X.—*Observations on the Temperature of Newly-Born Children.* By T. J. MACLAGAN, M.D., Dundee. Communicated by Dr J. MATTHEWS DUNCAN.

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The observations which form the basis of this paper were made on newly-born children with the object of determining whether their temperature differed from that of the adult, and if so, how and to what extent. They were made during a recent residence in the Edinburgh Maternity Hospital, with the full sanction of the attending physician, Dr CHARLES BELL. The thermometers* used were CASELLA'S straight self-registering. The rectum was the part chosen for the insertion of the instrument. The utmost expedition was used in ligaturing the cord, and separating the child from its mother. This being effected, the bulb of the thermometer was at once introduced into the rectum, and the child was wrapped in flannel, and committed to the charge of a nurse, who held the instrument steadily *in situ*. In five minutes it was removed, and the temperature noted. The observations were repeated every fifteen minutes during the first hour, every thirty minutes during the second and third hours, and then every hour up till the sixth hour after birth; after that at wider intervals up to twenty-four hours; and then only twice a day between ten and eleven in the morning, and between six and seven in the evening.

By the adoption of the above method, the first observation was made whilst the child yet retained the temperature imparted by the mother, whilst any subsequent change could not fail to be noted in consequence of the frequency with which the observations were repeated.

In order that the peculiarities of the child's temperature may be made as clear as possible, the facts observed shall be treated of under three different heads. We will consider (*a*) the temperature at the time of birth; (*b*), the range noted during the first twenty-four hours of extra-uterine life; (*c*), that of the next five days.

(*a*). The temperature of the child at birth is the same as that of the mother. If hers be high during the second stage of labour, that of the infant at birth will show a corresponding elevation; if normal, so also will the child's be. The mean range of the maternal temperature at the time of delivery was found to be

* The instruments were verified by the maker by a standard which is in perfect accordance with that of the Royal Kew Observatory.

99°154; that of the child at birth, 99°872. The highest was 103°5 for the mother, and 104° for the child; the lowest 97° and 98°1. As the former case was altogether abnormal, it ought perhaps to be excluded in striking the average. By doing so, we get a mean range for the mother of 98°6, and for the child of 99°3—a difference of °7 in favour of the child. This slightly higher range on the part of the child is fully accounted for by the fact that the infant's temperature was taken in the rectum, whilst the mother's was taken in the axilla. From observations made on the adult with the object of determining the point in question, I found the temperature of the former locality to be from half a degree to a degree above that of the latter. Making allowance for this, the range of the mother and child may be regarded as the same. The case with the high range, in virtue of its abnormality, serves well to illustrate the close connection which exists between the two. In it the mother's temperature towards the end of labour rose five degrees above the normal standard; the child's at birth was found to have undergone a similar elevation.

(b.) The range of the first few hours after birth is altogether peculiar. When the child is separated from the parent, and commences its new mode of existence, a marked change takes place. The temperature acquired from the mother is no longer sustained. The thermometer introduced into the rectum shows a fall which varies in different cases both in rapidity and extent, but which is never altogether wanting.

In children born at the full time, the average period after birth at which the temperature reached its lowest point was two hours. The average extent of the fall was five degrees below the normal standard of the adult; the greatest was to 90°8, the least to 96°—the average being to 93°4. The mean time which elapsed before the temperature again rose to what might be regarded as its normal range was 22·25 hours after birth; the shortest was two hours; the longest forty-four. In one sickly child it was four days before the depression was recovered from. In a seven months' child the temperature fell to 90°2, more than eight degrees below the adult standard of health; and during the thirteen days on which it was under observation the highest point reached was 94°6, the mean range being 92°3.

(c.) So much for the first twenty-four hours. The observations made after that time were made only morning and evening. I have selected sixteen cases, in which no disturbing element intervened at all likely to affect the normal range, and find that the mean range for the first five days immediately succeeding the time at which the normal standard was attained was in the morning 97°43, and in the evening 98°06, the average being 97°74—that is, more than half a degree below the normal standard of the adult. As the temperature of these cases was invariably taken in the rectum (in which we have seen that the range is higher than in the axilla), it may be inferred that the child's tempera-

ture during the first few days of its existence is a degree lower than that of the adult. It must also be mentioned, however, that all these observations were made during the winter, and that possibly the external atmosphere may have a greater effect on the temperature of the child than on that of the adult. I have never had the opportunity to repeat them during the warm weather of summer.

How are these peculiarities to be accounted for? Why should the child's temperature fall so rapidly, and to such an extent, immediately after birth? And why should it, on recovering from this temporary depression, still be lower than that of the adult?

(a.) That the child at birth should have the same temperature as the mother is what would naturally be expected. Considering the close connection which exists between them, and the manner in which the child is nourished by the mother, it could not well be otherwise. The circumstance calls for no explanation whatever.

(b.) With regard to the peculiar range of the first few hours of the child's separate existence, it is quite different; and we have now to inquire why it is that the child's temperature should fall so rapidly, and to such an extent, immediately after birth. It is probable that the sudden change from the high temperature of the womb to the low temperature of the external air exercises to some extent a chilling influence on the child—an influence which it can the less resist, and with the more difficulty recover from, in consequence of the peculiarities of its circulatory system allowing of the passage of so much venous blood into the arterial circulation. That, however, is not of itself sufficient to account for a fall so sudden, so great, and of so short duration; for assuredly, if that were the sole cause, recovery from a very low range so produced would be a much slower process than it is. There must be some other and more powerful agent at work; and this we have in the first necessary act of the child's independent existence—respiration. I believe that the passage of air into the lungs has at first a refrigerating influence, and is the chief, if not the sole, agent in producing the great and sudden fall which takes place immediately after birth. This explanation is to a certain extent borne out by what was observed in one case in which the child was apparently still-born, and in which considerable difficulty was experienced in inducing the respiratory act. The temperature in the rectum half an hour after birth (immediately after respiration was established) was $98^{\circ}3$; in the next half-hour it fell to $92^{\circ}6$. The state of the child at birth was such that attention was directed solely to the respiration, and until that was right the temperature was not taken. Just before delivery, however, the mother's stood at 100° , so that the child's may with propriety be supposed to have been $100^{\circ}7$ in the rectum. In ordinary cases, in which breathing commenced at once, the mean fall during the first half hour was in full-grown healthy children $5^{\circ}2$, and during the second half hour $1^{\circ}4$. In this case it was during the first half

hour $2^{\circ}4$, and during the second half hour (after respiration was established) $5^{\circ}7$. In all other cases in which a comparison could be made the fall was much greater during the first half hour than during the second; in this one the reverse was the case; and the only explanation of this circumstance is to be found in the tardy establishment of the respiratory act. So far as one case can do so, this one shows that it is not until the child breathes that the temperature falls to any great extent; though the diminished range may also be partly explained by the cooling influence of the external air on the blood in the very active cutaneous circulation.

But the question naturally arises, Why should the respiratory act, which in the adult has a heat-producing effect, have an opposite result in the infant? The answer involves a brief consideration of the whole question of the production of animal heat. To the various theories which have at different times been advanced to account for this I shall not allude further than to say, that all have given place to that which ascribes it to chemical action—to the changes which are constantly going on in the blood in all parts of the capillary system—general and pulmonic. As these changes take place in organs and parts which are dependent for the proper performance of their functions on the integrity of the nervous system, it follows that the amount of heat produced is apt to be modified by the operation of that system. Medicine abounds in illustrative cases in which a part of the body, a limb for instance, in consequence of being deprived of its nervous supply by disease or accident, has a lower temperature than it had when that supply remained intact.

Sir B. C. BRODIE (I quote from KIRKES' "Physiology") "found that if artificial respiration was kept up in animals killed by decapitation, division of the medulla oblongata, destruction of the brain, or poisoning with worara poison, the action of the heart continued, and the blood underwent the usual changes in the lungs, as shown by the analysis of the air respired, but that the heat of the body was not maintained; on the contrary, being cooled by the air forced into the lungs, it became cold more rapidly than the body of an animal in which artificial respiration was not kept up."

Absence of the due nervous influence is, I believe, the true explanation of the rapid and transient lowering of the child's temperature during the first few hours of extra-uterine life. It is, indeed, unlikely that the child should have its connection with the mother severed, and commence its new and independent existence with patent foramen ovale, unclosed ductus arteriosus, and lungs hitherto untried, and from the first maintain the temperature imparted to it by the parent; but, as already explained, the existence of this peculiar state of the organs of circulation is inadequate to account for a fall so very rapid and of so short duration. Closure of the foramen ovale and ductus arteriosus cannot explain the speedy return to the normal range, for these passages are not

obliterated for some considerable time after birth; respiration goes on as from the beginning, and why should it after a few hours cease to exert the same lowering influence which it exercised at first? It seems to me that the only feasible explanation is to suppose that the hitherto unexercised influence of the nervous system over the respiratory function is not at once called into vigorous and efficient action—that though the influence required for inducing the muscles of respiration to act is in full force from the beginning, there is still wanting, or only partially supplied, that more delicate and less easily explained agency without which, even though the blood may undergo the usual changes, the due amount of heat is not generated; and that coincidently with the establishment of this influence does the temperature of the child rise to its normal range. This explanation is quite in harmony with the fact that in delicate and premature children the fall is greater than in vigorous ones and those born at the full time, in whom also the normal standard is more rapidly reached, in consequence probably of the more speedy establishment of the due nervous influence.

(c). During the five days immediately succeeding that on which the temperature rose to a height which might be regarded as normal, we have seen that the range was one degree below that of the adult, after due allowance had been made for the difference resulting from the manner in which the thermometer was applied.

This lower range of the early period of extra-uterine life admits, I think, of a very ready explanation.

As a general rule, the degree of heat produced bears a definite relation to the activity of the respiration: in birds, in which respiration is very active, the temperature is high; in reptiles, with a sluggish respiration, there is a low temperature.

Anything which interferes with the proper oxygenation of the venous blood, or with the due supply of the purified fluid to the tissues, has a lowering effect on the temperature. Such agencies are constantly at work in the newly-born child. The patent condition of the foramen ovale and ductus arteriosus permit of so free a commingling of the venous and arterial blood, that a lower temperature than exists after the closure of these passages must result; for, in the first place, less blood goes to the lungs at each contraction of the right ventricle, and so less heat is produced there; and, in the second place, the blood which goes to the tissues is less pure, and consequently less of an interchange takes place in the capillaries of the systemic circulation.

How long the child's temperature continues lower than that of the adult I am not prepared to say, as my observations were limited to the first week of extra-uterine life, but should think it probable that the adult standard of health is not maintained till the foramen ovale and ductus arteriosus are closed, or nearly so. This, however, is a mere hypothesis, and must remain so, as the time of closure of

these orifices cannot be accurately ascertained. Their obliteration is extremely rare before the completion of the first week of separate existence; but cases are on record in which the foramen ovale, and others in which the ductus arteriosus has been found obliterated before birth; whilst there are recorded several in which the foramen ovale was patulous for many years.

The natural vigour of the child seems to exercise some influence on the extent and duration of the fall which takes place after birth.

I made some calculations with the object of finding out whether the weight of the child at birth or the weight of the placenta bore any fixed relationship to the child's range of temperature, but failed to establish any necessary connection. The only conclusion to which I came was, that those children which gave the most decided indications of being in a vigorous healthy state were also those in whom the temperature fell least, and in whom it soonest again rose to the normal standard. In a feeble seven months' child the range fell to $90^{\circ}2$, and only once rose as high as $94^{\circ}6$, during the thirteen days that it was under observation. In another case, a vigorous healthy child, born at the full time, the lowest point was 96° , and in two hours after birth the standard of health was reached.

It is very probable that the vigour of a healthy child, and the higher range which it shows, are both merely evidences of a better developed state of the organs generally, and especially of the nervous and circulatory systems, on the integrity of which the production of a due amount of heat is dependent.