PERINATAL DEATHS IN CZECHOSLOVAKIA*

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Macgregor (1946) is certainly right in saying that the pathology of stillbirth and of the neonatal period is still a somewhat neglected field. So it was in my department until 1940. In fact, the bodies of stillborn foetuses were for the most part delivered directly to the department of normal anatomy and thus completely escaped adequate post-mortem study. This, however, was stopped after the closing of the Czech university by the Germans in 1940, and since that time I have had complete post-mortem material of this kind, owing to the fact that in Czechoslovakia necropsies are compulsory in people who have died in public hospitals.

My interest in this subject was also aroused by the magnificent work of Potter et al. (1940) in Chicago. But it seems that there has been a general trend towards the study of this question, as several papers on this subject have since appeared. In Great Britain remarkable work has been done by Macgregor (1946) in Edinburgh, Evans and Smith (1946) in Manchester, Baird (1945), Russ and Strong (1946), and others. In Russia, the work of Morozova (1946) and Komarova (1946) is on similar lines.

There are two main reasons for presenting my own material. First, it is more extensive than other published material except Potter's. This means that statistical errors due to small numbers are reduced. Secondly, it may be of interest to compare the 'perinatal' mortality in my country with that in the United Kingdom as far as this can be done in view of the somewhat differing criteria.

'Perinatal Mortality' Period

The term 'perinatal mortality' has been used for a long time by French obstetricians. It seems practical, as it comprises deaths before, during, and after delivery. Its delimitation, however, is arbitrary in two respects. First, there exists some uncertainty as to the lower limit of prematurity. Very premature, obviously non-viable foetuses are sometimes discarded as abortions, and no accurate limit for this is indicated. This of course may influence

the figures. I have kept to the criteria suggested by Potter, who has set the limit as low as 400 g. in weight. This means that all foetuses above this weight are included in my statistics.

Secondly, the upper limit of the period considered as neonatal is subjected to similar variation. With Potter it was originally a fortnight, but later she extended it to one month. The latter period is usually accepted by British authors.

In my statistics, however, it was only ten days. The reason for this lies partly in the fact that I was originally concerned especially with causes of deaths consequent on birth stress, and partly to practical circumstances. As mothers, owing to shortage of beds, are usually dismissed from the maternity unit in Prague within ten days, it would have been very difficult to follow up the children longer than that. Babies who appear ill are, to be sure, immediately transferred to the children's clinics, from which the necropsies are also performed by me. Nevertheless, some of the deaths occurring after the tenth day of life might escape, and this would lessen the reliability of my statistics. Owing to this difference my figures are not exactly comparable with those of the British authors previously named. On the other hand, the difference cannot be of much importance, considering the fact that by far the greater number of neonatal deaths occur within the first few days after birth. This is clearly shown by fig. 1, which shows the distribution of deaths in the first ten days. From this it will be seen that if the

FIG. 1.—Number of deaths within the first ten days.

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upper limit of the neonatal period is extended to one month some additional deaths will be included, but the difference will not be very large.

The Material Presented

The necropsies to which my statistics refer all came from the maternity unit in Prague. There are three obstetrical departments there, one of which, however, was German until the end of the war, during which period its necropsies were not performed by me. There is also a private-patient department, and this is included in my material. In the period 1943-6, that is in four years, there were 38,999 births in these clinics. There were 862 stillbirths, that is 22.1 per 1,000, and 1,334 neonatal deaths (34.1 per 1,000); the total number of deaths was 2,196, which means a mortality of 56.2 per 1,000. In forty-nine necropsy could not be performed for various reasons, so that my statistics are based on 2,147 necropsies.

I do not contend that these figures are representative of the country as a whole. In the clinics the standard of obstetrical care is always higher than in general practice; on the other hand, however, complicated cases are likely to be sent to the clinics, and this tends to raise the mortality. As far as I was able to get information from the State Statistical Department, the stillbirth rate was from 15.0 to 15.5 per 1,000 in Bohemia and Moravia, but it seems that the borderline between abortions and prematurity has been set somewhat higher than in my material. The neonatal death rate up to the fifteenth day of life was 34.3 per 1,000 in 1943 and 32.2 in 1944, which is about the same as in the clinic.

These figures indicate that approximately every twentieth pregnancy ends with death of the child in the perinatal period. This obviously means a tremendous loss of national energy, and it is therefore not surprising that so much work has recently been devoted all over the world to the analysis of the causes of the perinatal mortality.

On the other hand, I believe that the conditions in my country, concerning perinatal deaths, do not compare unfavourably with those in other countries. Baird says that in England the average stillbirth rate in 1938 was 38.27 per 1,000, whereas for Greater London in 1939-41 it was 30.0. In Scotland, according to the Registrar General's figures, the stillbirth rate for 1943-1945 was 33.6; the neonatal mortality rate over the same period was 30.4.

Sex ratio. Of the 39,000 births 20,303 were boys, and 18,696 were girls (table 1). Thus there was a surplus of 1,607 boys, and the sex ratio was 108.5:100. It is a well established fact that slightly more boys are born in general, and this disproportion is said to be consistently increased during wars. Although Czechoslovakia was not exactly at war, it nevertheless seems that the same conditions were prevalent. On the other hand, the rates both of stillbirths and neonatal deaths are considerably higher in boys than in girls. In

my material the total perinatal mortality for boys was 59.6, and that for girls 52.6. Thus boys are markedly more susceptible to the causes of perinatal death, though the difference, 226 cases, was not large enough to compensate for their higher birth rate.

Causes of death. In table 2 a synopsis is given of the causes of death, as they were established at necropsy. Single causes of death show much overlapping. A newborn may for instance have intracranial haemorrhage and pneumonia at the same time, and it is a matter of conjecture which condition is considered the main cause of death. This overlapping is particularly prevalent between asphyxia and intracranial haemorrhage, so that I felt it necessary to include such cases under a separate heading.

Otherwise the table is self-explanatory, and there is no need to go into a detailed discussion of the single causes of death as this has been recently done by Macgregor and others in this country. Nevertheless some comment seems indispensable.

The cases are divided into two groups, prenatal deaths and neonatal deaths. The criteria for life at birth were the usual ones, but it was sometimes difficult to decide whether the child had been born dead or living, and there were also some discrepancies between the clinical and pathological findings.

~ Each group is divided according to maturity at birth. As to the criteria of non-viability, viability, maturity, and postmaturity, these are always arbitrary. I have kept to those given by Potter, chiefly as far as weight is concerned. That is, foetuses weighing from 400 to 1,000 g. are classified as non-viable, those between 1,000 and 2,500 g. as immature* but viable, and those over 4,500 g. as postmature. This, of course, is a very rough estimate, as there is no doubt that foetuses born at term may be less than 2,500 g., particularly if they are twins or triplets, and, on the other hand, sometimes a foetus born before term may be more than 2,500 g. But as, with a few exceptions, the differentiation of the organs keeps pace with weight, this rough estimate may well serve the purpose in question. As to viability, foetuses under 1,300 g. seldom survive, and the deaths in this class make up most of cases in which no other cause of death than immaturity can be demonstrated, and which I have classified under the heading of debility.

ASPHYXIA. As in any statistics of perinatal death, the most frequent cause of death appears to be asphyxia. If the cases of protracted asphyxia due to inhalation of foreign material as well as those where asphyxia is combined with haemorrhage are included, it makes a total of 31.7 per cent. This is considerably less than the figure arrived at by Macgregor, but one must keep in mind that in the hospital series she studied (Macgregor, 1943),

* I am using the term 'immature' instead of 'premature,' because, logically, delivery may be premature but the child is immature.

TABLE 3
MATURITY AND PREMATURITY

	Number of births	Stillborn	Neonatal deaths	Total deaths	Death rate per 1,000
Mature ..	34,097	351	318	669	19.7
Premature	4,902	480	998	1,478	301.7
	38,999	831	1,316	2,147	

TABLE 1
SEX RATIOS OF BIRTHS AND PERINATAL DEATHS

Sex	Number of births	Sex ratio	Peri-natal deaths	Death rate per 1,000	Sex ratio
Boys ..	20-303		1,211	59.6	
Girls ..	18-696	108.5 : 100.0	985	52.6	122.9 : 100.0
Difference...	1-607		226	7.0	

TABLE 2
CAUSES OF DEATH AS ESTABLISHED AT NECROPSY

Cause of death	Prenatal						Neonatal						Total prenatal plus neonatal	%	Ratio of boys to girls	Im-mature	Mature	Correspondence of clinical diagnosis	%
	Immature		Mature		Post-mature	Total	Immature		Mature	Post-mature	Total								
	n.v.	v.	n.v.	v.															
Asphyxia	66	153	208	7	434	10	32	19	61	495	23.0	271 : 224	261	234	364	73			
Asphyxia due to inhalation of foreign material ..		5	13		18	2	52	22	76	94	4.4	53 : 41	59	35	35	37			
Asphyxia plus intracranial haemorrhage ..		22	34		56	3	23	10	1	37	4.3	55 : 38	48	45	67	72			
Intracranial haemorrhage ..	11	18	28		57	40	226	61	1	328	18.0	232 : 153	296	89	150	42			
Haemorrhachis							20	4		24	1.1	15 : 9	20	4	0	0			
Encephalitis							5	3	1	9	0.4	7 : 2	5	4	3	30			
Other foetal traumata ..	1	3			4	1	4	3		8	0.56	10 : 2	9	3	1	8.3			
Craniotomy	3	8	5		16						0.75	8 : 8	11	5	16	100			
Congenital malformations	14	23	7		44	4	36	32		72	5.4	58 : 58	77	39	55	47			
Erythroblastosis foetalis ..	1	6	6	1	14		7	22		29	2.0	20 : 23	14	29	20	47			
Haemorrhagic diathesis ..							2	1		3		2 : 1	2	1	0				
Congenital syphilis	1	10	2		13		4	3		7	0.93	10 : 10	15	5	5	25			
Pneumonia		1	6		7	8	181	74		263	12.5	141 : 129	190	80	76	28			
Umbilical sepsis							4	10		14	0.7	9 : 5	4	10	5	36			
Incidental causes						1	67	36		104	4.8	49 : 55	68	36	43	41			
Debility						106	124			230	9.3	129 : 101	230		186	80			
Unspecified causes	56	74	29	2	161		24	5		29	8.9	105 : 85	154	36					
Various	2	2	3		7		12	10		22	1.35	12 : 17	16	13	9	31			
Total	155	325	341	10	831	175	823	315	3	1,316	100.00	1,186 : 961	1,479	688	1,025	48			

the stillbirth rate was much higher. I do not go into detail concerning the causes of asphyxia as was done in the remarkable paper of Russ and Strong (1946), for reasons which I shall mention later.

INTRACRANIAL HAEMORRHAGE. Second in frequency as a cause of death is intracranial haemorrhage. In my material it amounts to 18 per cent. of all perinatal deaths, and if we add the cases where haemorrhage was combined with asphyxia, it is 22.3 per cent. In Macgregor's survey it is still higher, amounting to 36.4 per cent. I would stress that a correct diagnosis of intracranial haemorrhage requires a very painstaking post-mortem technique, as artificial haemorrhage is readily produced.

Intracranial haemorrhage is mostly caused by birth stress, particularly if there is disproportion between the head of the foetus and the diameters of the pelvis. In cases of forceps delivery a direct injury by this instrument is often responsible. There is no doubt, however, that haemorrhage may be due solely to asphyxia or that the latter may at least contribute to it by raising the blood-pressure. It seems that ventricular haemorrhage in particular, which is mostly seen in premature foetuses, may be explained in this way. Be that as it may, another important contributory factor in the genesis of haemorrhage must be taken into consideration; it is the physiologically low coagulability of foetal blood as a result of hypoprothrombinaemia, probably due to lack of vitamin K. In one of the obstetric departments, where prophylactic treatment with a water-soluble preparation of vitamin K is consistently given to the prospective mothers, the incidence of deaths due to haemorrhage has been considerably reduced.

HAEMORRHACHIS. Other traumatic lesions occurring during labour, such as disruption of the vertebral column, play an almost negligible role. This is somewhat different with haemorrhachis. It is the routine in my department that, whenever the usual post-mortem technique fails to demonstrate any obvious cause of death, the vertebral canal is opened. By this, an extensive epidural haemorrhage may be found as the clear cause of death, particularly in premature infants who otherwise would receive a diagnosis of debility. This has been stressed by Hausbrandt (1938) in Germany; we came to the same conclusion before his communication was published but not during the period under discussion, so that we may have missed some cases of that kind. Recently, being more consistent in opening the vertebral canal, we have noticed that this condition is much more frequent than has generally been supposed.

CONGENITAL MALFORMATIONS. Whereas the causes so far discussed are all connected with birth stress, congenital malformations are generally referred to as the 'irreducible minimum,' because their occurrence is entirely independent of obstetric skill or ante-partum and postnatal care. It is remarkable, however, that their incidence in my material was

considerably lower than in that of most British studies of the subject, being only 5.4 per cent. in contrast to 18.7 per cent. as given by Macgregor. For this difference no satisfactory explanation can be given. There is again some overlapping with other causes of death; for instance, a baby with a malformed heart may die not of this but of asphyxia or intracranial haemorrhage. We have, however, classified all cases having a malformation serious enough to be considered a potential cause of death under this heading, and not according to the actual cause of death. Thus the discrepancy cannot be simply explained by a different method of classification. The fact that the usual predominance of females in congenital malformations is not apparent in my material may be accidental.

ERYTHROBLASTOSIS FOETALIS. Erythroblastosis foetalis appears to be a much more frequent cause of perinatal death than was believed until recently. In addition to the three well-known manifestations, there are cases of prenatal death obviously due to familial erythroblastosis in which, however, the foetus shows no signs of the disease except some enlargement of the spleen, but maceration and autolysis renders microscopical diagnosis impossible. Moreover, consistent microscopical examination of foetuses, in which death was due to some other cause shows signs of erythroblastosis more frequently than would be suspected, and the correctness of the diagnosis can be confirmed by serological examination of the mother's blood for Rh-factor antibodies. We have introduced the term 'latent erythroblastosis' for such cases. We consider them very important, because, although erythroblastosis was not the actual cause of death, such findings may be a warning of the potential danger of later pregnancies, ending in typical erythroblastosis. Since we became aware of this fact the diagnosis has appeared considerably more frequently in our post-mortem records, and, therefore, the figure given in this synopsis may be rather too low.

HAEMORRHAGIC DIATHESIS. The rare finding of haemorrhagic diathesis in the newborn may be due either to erythroblastosis or to excessively severe hypoprothrombinaemia.

CONGENITAL SYPHILIS. The figure given here for congenital syphilis (less than 1 per cent.) might give the impression that this cause of perinatal death is practically negligible. I am afraid, however, that this is far from being correct. Earlier in the course of this study we perhaps depended too much on the macroscopical findings and dark-field examination of the liver. Later we learnt that in certain cases, chiefly macerated foetuses with at most a slight enlargement of the spleen, the dark-field examination sometimes gave a negative result whereas fairly numerous spirochaetes were demonstrable in tissue sections. Furthermore, there are cases of congenital syphilis in which the liver contains no spirochaetes, or very few, although these are found in numbers in some other organ such as the adrenal, the lungs, the thymus, or the pancreas.

We use Kanzler's method for staining spirochaetes in frozen or in single paraffin sections, and have found it entirely reliable. Since we made it a rule, to examine almost every macerated foetus in this way, the number of positive diagnoses has increased considerably. In the first five months of 1947 we have had seventeen, which is about 5.7 per cent. of all perinatal deaths. Among the latter there were thirty-one macerated foetuses, and thirteen of the positive cases (almost half) in this group. This, of course, may be due partly to an actual increase in syphilitic infection, for which the general decline in morality would sufficiently account. But I nevertheless believe that the improved method of diagnosis is at least partly responsible.

INFECTION. The further three items might as well be placed under the common heading of infection, as is done by Macgregor. For the cases placed under the term 'incidental causes' are mostly those of enteritis, or sepsis due to pyoderma, or otitis media. All three items together make 18 per cent., slightly less than with Macgregor's figure.

In my material the number of cases of umbilical sepsis is negligible. On the other hand pneumonia is the third most important cause of perinatal death, being outrated only by asphyxia and intracranial haemorrhage. There is little to be added to Macgregor's (1939) excellent paper on this subject. I am particularly in agreement with her statement that the diagnosis of pneumonia in the newborn cannot be made safely without microscopical examination. I would also call attention to the occurrence of pneumonia in stillborn foetuses, of which we saw seven instances. The problem of pathogenesis of this adnatal pneumonia is an intriguing one. There is no doubt that in asphyxia premature stimulation of the respiratory centre generally results in more or less massive aspiration of amniotic fluid, which at that time may have been infected. I have seen several cases in which the lungs of a stillborn asphyxiated foetus contained masses of bacteria. If the amniotic infection is of anaerobic gas-forming character there may be a precocious production of gas in the lungs, so that these float in water although the foetus was incontestably stillborn. But in such cases there would be no signs of inflammation, for this would have had no time to develop, as the foetus would have succumbed immediately to asphyxia. However, it may happen that infection of the amniotic fluid starts long before the interruption of the placental circulation induces breathing in the foetus. From recent experimental work it may be considered an established fact that long before labour sets in the foetus makes rudimentary breathing movements, which allow the amniotic fluid to enter the lungs. Infections of the amniotic fluid in the first stage of labour may thus have produced inflammatory changes by the time the child is born. Pending further experimental proof, this seems to be the best hypothetical explanation of the adnatal pneumonia.

DEBILITY. Under the item 'debility' are included cases in which no other cause of death could be established except prematurity. The latter may be assumed as a sole cause of death in non-viable immature infants or in those whose weight does not exceed 1,300 to 1,400 g. My colleague, Prof. Švejar (Sikl et al., 1946) has given a very clear account of the ultimate causes of death due to prematurity. On the basis of the experimental work of Raiha, Hiltunen, and other Scandinavian authors, he comes to the conclusion that it is the incomplete development of cytochrome, the tissue respiratory ferment, that is to be blamed. Anyway, it is well known that newborn babies with a weight as low as 600 g. may sometimes be kept alive, but this requires painstaking care. Thus the conception of viability is relative, much depending on the equipment of the clinic. Unfortunately it cannot be said that our obstetrical clinics are quite up to date in this respect.

I have been surprised at the fact, that in Macgregor's paper the item 'debility' is entirely omitted. It seems that, with her, such cases have been included under the heading 'inconclusive autopsy.' However, we reserved the term 'causa incerta' chiefly for macerated foetuses in which autolysis of the organs precluded diagnosis. In addition there are a few cases born alive with a weight above 1,400 g. in which no obvious cause of death could be established.

Influence of prematurity. From all statistical surveys on this subject the far-reaching influence of prematurity on the neonatal death rate is obvious. Among the 39,000 births on which my statistics are based there were 4,902 premature, that is 12.5 per cent. (table 3). Of these, 480 were stillborn and 998 died in the neonatal period, which gives a total of 1,479 deaths. This makes a death rate of 301.7 per 1,000 of the premature. It is, however, to be stressed that 331 non-viable premature infants have been included. Among the 34,097 mature, however, there were only 669 deaths, thus the mortality was as low as 19.7 per 1,000, that is, more than fifteen times less than in the premature group. Thus the detrimental influence of prematurity comes out very markedly.

If we compare the percentages of the single causes of death in both groups, the differences appear to be rather slight except for the fact that in the immature group there is the additional item of debility. This, however, would give an entirely wrong idea of the importance of the causes of death in the immature group. Instead of comparing the same number of deaths in both groups, one must rather take as a basis the same number of births. Then the result is quite different. From fig. 2, the much greater susceptibility to any cause of death in the premature is clearly seen. Thus premature labour appears to be the prime problem in the prevention of perinatal mortality. To deal with the causes of premature labour, however, would much exceed my competence.

Collaboration of Clinician and Pathologist

In their remarkable paper on stillbirth and neonatal death, Evans and Smith (1946) make the following statement: 'In no other group is the close collaboration of pathologist and clinician so essential: without the clinician the autopsy findings cannot be interpreted; without a pathological examination opinion on the cause of death is often little better than guess-work.' As to the second half of this statement, I would refer to table 2. In the last two columns the conformity of the clinical

FIG. 2.—Distribution of causes of death.

diagnosis with the post-mortem findings is given in percentages. This varies between 0 and 80 per cent. A correct diagnosis is most often made in debility, as this is the most common diagnosis in neonatal death of the premature. A fairly close correspondence is also shown between asphyxia and intracranial haemorrhage. On the whole, however, one may imagine how different these statistics would look if they were based on clinical diagnosis alone.

The first half of the statement quoted is no less true. As a matter of fact, Evans and Smith were

able, thanks to close collaboration between the clinician and the pathologist, to push the analysis of the causes of perinatal death much further than I could, in spite of my considerably larger material. I did my best to obtain such close collaboration, but the result was far short of expectations.

When, in 1941, I dealt with the subject for the first time, in a lecture delivered before the Czech Obstetrical Society in which I discussed my post-mortem experience of the previous year, it aroused much interest among the obstetricians, and it was decided then to go on with this work in the closest collaboration possible. This was actually done, and in 1943 a clinico-pathological symposium was held on the basis of the material of the previous two years. In this, the obstetricians took up the argument and gave a very thorough analysis of their fatal cases. The whole discussion was later published as a pamphlet, but in Czech only (Šíkl et al., 1946).

Later on conditions took a turn for the worse. The Germans greatly reduced the medical staff of the clinics, and those remaining were too overburdened to continue working on these lines. When the war was over many new medical men joined the clinics. They had not attended the preceding discussions and, in consequence, had little interest in the subject.

To overcome these difficulties I have recently compiled a rather elaborate questionnaire covering all data that may be helpful to the pathologist in his evaluation of post-mortem findings. It is meant to be filled in by the obstetrician and sent in along with the death certificate. I am doubtful how far this will work, but if it does I shall in course of time be able to give a much more adequate analysis of the causes of perinatal mortality than has been possible here.

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