TABLE A.—Nasal Staphylococcal Carrier Rates at the Beginning and End of the Trial

	No. of Clinics	No. of Patients	Coagulase-positive Staphylococci		
			No. Isolated	No. Resistant to:	
				Penicillin	Tetracycline
Before trial	15	180	38 (21%)	4 (2%)	3 (2%)
After ..	10	134	25 (19%)	6 (5%)	10 (8%)

especially those resistant to tetracycline. Little significance can be attached to these results, however, since they take no account of the treatment to which each patient had been exposed.

Results in Different Treatment Groups

More detailed analysis of the results in relation to treatment groups is given in Table B. It is unfortunate that the distribution of staphylococcal carriers at the beginning of

TABLE B.—Results in Different Treatment Groups

Treatment	No. of Patients	Beginning of Trial			End of Trial		
		No. of Staphs.	R. to P.	R. to T.	No. of Staphs.	R. to P.	R. to T.
Penicillin	42	13 (31%)	2 (5%)	1 (2%)	9 (21%)	3 (7%)	1 (2%)
Tetracycline	49	12 (24%)	1 (2%)	0 (0%)	8 (16%)	2 (4%)	8 (16%)
Control	43	4 (9%)	0 (0%)	0 (0%)	8 (19%)	1 (2%)	1 (2%)
Total ..	134	29 (22%)	3 (2%)	1 (1%)	25 (19%)	6 (4%)	10 (7%)

All percentages referable to number of patients in relevant treatment group. R. to P.=Resistant to penicillin. R. to T.=Resistant to tetracycline.

the trial was not uniform between the three treatment groups, but the trends within the groups are clear. While the control group showed a slight rise in the carrier rate, there was a corresponding fall in each of the treatment groups. In both the latter, however, the relative number of staphylococci resistant to the particular antibiotic rose. This rise was significant in the case of tetracycline, but not significant in the penicillin group.

Changes in the Carrier State of Individual Patients

Coagulase-positive staphylococci were isolated from the anterior nares, both at the beginning and at the end of the trial, of 14 patients. Of these, nine were treated with penicillin, four with tetracycline, and one was a control. The sensitivity patterns remained unchanged after the trial in the single control patient and in eight out of the nine penicillin-treated patients. The staphylococcus isolated after the trial from the remaining penicillin-treated patient was resistant to penicillin and sensitive to tetracycline, whereas that found before the trial had been sensitive to both antibiotics. In contrast, each of the four staphylococci isolated from the tetracycline-treated patients after the trial was resistant to tetracycline (but sensitive to penicillin), whereas before the trial fully sensitive strains had been isolated in each case.

Though these figures are small there was clearly a greater tendency for sensitive strains to be replaced by resistant ones in the tetracycline-treated group than in the group receiving penicillin.

In a further 11 patients staphylococci were found after the trial but not before it. Four of these patients were treated with tetracycline, and each corresponding staphylococcus was resistant to this antibiotic; two were also resistant to penicillin. No patients receiving penicillin fell into this group, but of the seven staphylococci isolated from controls five were sensitive to both antibiotics, one was resistant to tetracycline and sensitive to penicillin, and one was resistant to penicillin and sensitive to tetracycline.

Conclusions

The development of antibiotic-resistant staphylococci in the anterior nares was not a serious problem in this trial,

but when it did occur it was almost exclusively in response to tetracycline. Sixteen per cent. of the patients treated with tetracycline were nasal carriers at the end of the trial and in each case the staphylococcus was resistant to this antibiotic. At the beginning of the trial there were no carriers of tetracycline-resistant staphylococci in this group.

In contrast, the penicillin-treated group showed an increase of from 5% to 7% in the carrier rate of penicillin-resistant staphylococci—an increase similar to that in the controls.

Development of tetracycline-resistance in patients treated with penicillin was never observed. But in two patients treated with tetracycline staphylococci resistant to both drugs were found at the end of the trial.

COLD INJURY IN THE NEWBORN

A STUDY OF 70 CASES

BY

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Though the clinical picture of cold injury in the newborn had been described as early as 1889 by Hensch, and has been recognized by individual paediatricians in this country for some years (Braithwaite, 1955; Smallpeice, 1955; Everley Jones, 1955; Williamson, 1955), it was Mann who first gave a full description of the syndrome and made recommendations for its prevention (Mann, 1955; Mann and Elliott, 1957).

The condition is still not as widely recognized as it should be and it is not described in current paediatric textbooks. Though preventable, it still occurs and is often undiagnosed; this survey of all newborn babies with cold injury admitted to the Children's Hospital, Birmingham, in the years 1946–56 has therefore been made. We describe the clinical features, the aetiological factors, and the results of a follow-up investigation of those who survived.

Material

Though the diagnosis of chilling as the cause of illness in newborn babies was not often made in this hospital before 1951, we included in our initial survey all babies admitted during the years 1946–56 whose rectal temperatures were less than 96° F. (35.6° C.) at some time during the first 24 hours after admission. In this way we hoped to discover not only the incidence of hypothermia due to chilling but also the frequency of hypothermia in other diseases of the newborn. Thermometers registering temperatures below 95° F. (35° C.) were not in use before 1951, so that in the early years even the temperatures of severely chilled babies were recorded as "95" or "below 95."

The total number of such patients was 183. The diagnoses are shown in Table I; in nearly all cases they were unequivocal and in only seven did we feel sufficient doubt about the diagnosis to regard the case as unclassifiable. When hypothermia is not primarily due to external chilling or to prematurity the illness is severe and diagnosis of the primary disease is not difficult. Moreover, post-mortem confirmation of the

TABLE I.—*Diagnoses of All Neonates With a Temperature Reading Below 96° F. (35.6° C.) in the First 24 Hours After Admission (1946–56). (183 Patients)*

Primary cold injury	70
Prematurity	48
Cerebral birth injury	23
Severe infection	15
Congenital heart disease	6
Perinatal asphyxia	9
Severe malnutrition	3
Paroxysmal tachycardia	1
Infection and cerebral birth injury	1
Unclassifiable	7

diagnosis was obtained in 33 of the 54 cases classified as cerebral birth injury, infection, congenital heart disease, or perinatal asphyxia. (Those premature babies with additional disorders such as cerebral birth injury and asphyxia are included in the prematurity group.) The cases classified as "primary cold injury" were not, however, given this label merely because of the absence of other diagnosable disease. Even in the earlier years, when we did not personally see the patients and low-reading thermometers were not in use, the hospital case-notes contain enough of the characteristic clinical features to make the diagnosis reasonably certain. Not all these babies were free from infection, but the infection, when present, was minor, and any case in which it was thought that the infection was more serious and played a substantial part in causing hypothermia was placed in the "severe infection" group. In such cases the characteristic features of "primary cold injury"—for example, facial redness—were not found.

Only three premature babies have been included in the "primary cold" group. Small premature babies are relatively thermolabile, and a moderate hypothermia does not necessarily represent a pathological state as it does in the mature infant. A temperature of 91–96° F. (32.8–35.6° C.) may be as satisfactory for the small premature baby as one of 96–98° F. (35.6–36.7° C.), and the diagnosis of "cold injury" must be applied with caution to premature babies. In the early years of this review period it was the practice to admit premature babies to this hospital solely on account of prematurity, and many of these babies were in reasonably good condition on admission and remained so. The three premature babies who have been included in the category of "primary cold injury" were over 5 lb. (2,270 g.) at birth and were severely chilled. Environmental factors seemed to be responsible for their hypothermia.

The relatively high incidence of hypothermia due to cerebral birth injury is perhaps not surprising. The thermoregulatory centres are liable to be affected under these circumstances, particularly when the injury is severe. Of these 23 patients, 18 (78%) died, and in the 15 on whom necropsy was performed intracranial haemorrhage was found. The high fatality rate suggests that hypothermia is a grave sign in cerebral birth injury.

Hypothermia in congenital heart disease is also of grave significance. All six babies in this group died. Necropsy showed a severe form of heart disease in all, and, though external chilling may have been a contributory factor, it is reasonable to assume that the cardiac lesion itself was mainly responsible for death. One infant, in whom no cardiac lesion was suspected and who was classified under "primary cold injury," was found to have a septal defect at a follow-up examination. His case is discussed later. It seems unlikely that his cardiac lesion played any part in the occurrence of hypothermia.

Primary Cold Injury (70 cases)

The clinical features of this condition are well illustrated by the following two cases.

Case 1

Derek was born at full term on January 31 at home. The delivery was normal, and his birth weight was 7 lb. (3,175 g.). His condition after birth was good; he cried immediately. He was bathed and put into a cot with several blankets and a hot-water bottle. The cot was kept near the coal fire, which was burning day and night. On the day of his birth snow had fallen, and the maximum air temperature was 21° F. (–6.1° C.), the minimum 17° F. (–8.3° C.).

The midwife noticed that he was cold in the first 12 hours. After the first day he would not suck and he became more lethargic until he was admitted to hospital at the age of 3 days. His rectal temperature was 85° F. (29.4° C.). His body had a mortuary coldness. He lay quietly, and his face looked healthy because the complexion was florid. The hands and feet were pink and oedematous, and the cheeks and buttocks were hard with sclerema. There were no signs of infection.

Progress and Treatment.—He was nursed, normally clothed, in a Sorrento cot in a cubicle kept at 65–70° F. (18.3–21.1° C.). He was fed by a gastric tube with 5% dextrose. He slowly became more active and his temperature rose over the next three days. He passed no urine for the first 24 hours and his blood urea then was 135 mg./100 ml. Sclerema persisted for five days and oedema for a further six. The blood urea was normal before discharge. When examined at the age of 15 months he was physically and mentally normal.

Case 2

Andrew was born at full term on January 18 at home. His birth weight was 8 lb. (3,630 g.). The delivery was easy and he cried immediately. There was some delay in attending to him because of the midwife's concern with the mother, who had a post-partum haemorrhage. He was bathed, clothed, and put in a cot with several blankets and hot-water bottles. Outside there was snow on the ground and the maximum air temperature in the first day of life was 33° F. (0.6° C.), the minimum 27° F. (–2.8° C.). The cot was kept at the foot of the bed between the window and the fire, which was allowed to die at midnight and was rekindled at 7 o'clock each morning.

He was slightly cyanosed on the first day and the cyanosis increased over the next three days. His feet and ankles were swollen on the day before admission. The rectal temperature on admission was 86° F. (30° C.). His skin was deathly cold. He was inactive. The face was ruddy and looked healthy. The feet and hands were oedematous and slightly cyanosed. The buttocks were hard with sclerema. There was no evidence of infection. With the same treatment as the first patient received, the sclerema disappeared within two days and the oedema after a week. He suffered no ill effects and was physically and mentally normal when examined at the age of 2 years 3 months.

Aetiology

A low environmental temperature has been emphasized by previous authors as the most important aetiological factor, and our inquiries fully confirm this.

External Temperature

Fig. 1 shows the minimum air temperature recorded at Edgbaston Observatory on the day before the onset of symptoms in each patient. All patients came either from Birmingham or from places within a 15-mile (24-km.) radius of the city, so that the figures are a good guide to external temperature at the time of the

occurrence of cold injury in each baby. It will be seen that the temperature in 53 instances out of 70 was below 35° F. (1.7° C.). Fig. 2 shows the number of patients whose symptoms started in each month of the year. Fifty-six occurred in the months of January, February, and March. Finally, inquiry from the mothers of the 31 survivors whom we were able to trace (it was not felt justifiable to question the parents of the babies who died) showed that in 17 cases there was snow and ice on the day of birth, and in a further six cases the weather was said to have been "bitterly cold."

The occasional occurrence of cold injury at relatively high air temperatures is of interest. There were seven examples where minimum air temperatures were 44° F. (6.7° C.) or over (one in March, one in April, one in May, one in June, one in September, and two in November). The symptoms and signs in these patients were characteristic, and in the one fatal case the necropsy findings were in keeping with the diagnosis. Three of these babies had long histories (two to three weeks). Chilling was apparently more gradual than usual, as one might expect with air temperatures which were not very low. Another baby had prolonged physiological jaundice, which may have interfered with internal thermoregulation. The remaining three patients

FIG. 1.—Minimum air temperatures (70 cases).

FIG. 2.—Month of onset of symptoms of primary cold injury.

were less than 5 days old, and no reason can be found for their hypothermia. Farquhar (1957) mentions similar cases.

Room Temperature

The average bedroom in this country is heated inadequately or not at all, so that its temperature to a large extent reflects the external temperature. A coal fire is usually allowed to die at night, or an electric fire is switched off when the family goes to bed. Though conditions may be modified for the new baby, it may not be realized that he is less able to withstand the low temperatures of the early morning than are older children and adults. Draughts from an ill-fitting closed window may also lower the bedroom temperature.

At the follow-up examination of 31 of the survivors we attempted to get some idea of the incidence of such factors by questioning the mother about environmental conditions in the affected infant's first few days of life. In spite of the lapse of time, many mothers answered readily, and we felt that the drama of the baby's illness had impressed these facts upon their minds and that their answers were fairly accurate. Of the 25 born at home, in 11 cases the mothers remembered either that the coal fire had been allowed to die at night or that the electric fire was switched off. (One of the two babies born in a hospital had been put into a newly opened ward with no heating; four had been born in nursing-homes; the heating arrangements in these institutions are unknown to us.) We were unable to obtain accurate information about the position of the cot in relation to open windows or other sources of draughts, but it was often next to the mother's bed, away from the fire. All babies were nursed in cots. It has been pointed out (Smallpeice, 1955) that the general fear of overlaying does not allow the baby to be nursed in the mother's bed, though this traditional practice might prevent neonatal chilling.

Other External Factors

Though it appeared that the babies were adequately clothed, it is not perhaps realized that clothing and blankets may be insufficient to protect a baby from the effects of a cold room. They may in fact accentuate chilling. Tight wrapping ("cocooning") may restrict muscular movement and peripheral circulation; and the wrappings may act as efficient insulators and keep the baby cold when the room temperature rises after the fire is relit in the morning.

Cold injury may be initiated within the immediate post-partum period if chilling is allowed to occur then. If the midwife is busily attending to the mother, or the baby is born before the midwife's arrival, he may be exposed to a low room-temperature for several minutes, and it is not difficult to imagine the severe effect of this sudden chilling on a body not conditioned to it. In only four of our cases was there a history of immediate exposure, but in 22 (31%) the baby was said to have been unwell from birth (Table II). This surprisingly high figure suggests that chilling at birth is more important than is generally realized. The ritual bath may also be an additional factor of importance, but we have no data on this point.

TABLE II.—Day of Life on Which First Symptom Was Noticed

	1st Day	2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day	-2 Wks	-3 Wks	-4 Wks	Indefinite
No. of cases	22	7	12	6	2	2	6	6	3	1	3

Inherent Factors in the Neonate

Why should a full-term newborn baby be unable to withstand such chilling? Relative lack of movement, perhaps exaggerated by tight wrapping, and immaturity of shivering mechanisms will cause diminished heat production. Poorly developed vasomotor reflexes (Herlitz, 1943; Bower, 1954, 1956), relative deficiency of subcutaneous fat, and a high ratio of surface-area to body-mass will increase heat loss. Refusal to feed, the commonest symptom, will aggravate cooling by failing to supply material for the increased katabolism necessary to counteract loss of heat. Prematurity might be expected to be a common predisposing factor, for all these factors are exaggerated in this condition. The fact that serious chilling is not very common in small premature babies is probably because doctors and midwives are well aware of the necessity of keeping a premature baby warm, whereas the necessity of guarding against chilling of the full-term neonate in winter is not generally appreciated.

History

It is unusual for the correct diagnosis to be made before admission to hospital, and it is still all too common for several days to elapse before any of the attendants realize that the baby is ill. We believe there are two main reasons for this. Firstly, the ruddy complexion of the baby gives a false impression of health (this is discussed below), and, secondly, the onset is usually insidious and there is no dramatic event, such as a convulsion, to alert the parent, the midwife, or the doctor.

Table III shows the frequency of the symptoms in the histories given by the parent or midwife, who often brought the baby to hospital. Slowness or refusal of feeds was, as in Mann's experience, the commonest symptom (73%). It is a common feature of all neonatal illness, and it is therefore unhelpful in leading the attendants to make a correct diagnosis. Nevertheless, if anorexia persists, it should lead to a search for more specific features. Lethargy and drowsiness (34%)

TABLE III.—*Primary Cold Injury—Frequency of Symptoms (70 Cases)*

Symptom	No.	Percentage
Slowness or refusal of feeds	51	73
Swelling (usually limbs)	37	53
Coldness to touch	25	36
Lethargy and drowsiness	24	34
Vomiting	12	17
Oliguria	9	13
Redness of skin	8	11
Jaundice	7	10
Haemorrhage	4	6
Hardening of tissues	4	6
Rigidity of limbs	2	3
Convulsion	1	1

have the same implication. The other two common symptoms, swelling (oedema), usually of the limbs (53%), and coldness to touch (36%), are more specific and, if present, should point to the diagnosis. Oedema was noticed by parent or midwife in as many as half the patients. Its usefulness as a pointer to the diagnosis should be emphasized, for other causes of oedema in full-term babies at this age, such as congenital heart disease and haemolytic disease, have their own recognizable features. Other characteristic signs, such as oliguria, skin reddening, and induration, were noticed less often, but when present they should suggest the diagnosis.

The ages at which the first symptom was noticed are shown in Table II. In the majority (81%) this was in the first week. Apart from the largest group, whose symptoms date from birth, the commonest age at onset was 3 days. This peak may, however, be misleading, since during the first two days a baby may be expected to be lethargic and unwilling to suck, and only at the end of that time may the parent or midwife suspect that he is unwell. Cold injury should be considered as a likely diagnosis in a baby, born at home in the first three months of the year, who in the first week of life refuses to feed. If this symptom occurs after the first week, other causes, such as infection or congenital heart disease, assume greater importance.

Clinical Picture

The important clinical features noted on admission are shown in Table IV. Their incidence in the total group is shown in the first column. In case the detection of these features had been more efficient in the last five years of the survey, when interest in the condition was greater, their incidence in the 35 patients

TABLE IV.—*Clinical Features Noted on Admission*

Clinical Feature	Total (1946-56) (70 Patients)		Recent Group (1952-6) (35 Patients)	
	No.	Percentage	No.	Percentage
Oedema	54	77	31	89
Immobility	41	59	21	60
Sclerema	27	39	14	40
Red face	31	44	16	46
Cyanotic face	11	16	7	20
Pale face	3	4	3	9

admitted in 1952-6 is given for comparison. It will be seen that there is little difference between their relative frequencies in the recent group and in the total group. The only noteworthy difference is in the frequency of oedema, which is greater in the recent group.

Oedema was the commonest sign, noted in 77% of the total group and 89% of the recent group. We have already emphasized its usefulness as a diagnostic feature when it occurs in a full-term neonate without signs pointing to other disorders. The term sclerema has caused much controversy. We have used it in Parrot's sense (quoted by Henoch, 1889): "An induration and rigidity which the skin of the infant offers to pressure . . . [the skin] loses its softness; and finally can no longer be raised from the subjacent parts, to which it appears firmly attached . . . [it] soon acquires the consistency of thick leather. All soft parts then appear as rigid as wood or stone; there is no pitting on pressure." It may be found on the cheeks, buttocks, or limbs, or it may be so widespread as to suggest a suit of armour. Respiration is very shallow and there may be real difficulty in passive movement of the limbs. Sclerema was noted in 39% of the total number, but its true incidence may have been higher.

Facial erythema, a striking feature, was commented upon in 44%, whereas cyanosis was mentioned in only 16%. These figures illustrate the frequency of a sign which is too apt to convey an impression of health to an unwary observer by comparison with cyanosis, a sign which in other states is more sinister. The erythema is presumably due to relative failure of dissociation of oxyhaemoglobin at low temperatures. The situation is analogous to that in pink disease, where the cold extremities are often pink rather than cyanotic.

Pallor was noted in only three cases, but we think it is commoner than this.

Once the body is palpated the coldness should be easily appreciated, and the combination of coldness and sclerema is in severe cases reminiscent of frozen meat. "There is an aura of coldness about the body," as Mann says, and the mother of a severely chilled baby told us that even the baby's breath was cold. Yet in the milder cases it is easy to miss the hypothermia, presumably because the medical attendant instinctively thinks of illness in terms of a raised temperature, and unless the possibility of this syndrome is borne in mind the coldness to touch may not be appreciated. It is still perhaps not fully realized that the standard clinical thermometer may also give a false impression, since a temperature below 95° F. (35° C.) will, of course, register as 95° or slightly higher, according to how

FIG. 3.—Admission temperatures and presence of sclerema (35 cases, 1952-6). White columns: No sclerema. Hatched columns: Sclerema.

vigorously the thermometer was shaken. In the early years of this survey many babies with typical clinical features were recorded as having admission temperatures of "95" or "below 95," and it was only when special low-reading thermometers were employed that the severity of the chilling was fully appreciated. The admission temperatures of babies admitted when low-reading thermometers were in use (1952-6) are shown in Fig. 3). The 35 whose temperatures were held to be true readings ranged from 80° to 95° F. (26.7 to 35° C.). The presence or absence of sclerema is shown in each case. We had hitherto considered it to be a sign of severe chilling, and were surprised to see that it was almost as common in those with relatively high temperatures as in those with low ones. Nor in our series could it be related to the length of history.

Immobility was commonly noted (59%). It is no doubt due partly to the general diminution of activity, but the splinting effect of large sclerematous areas must also be important. Some of these babies are literally "frozen stiff."

Oliguria is common in the first 24-48 hours after admission.

Sex Incidence.—There were 42 boys and 28 girls. This striking male preponderance was also found by Mann (1958) and Oppé and Simpson (1957), and is difficult to explain.

Investigations

In view of the parlous state of some of these babies, venepuncture and other disturbing procedures were usually avoided. However, blood was taken for chemical estimation in nine cases.

The only striking finding was an initial blood urea of 90 mg./100 ml. or above in the five babies whose initial temperature was below 89° F. (31.7° C.), while it was below 50 mg./100 ml. in three babies whose temperatures at admission were above 89° F. The remaining patient, whose admission temperature was not properly recorded, had widespread oedema and sclerema and was probably severely chilled; his urea was 134 mg./100 ml. Oliguria during the first few days was noted in five of the six severe cases but was not found in two of the three milder cases. High phosphorus and high potassium levels were found in two of the severely chilled patients. Two explanations of these findings are possible: that tissue breakdown was responsible, or that there was a gross diminution in glomerular filtration rate.

No other consistent biochemical abnormality was found, but the blood-sugar was not estimated. Mann and Elliott (1957) found severe hypoglycaemia in two out of six babies in whom the estimation was performed.

Treatment

There have been differences in the treatment of these infants over the years covered by this survey. It was soon discovered that rapid warming could lead to hyperthermia and convulsions, and vigorous warming was soon abandoned. The method employed over the last five years aims at raising body temperature gradually over several days. It is not unusual for this to take a week. The baby is admitted to a cubicle whose temperature range is 65-70° F. (18.3-21.1° C.), and is nursed fully clothed in a Sorrento cot. No extra clothing is used, except for a woollen bonnet. Hot-water bottles are kept in pockets on the sides and foot of the cot. Disturbance is kept to a minimum, in some cases even feeds being withheld for the first day. After this period tube feeding is used until one is sure that the baby is vigorous enough to take from a bottle.

We have been satisfied with slow warming in practice and have felt that its theoretical justification lay in the fact that by this method peripheral warming would not outdistance central warming. It has seemed to us undesirable that peripheral metabolism and oxygen need should be increased before the cardiorespiratory apparatus has been warmed sufficiently to cope with these demands. Even central warming (Polani, 1955; Farquhar, 1957) must be uneven in its effect, and we have favoured a method which will never cause steep temperature gradients between one part of the body and another.

Various antibiotics have been given routinely for prophylaxis and also because the clinical signs of infection may occasionally be absent and yet infection is revealed at necropsy. Additional oxygen has been administered only when cyanotic attacks occurred.

Additional glucose in gastric feeds (Mann and Elliott, 1957) has been given only occasionally, and from these few cases we cannot judge whether it is necessary.

It is not possible to compare the effect of various therapeutic measures in this retrospective survey, and

we cannot dogmatize on any of the above impressions. Even a prospective trial of slow warming against rapid warming would be difficult to carry out, in view of the difficulty of matching other factors such as length of exposure, type of exposure, initial temperature, severity of sclerema, etc. Nor would we feel it to be ethically justifiable.

Prognosis

Eighteen babies died, a mortality rate of 26%. On admission there seems to be no reliable indication of whether an individual baby is likely to survive. Though a very low initial temperature or the occurrence of sclerema is often followed by death, there are exceptions. Fig. 4 shows the initial temperatures of the

FIG. 4.—Admission temperatures and deaths (35 cases, 1952-6). White columns: Survived. Hatched columns: Died.

35 cases admitted in 1952-6, when low-reading thermometers were in use. Six of the seven deaths occurred in babies with temperatures below 88° F. (31.1° C.), yet the two babies with the lowest initial temperatures survived. Sclerema was found in five of the seven fatal cases, but nine babies with sclerema survived. Deaths were uniformly scattered over the years of the survey and could not be related to any particular change in treatment. There were seven deaths in boys (17%) and 11 in girls (39%).

Post-mortem examination was carried out in 15 of the 18 fatal cases. Macroscopic pulmonary haemorrhage was found in all, and in 11 it was the outstanding lesion. In the remaining four, infective lesions were also present; two had fibrino-purulent pleurisy and two had otitis media. One of the three in whom post-mortem examination was not performed had septic spots on the face for three days before death, and it is therefore possible that he had more serious infection elsewhere.

These findings are similar to those in the series of Mann and Elliott (1957), where five out of eight cases showed massive pulmonary haemorrhage, and infection was only an occasional finding.

Follow-up Survey

There is little information about the prognosis after survival of neonatal chilling. We therefore attempted to trace all survivors in the "primary cold injury" group, to examine them, and to interview their parents. We were able to do this in 31 cases. We obtained

information about the subsequent history and the present mental and physical state by letter in three more cases where the child now lived at a distance. One other patient was examined for other reasons within a few months of discharge but could not be re-examined at the time of the survey. And one patient, having made a complete recovery, had died of leukaemia at the age of 2 years. Thus we had information about 36 of 52 survivors (69%), which we regard as reasonably satisfactory in this area, where there is always a considerable shifting population. A low-reading thermometer had been used in 23 of these 36; the admission temperatures of 13 were below 90° F. (32.2° C.), so that severe cases formed a significant proportion of the survivors. At the interview we inquired about general health, developmental milestones, comparison with other children in the family, and scholastic progress when the child was of school age. In addition we asked the specific questions about the circumstances of the child's birth which we discussed above. We carried out

TABLE V.—Age at Follow-up Interview (34 Children)

Age in Years	1-	1½-	2-	3-	4-	5-	6-	7-	8-	9-	10-	11-
Number	6	1*	4	4*	4	4	—	1	1	—	6*	3

* Postal information in 1 case.

In addition, one patient died aged 2 of leukaemia, and one was an amputee with spastic quadriplegia when seen at 8 months.

a routine physical examination with special emphasis on neurological examination, and we measured heights and weights. The ages at the interview are shown in Table V.

Findings

Physical Development.—Twenty of the 25 children over 2 years of age were weighed and measured for height. The results were plotted on charts which use figures from the Oxford Child Health Survey and L.C.C. report of 1955 (Polani, 1958). The heights of 15 and the weights of 17 were within +1 S.D. and -1 S.D. (representing about the 84th and 16th percentile respectively); the heights of 19 and the weights of all 20 were above the -2 S.D. line. There is therefore no evidence of a general retardation of growth.

Physical examination of the group of 31 was normal with one exception. This was a girl aged 2 years 4 months who has acyanotic congenital heart disease (probably a septal defect). She is the one child whose height is below the -2 S.D. line.

Mental development was assessed by a consideration of developmental milestones, scholastic progress, comparison with siblings, and observation at the interview. Two children were mildly retarded. One, aged 5, was late in passing all his milestones, and his mother regards him as backward compared with his five siblings. The other, aged 10, has been rather dull and had occasional tonic convulsions until a year ago. The three children whose information was obtained by letter were mentally normal as judged by developmental history, comparison with siblings, and progress at school. The child who died of leukaemia had been normal until the terminal illness. Finally, one child was readmitted to hospital three times before the age of 8 months, and during his last two admissions he showed evidence of gross mental deficiency, with spastic quadriplegia. His temperature on the first admission was 88° F. (31.1° C.) and his clinical picture that of moderately severe chilling. He was 3 weeks old, having been kept in a maternity home since birth. Birth and neonatal period were said to

have been normal and no cerebral signs had been seen ; but we cannot, of course, be sure that he did not suffer perinatal cerebral damage.

The prognosis, therefore, appears to be very good for babies who survive the initial episode of chilling. Only 3 out of 36 had disabilities which might possibly be attributable to it—namely, cerebral palsy, mild mental retardation, and epilepsy with mild mental retardation. With one exception there was no interference with growth and physical or mental development in the remainder.

Discussion

Cold injury is, for the most part, a preventable disease. If ever central heating becomes a widespread method of heating houses in this country, then its incidence will presumably decrease. Apparently it is almost unknown in North America, probably because there the houses are properly warmed and many more confinements take place in hospital. However, it seems unlikely that many bedrooms in Britain will be efficiently warmed for some time to come, and therefore active measures will be needed to prevent the condition. The most important measure is the education of all who handle newborn babies at home in the danger of its occurrence during the cold months of the year, in the factors which predispose to it, and in its recognition. The appendix to the paper of Mann and Elliott (1957) sets out simple rules for midwives which, if followed, would substantially reduce the incidence of this disease. The recognition that a baby is chilled is also important, and in the early stages this can be difficult unless the condition is kept in mind. The complaint by the parent or midwife that a baby in the first week of life is refusing to feed, that it is cold, or that the limbs are swollen is highly significant in the cold months of the year. Unfortunately a low-reading thermometer will seldom be carried by the practitioner or midwife.

Probably all chilled babies should be admitted to hospital. Certainly the severely chilled ones need all the resources of modern paediatric care, even though the details of treatment are still controversial.

Summary

All hypothermic newborn babies (183) admitted to the Children's Hospital, Birmingham, over an 11-year period were classified into aetiological groups. Seventy of these were examples of "primary cold injury," the most important or only factor being external chilling.

In three-quarters of the 70 babies the minimum air temperature at the start of their illness was below 35° F. (1.7° C.); in four-fifths the chilling occurred in January to March. Other factors thought to be important are delay in wrapping the baby after birth, tight wrapping, failure to heat the room at night, as well as factors inherent in the neonate. Nearly all were born at home.

The commonest *symptoms* were feeding difficulty, oedema, coldness to touch, and lethargy. Symptoms dated from birth in a third and from the first week in four-fifths. The commonest *signs* on admission were oedema (77%), immobility, a florid complexion, and sclerema. Oedema is thus an important pointer to the diagnosis.

Oliguria was common in severe cases, and in a small investigation the blood urea, phosphorus, and potassium were found to be elevated.

Treatment varied, but it is agreed that warming should be slow.

One-quarter of the babies died. Pulmonary haemorrhage was a universal finding at necropsy.

A follow-up survey of 36 (69%) survivors showed that 92% were normal. One child has cerebral palsy and two are mentally retarded to a mild degree.

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ANENCEPHALY AND OTHER CONGENITAL ABNORMALITIES AN EPIDEMIOLOGICAL STUDY IN NORTHAMPTONSHIRE

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Congenital abnormalities merit the same detailed epidemiological study to-day which in the past has been devoted to infectious disease. The necessary information can be obtained from the local authority and hospital records ; medical practitioners and health visitors can give invaluable help in providing details of individual cases. In Northamptonshire a register of congenital abnormalities has been compiled for each local authority district from 1944. The information has been obtained as follows :

1. Routine searches have been made of the hospital birth registers, the domiciliary birth registers, and the infant mortality registers.

2. All midwives and health visitors have been asked to notify congenital abnormalities. Recently a new section has been added to the midwives' antenatal records and the health visitors' infant record cards asking for a definite statement whether or not an abnormality is present.

3. With the co-operation of the consultant obstetricians and paediatricians, their records have been made available for scrutiny in those cases where a congenital abnormality is present.

4. The records of the mental health department have been examined in regard to mental defectives ; the records of the handicapped pupils register of the school health department have also been examined for children with congenital defects.