemic · Sentinel · Public health service · Polymerase chain reaction

The epidemiological sentinel of the public health service in Saxony

Mathematical normal course

The morbidity of acute respiratory diseases (ARD) of a defined area and population is registered weekly. If long periods have to be analyzed, resulting in a large number of values which do not show a clear behavior, the trend can be represented by an elementary function. In such cases, the course of the trend can be determined by an approximation called "smoothing" [7]. This process consists of adapting data of periods by a function and substituting these data by the calculated value.

The mathematical normal course of the ARD/influenza sentinel is a smoothed temporal course of the weekly morbidity with seasonal changes taking into account the distribution of data and their trend for long periods. It is based on the weekly values of the last five epidemiological years and provides the prognosis for the next year. Seasonal changes are considered by sinus and cosine functions of the whole period of 52 weeks and asymmetric increases or decreases of the values are considered by sinus and cosine functions for the half period of 26 weeks. Coefficients a, b, and c are estimated by means of the least square method. Summing up, the temporal course of the morbidity is approximated by the following formula:

\[ y = a + bx + c \sin \left( \frac{2\pi}{52} x \right) + d \cos \left( \frac{2\pi}{52} x \right) \]

where x represents "continuous week number", y represents "new diseases per week", and a, b, c, d represents regression constants.

Pre-epidemic and epidemic threshold

Accidental variations of the morbidity are considered by a confidence interval. The pre-epidemic threshold is characterized as the upper confidence limit of the mathematical normal course. Exceeding of the pre-epidemic threshold indicates non-accidental deviation from the normal course. Regarding the incidence of ARD, the upper limit of this 99%-confidence interval proved to be significant. When this limit is reached, an epidemic will possibly begin. Exceeding the epidemic threshold
reliably indicates the existence of an epidemic. In comparison with the pre-epidemic threshold, the twofold distance to the mathematical normal course characterizes the epidemic threshold. This principle is documented in the Fig. 1, which illustrates the benefits of the ARD/influenza sentinel of the Public health service (PHS) during the season 2000/2001.

Our procedure describes objective and verifiable data on the beginning and the course of the epidemic, age-specific morbidity and excess morbidity of influenza. Data based on mathematical and statistical calculations are of medical and economical significance. Using these data the yearly irritations caused by the media about the influenza can be put into perspective.

Beginning, end and course of an epidemic

Exceeding the mathematical normal course means initially attention in connection with the microbiological sentinel, e.g., first detections of influenza viruses by polymerase chain reaction (PCR). Additional unspecific noxae responsible for the accelerated circulation of influenza viruses are rather speculative. In this connection, cold spells that should reduce mucosal blood circulation as well as toxic environmental noxae are suggested to facilitate the onset of influenza infection [5].

Within the epidemiological sentinel, the reliable beginning of an epidemic is indicated when the epidemiological threshold, defined as upper limit of the 99.9% confidence interval of the normal course, is exceeded. This situation has been demonstrated in Saxony over the last 25 years. The end of an epidemic is indicated when the normal course is reached again [7]. In the district of Annaberg, for example, an epidemic was observed for a period of 4–5 weeks during the season 2000/2001 (Fig. 1).

To ascertain an exact and objective involvement of different age groups, the same mathematical-statistical method for the calculation of the age-specific course is essential. This is demonstrated in Fig. 2, which shows the analysis of the situation in the district Freiberg (age group 1 to <7 years). Primarily, children and young persons up to 17 years of age were affected during the last H1N1 epidemic, whereas older people including elderly persons >60 years were moderately affected. The exact morbidity in the age groups is characterized by the excess morbidity.

**Fig. 1** Acute respiratory diseases: normal course and morbidity in the district of Annaberg (total) from the 27th week to the end of 2000 and from the beginning to the 26th week of 2001 (NC normal course, Preep. pre-epidemic threshold, Epid. epidemic threshold, Morb. morbidity)

Excess morbidity

Reliable data about the extent of an epidemic are required for the calculation of significance as well as for medical and economical reasons. The weekly excess morbidity is given by the difference between the real existing and the expected morbidity (normal course). The sum of the differences over the course of an epidemic represents the excess morbidity of the whole season. Data ascertained from the district Freiberg in Saxony during the season 2000/2001 are shown in Table 1.

**Preconditions for the epidemiological ARD/influenza sentinel**

The preconditions of the epidemiological ARD/influenza sentinel of the PHS are:

- Necessity of collecting data over 5 years until beginning of the analysis
- Participation of as many physicians involved in primary care as possible