Exact Correlation in Epidemics of Pneumocystis Pneumonia

K. KUČERA

Institute of Parasitology, Czechoslovak Academy of Sciences, Prague

Abstract. In studying interhuman transmissions of pneumocystis pneumonia in homologous groups of infants we can take advantage of the scheme illustrating the "exact graphically expressible epidemiological chronologic and local correlations" which reveal that the contamination among infants occurs during the first 20 days following the birth. The relatively long incubation period results in a prolonged and inconspicuous onset of the epidemics, the explosive onset being always of a seeming character. In the origin of an epidemic a significant role is played by sporadic cases. The epidemiological study of such cases reveals their possible connection with the existence of *Pneumocystis carinii* within the lungs of small rodents, especially in the periods of the cyclic overgrowing of their populations.

My attempt to characterize pneumocystosis from the epidemiological standpoint started traditionally from the study of human sources. During these initial studies, however, I tried to determine every human case of pneumocystosis within the territory, the administrative center of which in the years 1951—1955 was Gottwaldov in Czechoslovakia. Later on I made attempts to find some healthy active carriers of *Pneumocystis carinii* (KUČERA and JÍROVEC 1962). At last I investigated the lungs of small mammals for the presence of this parasite. In the present paper I am reporting the results of the initial phase of my studies which are completed by only some notes on my further investigations.

MATERIAL AND METHODS

In the present phase of investigation the existence of the healthy active carriers of pneumocysts should be considered as a hypothetical source of infection because of the absence of positive findings of the parasite in the upper respiratory tract of healthy persons. For this reason I tried to do without

Presented in part at the First International Congress on Parasitology in Rome, Sept. 24—26, 1964.

this hypothesis and to base my investigations exclusively on the study of the sick persons as sources of the infection. In this study I used clinical records on all children admitted to three "well-baby clinics" (a term for our institutes where healthy infants are concentrated, with affiliated centers for prematures) in the observed territory within the years 1951 to 1955.[1]) From these I found out all the infants who had suffered from some form of pneumonia up to the age of 6 months; because only few infants remained in the well-baby clinic up to this age I was obliged to provide information on all the other infants concerned by means of a rather difficult depistage action. In this depistage I used in the first place written questionnaires, furthermore I made personal visits in places where the infants were living and finally I studied the respective official medical records on all infants afflicted with an illness treated out of hospital or in a hospital.[2]) In any case of death in an infant I had to look up dissection records in the respective departments of pathological anatomy and to review the histologic material.[3]) As to the infants born in maternity homes, I used the records of these institutions to obtain information on the period preceding the onset of the disease.[4]) In infants born out of hospital I had to study on the one hand the living conditions of these babies from their birth up to the date of their eventual admission to the hospital and on the other hand the period following the hospitalization. For this purpose I had to see personally not only the households but in many cases also the adjoining field (see the onset of the third epidemic, described below). In a great majority of cases I carried out an intracutaneous test with pneumocystin the production of which I described in an earlier paper (KUČERA and JÍROVEC 1962). In some cases I had to catch myself small mammals in the surroundings of the places where the affected infants were living and to carry out the dissection of these animals as well as the histological examinations. For many years I used to execute myself the postmortem as well as the histopathological and protozoological examinations in one of the departments of pathological anatomy in the given territory and also in the following years, when I passed the function over to my successor, I took part in numerous dissections and examinations carried out in different pathologic-anatomical departments of this territory.

The graphical method worked out during the study and applied for the epidemiological investigation, is seen from Fig. 1 – 6. The graphical basis of the figures is formed by a millimeter net-work in which each square millimeter represents one day. The first oblique line from the left results from ranging the cases according to the date of birth. The second similarly shaped parallel line indicates the date at which each infant reached the age of 20 days.

From the different criteria of ranging the cases, the date of birth was chosen as the only suitable for the epidemiological purpose. Other criteria, such as the date of admission to the well-baby clinic or of the onset of the disease, which are unsuitable for such ranging, are illustrated in each case partly by the beginning of the thick line, partly by the left corner of a triangle. The thick line illustrates the length of the hospitalization of infants in the well-baby clinic (i.e. in the present article partly such clinic at Gottwaldov and partly at Kyjov) which is the center of a homologous group of infants. The triangle denotes interstitial pneumonia. A black triangle indicates interstitial pneumonia with a postmortem demonstration of pneumocysts, a dashed triangle interstitial pneumonia with

[1]) The writer is greatly obliged to Head Physicians: J. Salaquardová, M. Kotulek and J. Svozil, for the permission to make use of the case records.

[2]) The writer is indebted to the Head Physicians from the Paediatric Department (Dept. for sick infants only) of the hospital: B. Dokulil at Gottwaldov, J. Ševčík at Kyjov, J. Sommer at Kroměříž, S. Vrzala at Vsetín, A. Palacký at Uherské Hradiště, V. Filipovič at Hodonín, for the permission to make use of the records.

[3]) The writer is indebted to E. Vaněček, Pathologist of the Pathologic Dept. of the hospital at Gottwaldov, his successor, for the permission to make use of his records from 1953 to 1955 and of the histological preparations.

[4]) The writer is indebted to Head Physicians from the maternity homes: V. Král at Gottwaldov, F. Havránek at Uherské Hradiště, D. Kvíz at Kroměříž, A. Bednář at Kyjov and R. Houdek at Vsetín, for the permission to make use of the case records.

345 a positive intracutaneous test after recovery, an empty triangle interstitial pneumonia in which it was impossible for different reasons to carry out the test or a postmortem demonstration of the parasite but where all other criteria induced a strong suspicion of pneumocystosis. The end of the hospitalization period in the mentioned center of the studied homologous group is marked by the end of the thick line and by a number indicating the respective day of dismission. The end of the disease is marked by the right corner of a triangle and by a figure evtl. by a cross. The date of every admission or dismission from another institution, e.g. the department for sick children, is also illustrated in the graph. This is explained in detail in the legenda appended to the figures. From these figures it is possible to derive a number of data of a considerable epidemiological importance.

RESULTS

In this paper I should like to mention as an example the results obtained in two well-baby clinics, especially as regards the infants admitted to these institutes from August 1st, 1951, until December 31st, 1954.

Table 1 surveys all data obtained. Out of 1,631 infants admitted to these insti. tutes, 364 became ill with some form of pneumonia up to the age of 6 months. In 50 infants deceased the post mortem examination revealed histologically demonstrated pneumocystis pneumonia. Interstitial pneumonia with a positive intracutaneous test was diagnosed in another 130 instances from those who survived. This number was completed by 36 interstitial pneumonias in which the pneumocystic etiology was determined only by means of a clinical picture and on the basis of exact epidemiological correlations. Hence follows that out of 364 pneumonias 216 were of pneumocystic origin.

A more detailed information on the occurrence of pneumonias in these infants within the given period is shown in Tables 2, 3, 4 and 5.

In the following I intend to pay special attention to the "exact graphically expressible epidemiological chronologic and local correlations" which I already mentioned as an important clue for the process of evaluation (KUČERA 1964, 1966). Fig. 1 illustrates these correlations applied in one of the institutes which were the subject of my studies within the mentioned period. At the right bottom of the figure two deaths of infants showing a characteristic histopathological picture of pneumocystis pneumonia are recorded. Both these infants were born outside Kyjov (the dates of birth differing by 9 days) — one of them at home, in very bad hygienic conditions, the other at the maternity home at Uherské Hradiště — and both were transferred to Kyjov and admitted to the well-baby clinic because of their prematurity (one on the first, the other on the third day after birth). Both were afflicted with interstitial pneumonia, one by the end of April and the other by the beginning of May and both of them died approximately in mid-May. Just at the time when these infants were admitted to the well-baby clinic, three cases of interstitial pneumonia were recorded in this institute to which no attention was paid with regard to pneumocystosis till my investigation. One of these three patients died and there was no possibility to realize ex post a histopatho-

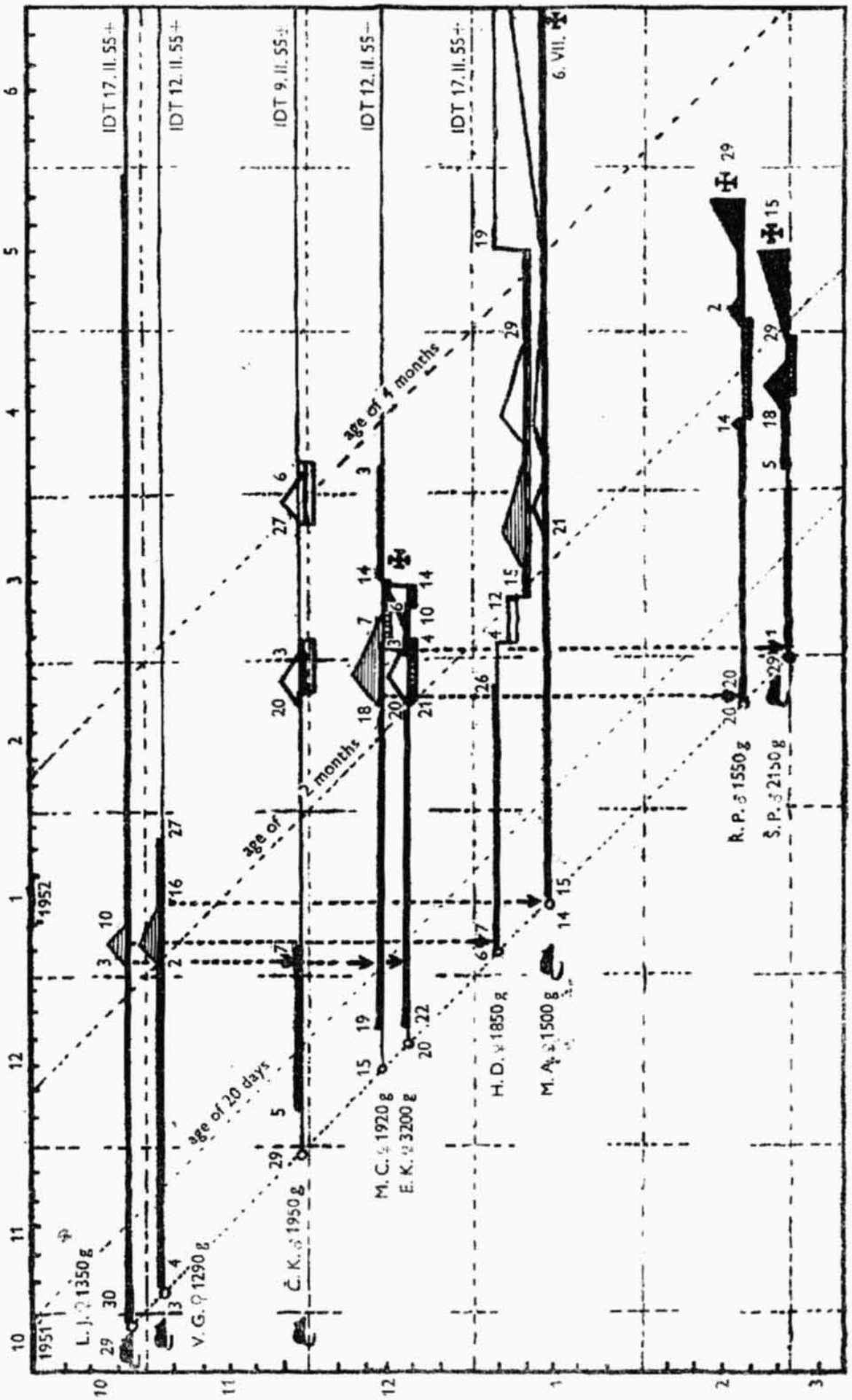
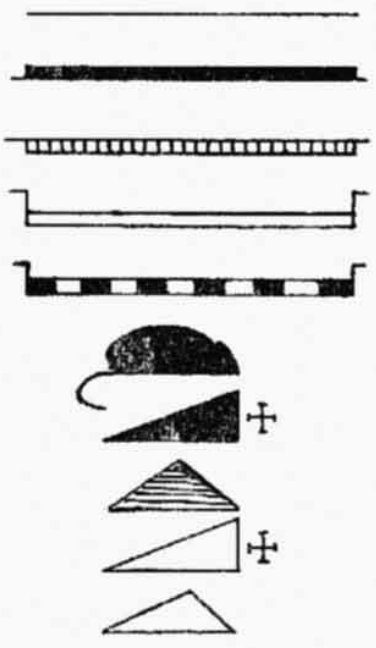


Fig. 1. The reconstruction of the onset of the first epidemic of pneumocystis pneumonia at Kyjov 1951—1952.

347 logical examination of his lungs; in the second patient the intracutaneous test with pneumocystin (KUČERA and JÍROVEC 1962) showed positive results and the outfall of this test in the third infant was indefinite. The exact graphical epidemiological chronologic and local correlation seems quite clear in these cases. In continuing the study in the ascendental direction we revealed the fact that shortly after the arrival of two of the cited three infants (born in the second half of December 1951 and fallen ill in February of the next year) two other infants suffering from interstitial pneumonia were present at the same department. These infants were both born in the country to families living in very bad hygienic conditions (the farmstead abounding moreover in numerous small rodents), were admitted to the well-baby clinic on the first day of their life and fell ill at the beginning of January. Later on they showed positive results of the penumocystin test. The ascendentally aimed search revealed no occurrence of interstitial pneumonia among children of this institute before the admission of both mentioned cases and they can therefore be taken for initial links of the epidemic, all the more that an analogous situation was revealed repeatedly in five other onsets of epidemics, as shown in Fig. 2, 3, 4, 5 and 6.

In the second epidemic (Fig. 2) the first death of infant showing a histological picture of pneumocystis pneumonia was recorded in August 1952. The infant (J. H., 1950 g) was treated in the Department for sick children of the hospital at Vsetín. It was born in poor hygienic conditions as premature and on the first day of its life it was transferred to Kyjov (about 90 km) to a well-baby clinic. Just at the time when this infant was admitted, a case of interstitial pneumonia was recorded at this institute to which no attention was paid with regard to pneumocystosis. (J. B. 2700 g). The last mentioned patient was also born in very poor hygienic conditions (gypsy) and there was the possibility of contact with numerous small rodents. The intradermal test in this infant was positive. No



The life of each case within the family.

The life of a case within the "well-baby" clinic at Kyjov or at Gottwaldov.

The life of a case within a department of the hospital at Kyjov or at Gottwaldov. (Department for sick children).

The life of a case within a department for sick infants at other towns.

The life of a case within a well-baby clinic at other towns.

The birth of a case in a family with insufficient hygienic conditions. Small rodents present.

Pneumocystis pneumonia with demonstration of Pneumocystis carinii.

Interstitial pneumonia with positive pneumocystis IDT.

Interstitial pneumonia diagnosed from clinical and epidemiological standpoint by means of precise chronological and local correlations with a case which was demonstrated as a real pneumocystosis.

Table 1. Short characterization of groups reported

Date of the epidemic	Group			Number of infants
1951 – 54	A	Infants hospitalized at "well-baby" clinics		
			Gottwaldov	584
			Kyjov	1047
			Total	1631
	B	Infants that developed pneumonias of different kind since their birth up to 6 months from the group A		
			Gottwaldov	105
			Kyjov	259
			Total	364
	C	Infants that developed pneumocystis pneumonia (Pneumocystis carinii demonstrated) from the group B		
			Gottwaldov	11
			Kyjov	39
			Total	50
	D	Infants that developed an intestitial pneumonitis (Pneumocystis carinii not demonstrated), positive to the intradermal test with "pneumocystin" from the group A		
			Gottwaldov	56
			Kyjov	76
			Total	130
	E	Infants that developed interstitial pneumonitis at the age of 2 – 4 months in close epidemiological chronological and local correlation with cases of pneumocystosis. IDT impossible to carry out. From the group A		
			Gottwaldov	7
			Kyjov	29
			Total	36
	F	Infants as in groups C + D	Gottwaldov	67
			Kyjov	113
			Total	180
	G	Infants as in groups C + D + E	Gottwaldov	69
			Kyjov	142
			Total	216

Table 2. Pneumocystosis during 1951 in groups according to Tab. 1

Group	Well-baby clinic in	Number of cases in month					Total
		VIII	IX	X	XI	XII	
A	Gottwaldov	23	22	18	16	14	93
	Kyjov	21	30	33	31	20	135
	Total	44	52	51	47	34	228
B	Gottwaldov	2	1	0	2	4	9
	Kyjov	1	3	3	5	6	18
	Total	3	4	3	7	10	27
C	Gottwaldov	0	0	0	1	0	1
	Kyjov	0	0	0	0	0	0
	Total	0	0	0	1	0	1
D	Gottwaldov	0	1	0	3	3	7
	Kyjov	0	0	1	1	1	3
	Total	0	1	1	4	4	10
E	Gottwaldov	0	0	0	0	0	0
	Kyjov	0	0	0	1	2	3
	Total	0	0	0	1	2	3
F	Gottwaldov	0	1	0	4	3	8
	Kyjov	0	0	1	1	1	3
	Total	0	1	1	5	4	11
G	Gottwaldov	0	1	0	4	3	8
	Kyjov	0	0	1	2	3	6
	Total	0	1	1	6	6	14

epidemiological connection with the first epidemic was revealed. The infant resided the whole month after birth in the unsanitary household before admission to the well-baby clinic. It must therefore be supposed an initiating case which contaminated later on further four infants (V. S. 1360 g, M. M. 1600 g, M. K. 1900 g and A. D. 2250 g).

The first death of an infant showing a histological picture of pneumocystis pneumonia in the third epidemic was recorded in December 1954 (M. S. 1660 g) (Fig. 3). This infant was born in the maternity home at Kyjov and transferred to the well-baby clinic (in the same building) on the first day of its life. Since the 11th October 1954 it was treated in the Department for sick children (in the same building). On August 19th, when it was admitted to the well-baby clinic, the onset of interstitial pneumonia in an infant J. M. 3100 g was recorded there. This infant was born without any assistance in a corn-field and immediately after birth it was burried in a heap of grass mixed with clay by its unmarried mother with the intention of murder. It was saved by people who observed the illtreatment and was taken to hospital. In the field, where the infant was born, numerous small rodents were found at that time. After the infant recovered, we made an intradermal test with a positive result. This case is in no connection with those from the second

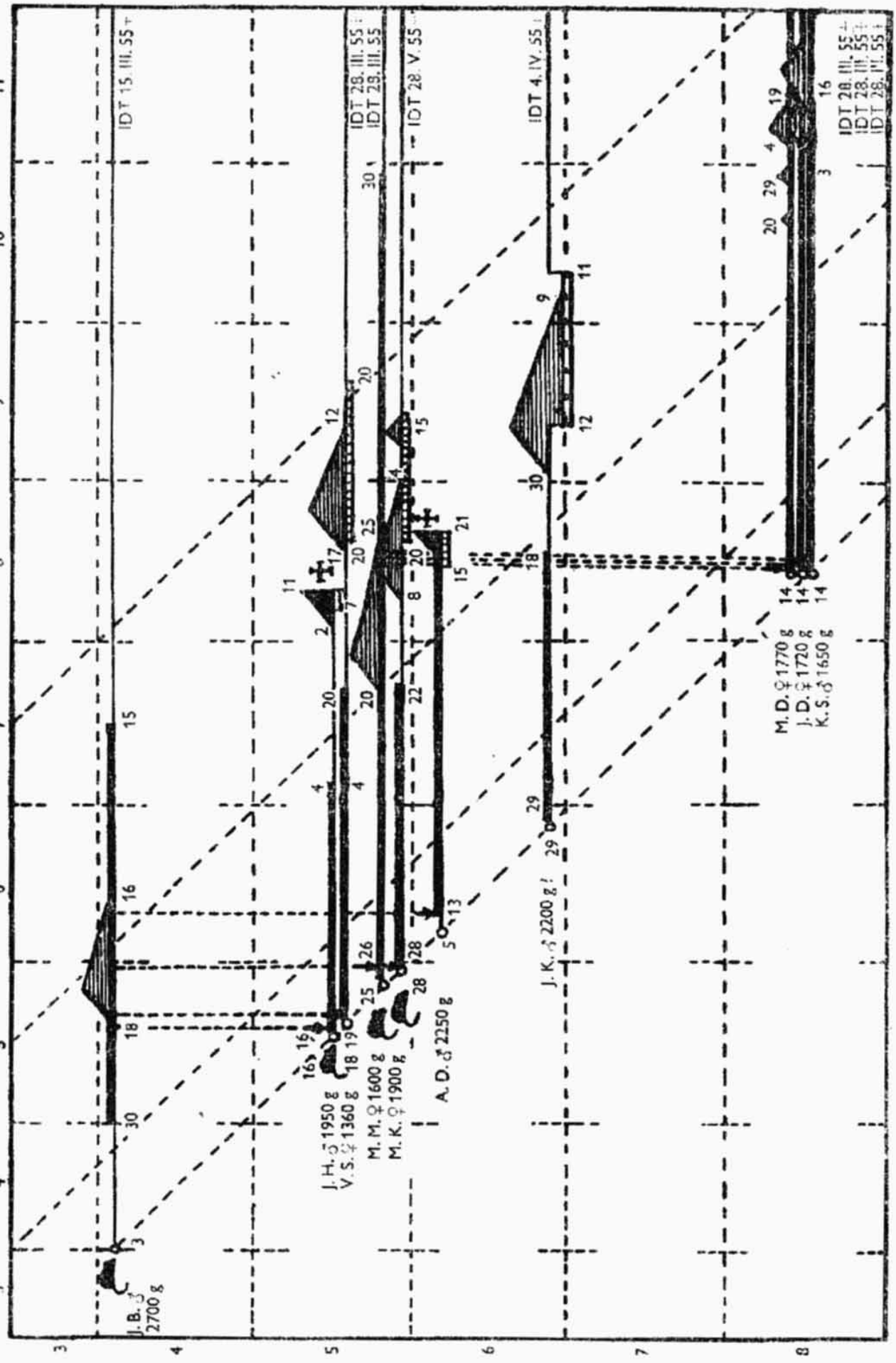


Fig. 2. The reconstruction of the onset of the second epidemic of pneumocystis pneumonia at Kyjov 1953.

Table 3. Pneumocystosis during 1952 in groups according to Tab. 1

Group	Well-baby cl. in	Number of cases in month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
A	Gottwaldov	18	9	11	15	15	22	11	9	9	18	16	11	164
	Kyjov	26	20	28	40	26	32	29	27	22	23	23	16	312
	Total	44	29	39	55	41	54	40	36	31	41	39	27	476
B	Gottwaldov	0	0	5	8	6	7	2	2	2	2	3	1	38
	Kyjov	3	3	6	7	7	7	9	9	9	15	9	5	89
	Total	3	3	11	15	13	14	11	11	11	17	12	6	127
C	Gottwaldov	0	0	1	3	1	0	0	0	1	0	0	0	6
	Kyjov	0	1	1	0	2	2	0	0	1	5	1	0	13
	Total	0	1	2	3	3	2	0	0	2	5	1	0	19
D	Gottwaldov	0	0	2	4	4	3	0	3	0	0	0	0	16
	Kyjov	1	1	1	4	1	1	3	2	4	5	5	1	29
	Total	1	1	3	8	5	4	3	5	4	5	5	1	45
E	Gottwaldov	0	0	1	0	1	0	0	0	0	0	1	0	3
	Kyjov	1	0	3	0	1	1	1	1	0	2	2	2	14
	Total	1	0	4	0	2	1	1	1	0	2	3	2	17
F	Gottwaldov	0	0	3	7	3	3	0	3	1	0	0	0	22
	Kyjov	1	2	2	4	3	3	3	2	5	10	6	1	42
	Total	1	2	5	11	8	6	3	5	6	10	6	1	64
G	Gottwaldov	0	0	4	7	6	3	0	3	1	0	1	0	25
	Kyjov	2	2	5	4	4	4	4	3	5	12	8	3	56
	Total	2	2	9	11	10	7	4	6	6	12	9	3	81

epidemic in the well-baby clinic. Therefore it must be supposed an initiating case.

Further three epidemics were investigated in the well-baby clinic at Gottwaldov. The first one of them (Fig. 4) started at the end of the year 1951, but the first death of an infant, showing a histological picture of pneumocystis pneumonia, was recorded at the end of January 1952 (L. K. 1600 g). The symptoms of interstitial pneumonia were observed simultaneously also in the other twin (L. Z. 1890 g), who recovered and later on developed a positive IDT. The common source of their contamination was the infant E. P. 2950 g, with interstitial pneumonia lasting from November 13th, 1951 to January 30th, 1952. This infant was born in a village known as a very backward one in respect of hygiene (Kašava), in a building harbouring numerous rats. Previously no case of interstitial pneumonia had occurred at the well-baby clinic, therefore it must be supposed an initiating case.

In the second epidemic at Gottwaldov the first death of an infant with a typical finding of *Pneumocystis carinii* occurred in May, 1953. The first was immediately followed by a second one. The deceased infants were twins Z. G. 1800 g and J. G. 1450 g. (Fig. 5). Both were born in the maternity home at Gottwaldov and were

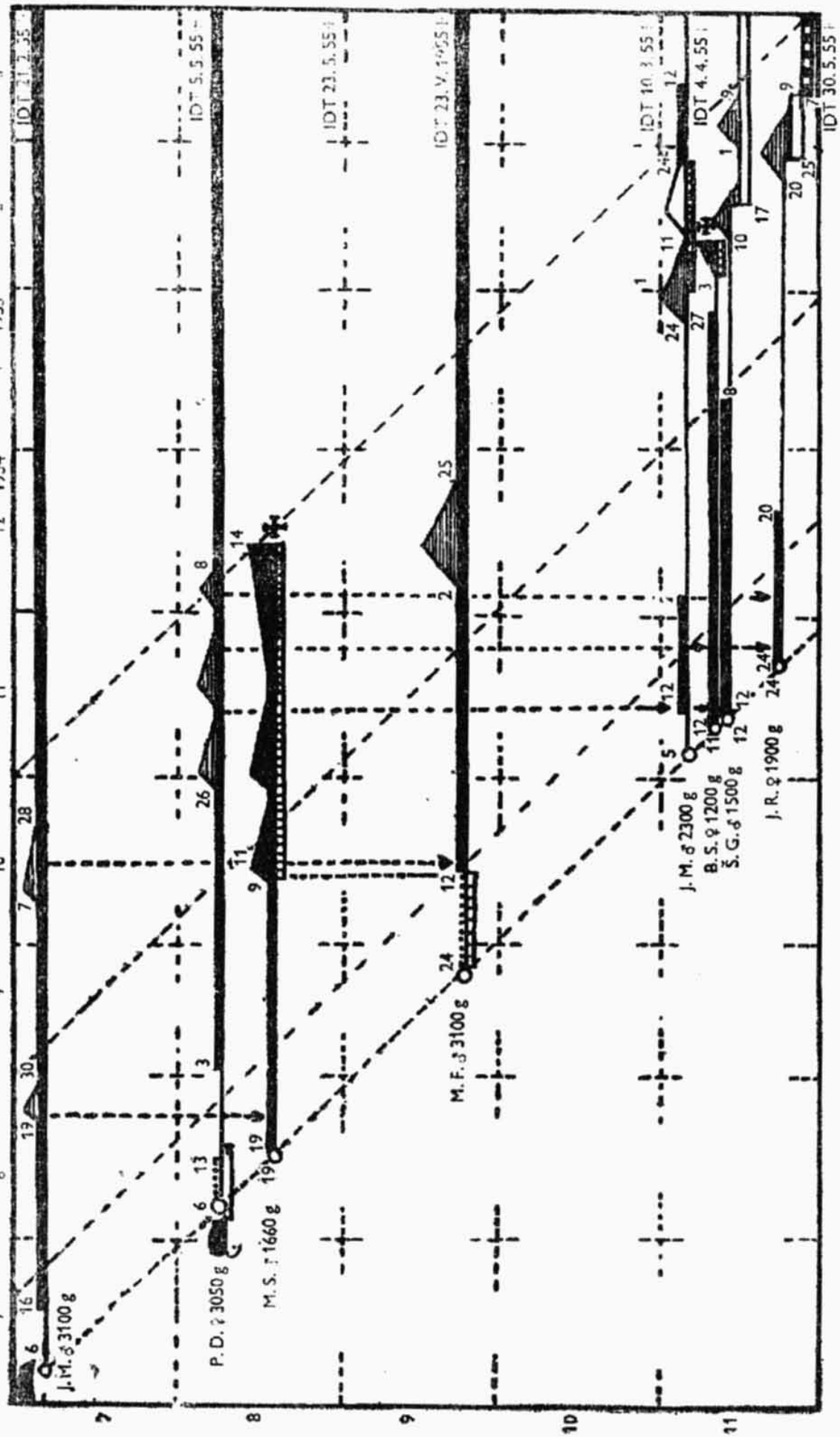


Fig. 3. The reconstruction of the onset of the third epidemic of pneumocystis pneumonia at Kyjov 1954.

Table 4. Pneumocystosis during 1953 in groups according to Tab. 1

Group	Well-baby cl. in		Number of cases in month												Total
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
A	Gottwaldov		13	12	24	12	12	24	25	22	11	11	0	5	171
	Kyjov		33	25	22	38	25	32	14	28	20	26	24	18	305
		Total	46	37	46	50	37	56	39	50	31	37	24	23	476
B	Gottwaldov		3	2	8	6	3	3	6	6	3	2	0	0	42
	Kyjov		8	7	5	3	8	10	2	9	9	10	10	13	94
		Total	11	9	13	9	11	13	8	15	12	12	10	13	136
C	Gottwaldov		0	0	2	0	0	0	1	1	0	0	0	0	4
	Kyjov		1	0	0	0	1	1	0	1	1	6	2	7	20
		Total	1	0	2	0	1	1	1	2	1	6	2	7	24
D	Gottwaldov		2	1	4	4	1	3	3	4	3	1	0	0	26
	Kyjov		3	1	2	1	3	2	0	4	4	1	3	4	28
		Total	5	2	6	5	4	5	3	8	7	2	3	4	54
E	Gottwaldov		0	1	0	0	2	0	0	0	0	0	0	0	3
	Kyjov		1	0	2	0	0	1	0	2	1	2	1	2	12
		Total	1	1	2	0	2	1	0	2	1	2	1	2	15
F	Gottwaldov		2	1	6	4	1	3	4	5	3	1	0	0	30
	Kyjov		4	1	2	1	4	3	0	5	5	7	5	11	48
		Total	6	2	8	5	5	6	4	10	8	8	5	11	78
G	Gottwaldov		2	2	6	4	3	3	4	5	3	1	0	0	33
	Kyjov		5	1	4	1	4	4	0	7	6	9	6	13	60
		Total	7	3	10	5	7	7	4	12	9	10	6	13	93

immediately transferred to a near-by building where the well-baby clinic was situated. Just at the time when they were admitted two cases of interstitial pneumonia were recorded in this institute (M. J. 1800 g, J. Z. 2600 g). One of the last mentioned infants was born in the country, in very poor hygienic conditions (J. Z.). The second one (M. J.) was born in the maternity home at Kroměříž, but since the age of 14 days, for more than one month, it was living at home, in very unsatisfactory hygienic conditions. In the buildings where both the mentioned infants were living, there occurred numerous small rodents. The ascendentally aimed search revealed no occurrence of interstitial pneumonia among children of the well-baby clinic at the time of hospitalization of both mentioned cases and they can therefore be taken for the initial links of the second epidemic in this institute.

The third epidemic at Gottwaldov (Fig. 6) was derived from the case V. A. 2400 g which was born in very unsatisfactory hygienic conditions in the country and had never been in any institution of the health service up to the day when it fell sick. The household harboured numerous small rodents. The patient was not admitted to the well-baby clinic until the end of his illness; he was transferred to the well-baby clinic from the Department for sick children at Gottwaldov which was

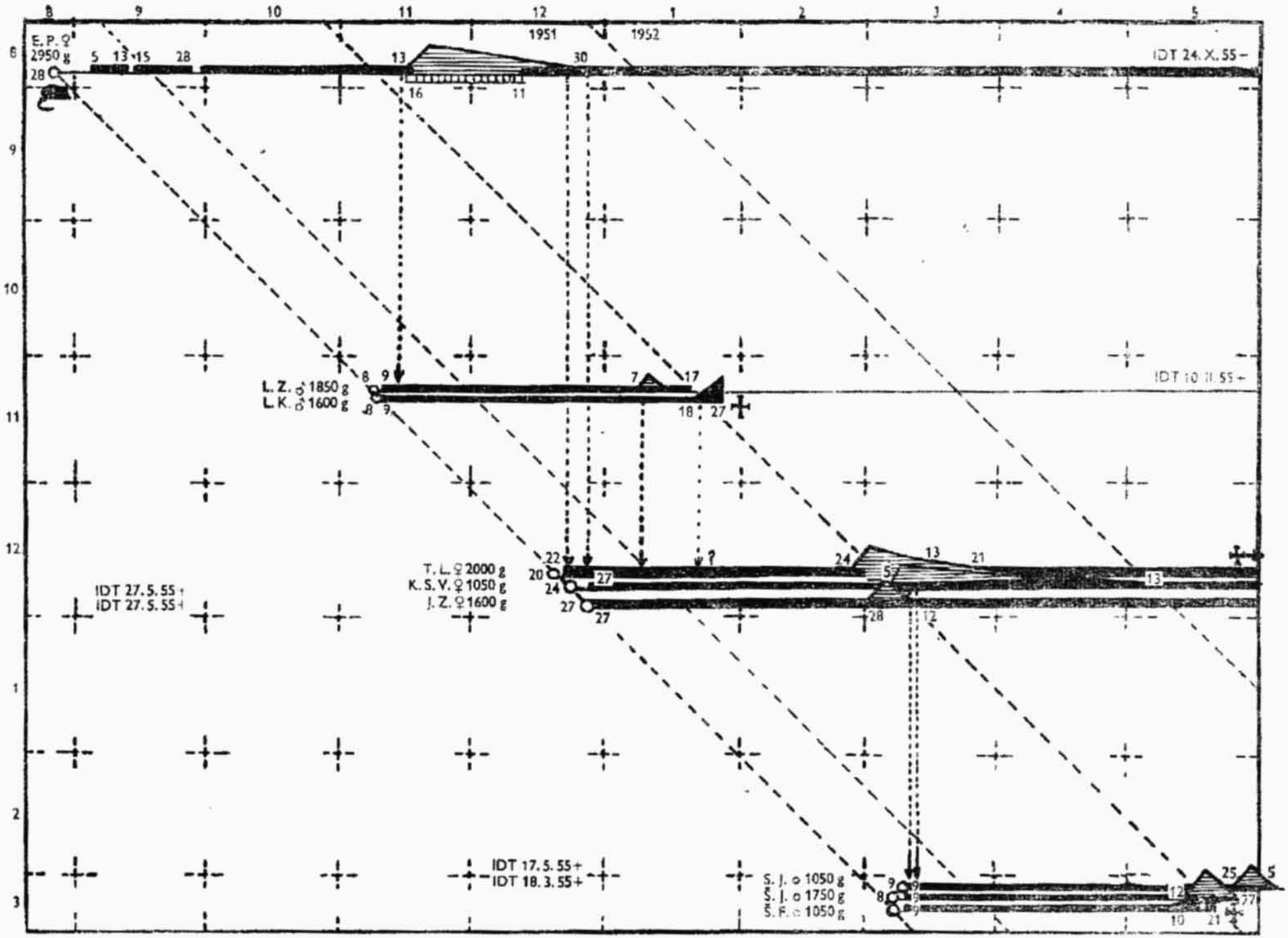


Fig. 4. The reconstruction of the onset of the first epidemic of pneumocystis pneumonia at Gottwaldov 1951—1952.

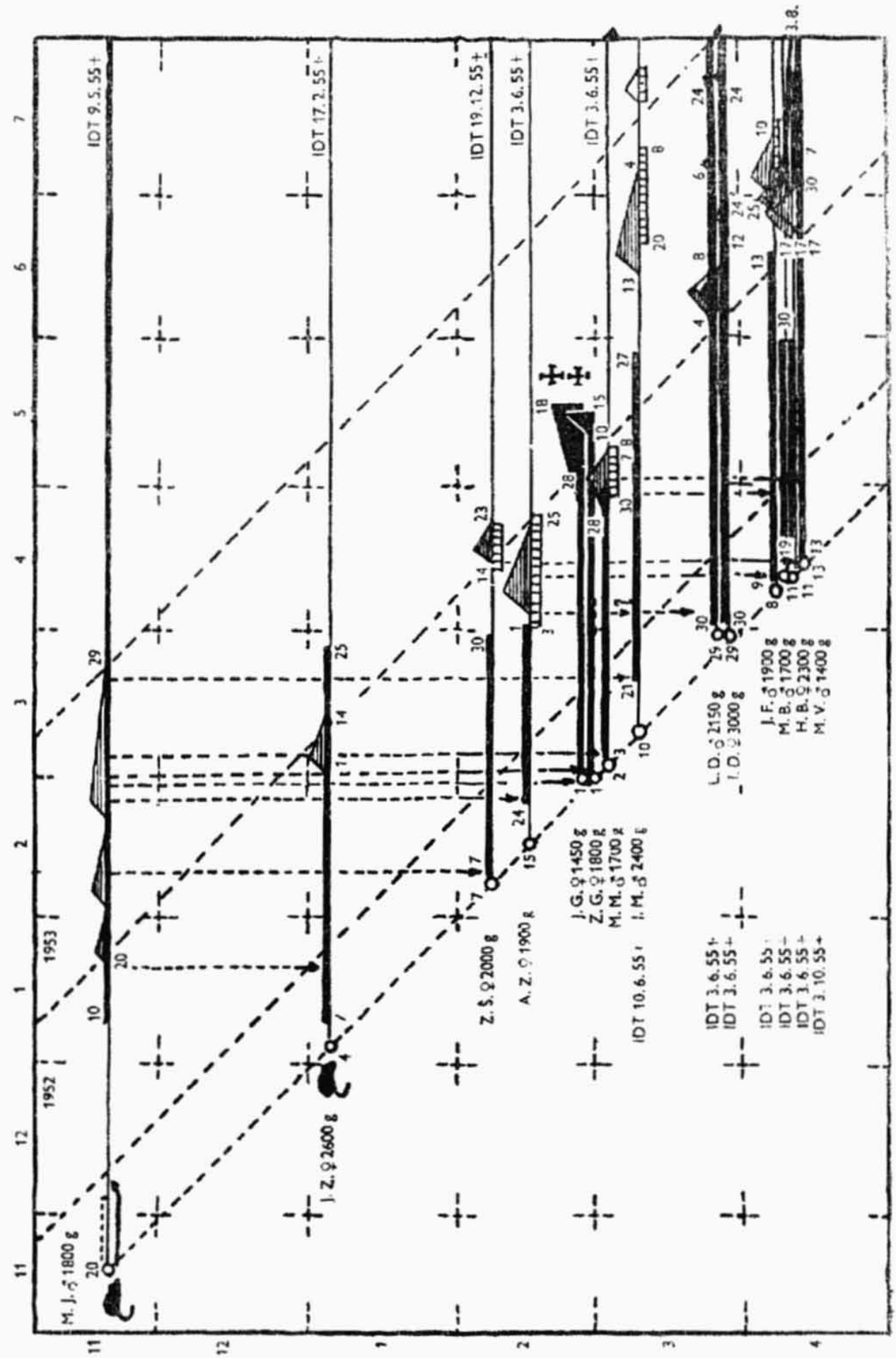


Fig. 5. The reconstruction of the onset of the second epidemic of pneumocystis pneumonia at Gottwaldov 1953.

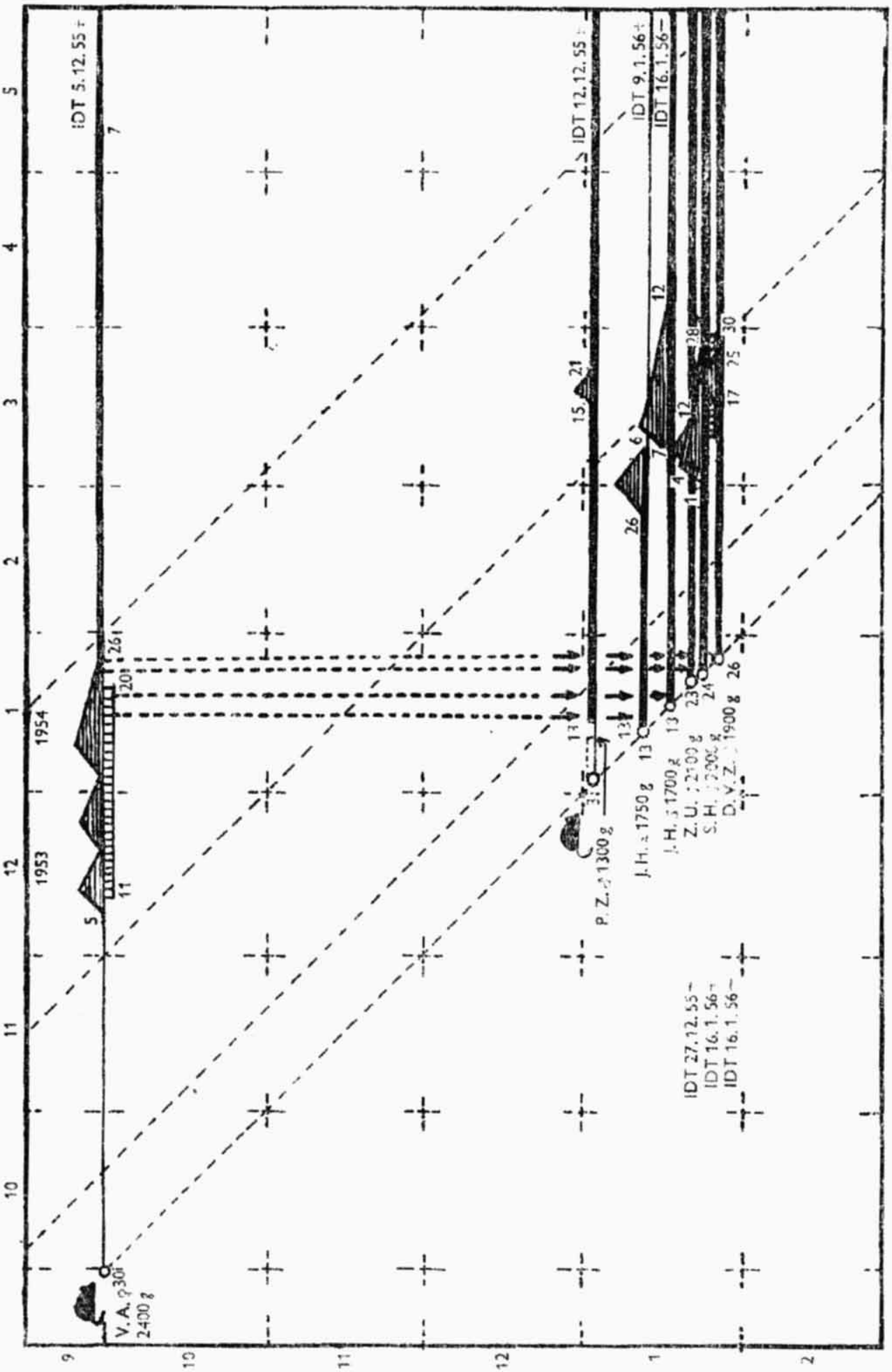


Fig. 6. The reconstruction of the onset of the third epidemic of pneumocystis pneumonia at Gottwaldov 1954.

Table 5. Pneumocystosis during 1954 in groups according to Tab. 1

Group	Well-baby cl. in		Number of cases in month												Total
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
A	Gottwaldov		19	10	19	11	22	16	13	16	19	0	4	7	156
	Kyjov		22	11	16	27	25	32	31	22	24	32	27	26	295
		Total	41	21	35	38	47	48	44	38	43	32	31	33	451
B	Gottwaldov		6	0	2	1	2	1	1	0	3	0	0	0	16
	Kyjov		9	3	4	7	1	2	6	5	2	3	5	11	58
		Total	15	3	6	8	3	3	7	5	5	3	5	11	74
C	Gottwaldov		0	0	0	0	0	0	0	0	0	0	0	0	0
	Kyjov		1	0	1	0	0	0	0	1	0	0	1	2	6
		Total	1	0	1	0	0	0	0	1	0	0	1	2	6
D	Gottwaldov		7	0	0	0	0	0	0	0	0	0	0	0	7
	Kyjov		4	1	0	0	0	0	1	1	0	1	3	3	14
		Total	11	1	0	0	0	0	1	1	0	1	3	3	21
E	Gottwaldov		0	0	0	1	0	0	0	0	0	0	0	0	1
	Kyjov		0	0	0	0	0	0	0	0	0	0	0	0	0
		Total	0	0	0	1	0	0	0	0	0	0	0	0	1
F	Gottwaldov		7	0	0	0	0	0	0	0	0	0	0	0	7
	Kyjov		5	1	1	0	0	0	1	2	0	1	4	5	20
		Total	12	1	1	0	0	0	1	2	0	1	4	5	27
G	Gottwaldov		7	0	0	1	0	0	0	0	0	0	0	0	8
	Kyjov		5	1	1	0	0	0	1	2	0	1	1	5	20
		Total	12	1	1	1	0	0	1	2	0	1	5	5	28

200 metres away from the well-baby clinic, the Sunday duty being performed by common medical staff.

If our scheme of the "exact graphical epidemiological chronologic and local correlations" of every case of pneumocystis pneumonia in the homologous groups of infants is directed descendentally ("downstairs") one can determine by its means also the extinction period of each single epidemic developed in a well-baby clinic.

Observing the figures 1—6 we may state that the majority of our cases of pneumocystosis had the first occasion to meet pneumocystosis in the first 20 days of their life. If the contamination among infants mostly occurs during this period, the epidemiological consequence will be that in the effort for prevention greatest attention is to be paid to this period.

As to the onset of the epidemics studied, I found it conspicuous that the first cases of pneumocystis pneumonia diagnosed in these epidemics were born in very bad hygienic conditions. All the cases initiating the epidemics were born in rural homes with great numbers of small synanthropic and exoanthropic rodents which is evident from the graphs. During my repeated personal visits to the families I always used to find the same possibility of a passive transmission of the infection

from animal to man. In three instances I was able to find *Pneumocystis carinii* in the lungs of rodents (*Microtus arvalis*, *Mus musculus*, *Rattus norvegicus*) caught in these households. Naturally it was only a long time after the onset of the disease in the respective children. These findings will be described in detail in a further paper.

Furthermore it struck me that the epidemics broke out in a time correlation with a cyclically increased population of small rodents in the given territory and that they receded in the following years when the population grew smaller. The extinction of the epidemics was not connected with an ultraviolet disinfection of the well-baby clinics in the region studied (KUČERA 1963).

According to our results (Tab. 1) 50 death cases are corresponding to another 166 cases of infection in the closest proximity of the deceased, which means a ratio of 50 : 216 approximately 1 : 4. A detailed analysis of the epidemics reveals that this ratio can be reverted to 4 : 1 for a comparatively short period if there is a rise in the concentration of susceptible individuals i.e. of infants up to the first 20 days after birth (or infants who are not able to prevent the multiplication of the parasite in their body) in the overcrowded institutes to which the infection had been introduced previously. Such a period of extremely high mortality in homologous groups of infants is generally running a short course. An example of such a period will be reported in a later paper.

In pneumocystis pneumonia the problem of the incubation period is of great importance. Here it will be mentioned only in short, because in a later paper it will be discussed in detail. Among 190 cases investigated there were 63 with an incubation period of 60—69 days, 42 with 50—59 days and 31 with 70—79 days.

The series of Fig. 1—6 illustrates only the onset of six epidemics. Their extinction is not reported in the present paper, but every epidemic, the onset of which is illustrated, had a further course with the exception of the sixth one. The whole course of the epidemics will be discussed and illustrated in a further paper.

DISCUSSION

The relatively long incubation period results in a prolonged and inconspicuous onset of the epidemics of pneumocystis pneumonia. This is illustrated in figures 1—6. This purely epidemiological difference in comparison with interstitial pneumonias of other etiology is a further feature differentiating pneumocystosis from other epidemic especially virological pneumonias. The seemingly explosive onsets of pneumocystic epidemics were described currently when no other than fatal cases were considered as initiating. On the other hand it is known that only epidemics of those infectious diseases, which have a short incubation period, may start violently.

The relatively long incubation period in pneumocystosis may be comprehended from the properties of the causing parasite. The pathogenity of this parasite is

359 very low, as demonstrated by the existence of pneumocystosis only among individuals with a defficient resistence to the infection in general. Accordingly the multiplication of *Pneumocystis carinii* in the host must be slow. The number of the parasite in human lungs is increasing for about two months preceding the appearance of the first symptoms of illness (the same as in the experimental animal pneumocystosis), scarcely for a shorter or a longer period and determines the duration of the incubation period as one of the leading factors, resulting in a prolonged onset of the epidemic. Some irregularity in the epidemiological pattern may be comprehended by considering the known fact that pneumocystosis becomes manifested exclusively in those individuals in which the parasite can multiply due to a special disposition of these persons. It is also known that the X-ray examination can reveal the existence of pneumocystis pneumonia before the manifestation of clinical symptoms. Some of the so-called silent pneumonias may, according to our experience, be of pneumocystic etiology.

In the first two or three months at the onset of an epidemic or frequently also at its termination, the majority of the infected infants recover. From the analysis of our six epidemics which we tried to trace up to the initial source of infection it follows that fatal cases begin to occur frequently after the agent had done one or two passages in the precedent human hosts. Silent pneumonias are doubtlessly a frequent reason of failure in the search for the actual onset of an epidemic. In the epidemiological and all the more in the clinical practice the source of infection is not searched for two or four months to the past as must be done in the case of pneumocystosis.

The connection of pneumocystic epidemics with small rodents cannot be considered as proved on the basis of the data presented in this paper. This was only the first indication suggesting the trend of further investigations, the results of which will be recorded in a later paper.

The method using the exact chronologic and local correlations for epidemiological investigation of pneumocystosis is suitable before all for comparatively "closed" and homologous groups of infants. The hospital departments for sick children must on the contrary be considered as "open" and inhomologous. The application of this scheme for such nonhomologous groups could be the reason of failure in the search for the actual onset of the epidemic.

The numbers of infants in Tables 1—5 are arranged according to the day of their admission to the respective "well-baby clinic". The cases of pneumonia (paragraph B) or of pneumocystosis (paragraphs C—G) are therefore arranged in the same way, without regard to the date of appearance of the first symptoms. Consequently it will not be possible to realize for instance a conception of the seasonal variation of pneumocystosis on the basis of these tables. Moreover it will be impossible to use them for the construction of epidemiological series because they include cases of pneumocystosis which became manifest only at home, after dismission of the infants from the well-baby clinics. Some of them returned to the same infant community while others were treated elsewhere so that for the group

studied they were lost as further sources of infection. Some details about these cases will be discussed in a later paper. 360

CONCLUSIONS

The purpose of this short report was to point out the method which can be used (on the basis of exact chronologic and local correlations) in a homologous infant community for graphical determination of the actual number of cases occurred in an epidemic of pneumocystis pneumonia and to show how it is possible to study, by means of this scheme, further epidemiological laws of this disease.

REFERENCES

KUČERA K. JÍROVEC O., Kožní test s pneumocystinem u osob s vysokým věkem. Čs. parasitol. 9 : 311–330, 1962.

KUČERA K., Pneumocystóza v ČSSR opět aktuální. Prakt. lék. 43 : 241–244, 1963.

—. Some new aspects on the epidemiology of infections caused by Pneumocystis carinii. First International Congress of Parasitology 21st–26th September 1964, Roma. Page 70 only.

—. The actual and apparent number of pneumocystis pneumonia cases in epidemics. Folia Parasitol. 13 : 248–269, 1966.