

Temperature in relation to injuries of the head / by W. McAdam Eccles.

Contributors

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Royal College of Surgeons of England

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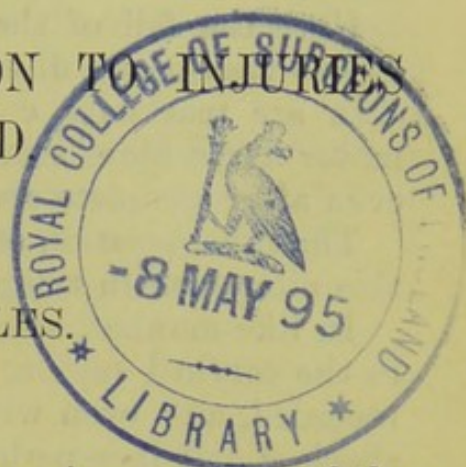
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TEMPERATURE IN RELATION TO INJURIES OF THE HEAD.

BY

W. McADAM ECCLES.



The subject of alterations in the average temperature of the body subsequent to injuries to the central nervous system, and apart from inflammatory conditions, is one of especial interest to the physiologist, and also to the physician and surgeon. Besides injuries, a considerable number of diseases of the brain and of the cord may effect like changes in the bodily heat, and these have been well tabulated by Dr. Hale White¹ in his interesting paper on the question of heat-centres in the human subject.

The present paper will only deal with such cases as come under the observation of the surgeon, although analogies may be drawn from the medical side; and it will, moreover, chiefly review the question of hyperpyrexia, though allusion will be made to the subject of sub-normal temperature.

The question will be dealt with under two headings:—

- I. Changes in the general body temperature.
- II. Changes in the temperature of particular regions of the body.

I. Changes which occur in the general body temperature after injuries to the head.

It is now a well-established fact that nearly all accidents which involve some injury to the head are liable to be followed by changes in the general body temperature, which can only be referred to some alteration in the mechanism of the central nervous system, and probably of a part or of parts of it which has or have to do with the regulation of heat; but whether this is due to an interference with a thermogenic or a thermolytic function is by no means clear.

¹ Guy's Hospital Reports, vol. xlii. p. 49.

A man receives a blow on the head and is "stunned." When seen, the surface of his body is in most cases cold and pallid, and the skin, especially of the forehead, is covered with cold sweat.

Here the fall of the surface temperature is almost certainly due to vaso-motor disturbance, whereby the blood-vessels of the skin are markedly contracted, and simultaneously the sudomotor nerve fibres stimulated; for secretion of sweat may occur even after complete arrest of the circulation.

Thus the question of the influence of the nervous system over this alteration in temperature will probably be undisputed.

In like manner, after certain injuries to the spine, especially in the cervical region, abnormally low temperatures have been recorded, and even without any marked symptoms of general shock;¹ but it is perhaps more common, after injuries of this kind, to get a high temperature—in fact, one of 122° F. has been recorded,² though this may have been hysterical.

Another class of cases are those in which there are very evident symptoms and signs of fracture of some part of the skull, with probably some lesion of the brain as well, in which there is a fall of temperature very shortly after the injury, and then a steady rise, without any marked intermission, in most cases, until death occurs, just before or after which the thermometer may stand at a great height.

It will be well here to give short accounts of a few selected cases.

Case I.—A woman, aged 54, was admitted into the West London Hospital, under the care of my colleague, Mr. Swinford Edwards, who has kindly given me permission to record the case, on March 7, 1891, at 3.20 P.M. She had fallen a distance of 14 feet into an area.

On admission, there was a contused wound over the right parietal bone, but no fracture could be felt. She had, however, considerable hæmorrhage from the right ear, with the escape of some cerebro-spinal fluid, pointing most probably to a fracture of the base of the skull. In addition, she had sustained a fracture of the first and second ribs of the right side, without any fracture of the clavicle.

She was cold and collapsed, and quite unconscious. She had not vomited.

She had very jerky respiration, with markedly prolonged expiration.

The pupils were moderately dilated, equal, and reacted some-

¹ Hutchinson, *Lancet*, 1875, vol. i. p. 714.

² Teale, *Lancet*, 1875, vol. i. p. 340.

what sluggishly to light, and there was marked impairment of the corneal reflex.

The temperature, taken soon after admission, in the rectum was 96.5° F., and a short while after the right side of the body was thought to be colder than the left; and on the temperature being taken in the axilla, it was found to be 97° F. in the right axilla, and 98.8° F. in the left.

Her temperature after this steadily rose, losing the difference on the two sides of the body, until it reached 107.8° F. before her death, which occurred nineteen hours after the accident.

TEMPERATURE.

March 7th.	On admission, 3 p.m.	.	.	.	96.6° F.
"	8 p.m.	.	.	.	99.6°
"	10 "	.	.	.	100.4°
"	12 midnight	.	.	.	102.6°
"	8th. 2 a.m.	.	.	.	104°
"	4 "	.	.	.	104°
"	6 "	.	.	.	104°
"	8 "	.	.	.	103°
"	10 "	.	.	.	103.4°
"	12 noon	.	.	.	103.6°
"	2 p.m.	.	.	.	104°
"	4 "	.	.	.	104.8°
"	6 "	.	.	.	104.8°
"	8 "	.	.	.	105.8°
"	10 "	.	.	.	106.6°
"	12 midnight	.	.	.	106.6°
"	9th. 1 a.m.	.	.	.	107.4°
"	2 "	.	.	.	107.8°
"	Death.				

Unfortunately, no *post-mortem* record is preserved to show the exact lesion in this case.

Case II. reported by Mr. J. P. MacLaren.¹—A railway signal fitter sustained a severe compound depressed fracture in the left antero-parietal region. The bone was elevated and the wound treated antiseptically.

The patient's temperature sixteen hours after the injury was 101° F., and the pulse 120. Twelve hours after this—that is, twenty-eight from the receipt of the blow—the temperature had still further risen to 103° F., and continued to steadily increase until it reached 109° F. just before death, which occurred thirty-four hours after the accident.

¹ British Medical Journal, 1893, vol. ii. p. 234.

TEMPERATURE.

Sixteen hours after injury, at 3 p.m.	101° F.
5 p.m.	103.4°
6 „	103.4°
9 „	105°
10 „	105°
10.30 p.m.	105.6°
11 p.m.	106.2°
11.30 p.m.	108°
12 midnight	108.4°
1 a.m.	109°
1.30 a.m.	109°
Death.	

Case III. reported by Dr. Hale White,¹ was under the care of Mr. Davies-Colley. A man received a gunshot wound on the right side of the head between the external angular process and the top of the pinna of the ear.

The bullet was extracted, but he died twelve hours after the operation, the temperature having risen to 104.4° F. The *post-mortem* examination revealed that the bullet had not perforated the dura mater, but had caused considerable contusion of the anterior extremity of the middle lobe of the right hemisphere and of the third frontal convolution.

Case IV. reported by the late Mr. Marcus Beck.²—A boy aged 7 fell off a wall at one o'clock on July 13, 1877. He became comatose from middle meningeal hæmorrhage. He was trephined, and became for the time somewhat better, but his temperature began to rise, and twelve hours after the accident it was 106° F., and just before his death, three hours later, it had reached 106.4° F., and rose to 108.4° F. within five minutes after death.

At the *post-mortem* examination no macroscopic injury of the cerebral substance could be detected.

Case V. also reported by Mr. Beck with the preceding.—A young woman, aged 25 years, had compression from middle meningeal hæmorrhage, and was trephined, and relieved for the time. Hæmorrhage, with the symptoms of compression, recurred, and her temperature rose to 103.6° F. before her death, which took place eighteen hours after the operation.

Case VI. A child, aged 2½ years, was admitted under Mr.

¹ Guy's Hospital Reports, vol. xlii. p. 91.

² Medical Times and Gazette, 1877, vol. ii. p. 159.

Butlin on August 25, 1890, after a fall from a window. On admission, there were all the symptoms of fracture of the posterior and middle fossæ of the base of the skull. The limbs were white and cold, but the temperature was 98° F. In twelve hours the temperature had reached 103° F., and rose to 104.2° before death, which occurred forty hours after the injury.

The *post-mortem* showed no signs of meningitis, and there was only some laceration of the under surface of both frontal lobes, with no large amount of extravasated blood. The base of the skull was extensively fractured.

Case VII.—A girl, aged 2 years and 9 months, was admitted under Mr. Willett on March 25, 1890. She had fallen 12 feet from a window, and was brought to the Hospital unconscious two and a half hours after the accident. No evidence of any fracture of the skull could be found. Her temperature on admission was 103.6° F.

She remained unconscious for seven days, and then slowly but completely recovered.

Case VIII.—A boy, aged 6 years, was admitted into St. Bartholomew's Hospital, under the care of Dr. Gee, suffering from epileptiform fits. There was no history of any injury, and the fits began some three months before admission.

There was headache, referred to the left parietal region. There was some paresis of the right leg and foot. No tumour or scar could be found on the head. It was decided to trephine over the motor area of the left hemisphere. Temperature normal from admission up to operation.

On August 8, 1893, Mr. Bruce Clarke, after chloroform had been administered, turned down a flap and elevated two trephine crowns of bone, one near the upper and the other near the lower end of the fissure of Rolando. The intervening piece of bone was then removed.

The dura mater was opened, and the veins on the surface of the brain seemed rather full, but there was no evidence of any meningitis.

As the cerebral substance appeared to bulge somewhat into the opening through the bone, it was explored by puncture in several directions through the cortex of the motor region.

The wound was then closed. An hour after the operation the temperature was 97.8° F., but it soon began to rise, and within twelve hours it was 105° F. It dropped to 99.8° F. on the morning of August 10th. The boy only had a very few fits after the operation. The temperature was irregular for some days afterwards.

TEMPERATURE.

August 8th.	Before operation	. . . . .	97.8° F.
"	After operation, 3 p.m.	. . . . .	97.8°
"	7 p.m.	. . . . .	99.4°
"	11 "	. . . . .	101°
" 9th.	3 a.m.	. . . . .	105°
"	7 "	. . . . .	102.6°
"	11 "	. . . . .	101°
"	3 p.m.	. . . . .	103.6°
"	7 "	. . . . .	103.4°
"	11 "	. . . . .	102.6°
" 10th.	3 a.m.	. . . . .	100.8°
"	7 "	. . . . .	100.4°
"	11 "	. . . . .	99.8°

The question as to the cause of the high temperature in these cases is a deeply interesting one.

There is a very great tendency at the present time to ascribe all temperatures to the effect produced by substances formed within the tissues by the action of micro-organisms, and this is no doubt the true cause in a large number of cases, especially those in which a wound co-exists. But it cannot be gainsaid that the nervous system itself has a very marked and distinctive action on changes in the body temperature.

It will be better perhaps to defer the discussion of this subject until the second section has been alluded to.

II. Changes in the temperature of different regions of the body, especially as exemplified by differences of temperature on the two sides of the body consequent upon head injuries.

Here we are met with very significant facts, though as yet but little has been deduced from them.

Many experimenters have shown that in the perfectly normal state of the body there is practically no difference in the degree of temperature of one side of the body when compared with that of the other.

Some interesting observations were made by Dr. Blake,¹ from which he found that exertion under the influence of powerful heat, such as that of the sun, tended to be followed by differences of temperature on the two sides of the body, but he offers no explanation as to their cause.

Very few observations of these differences have as yet been made after injuries to the head, and it is my hope that this

¹ Medical Times and Gazette, 1870, vol. ii. p. 420.

paper may lead to more interest in the subject and fresh clinical records.

Bastian¹ and Bourneville² have studied in measure the changes of temperature after hæmorrhage into the substance of the brain, and have noted marked differences on the two sides of the body.

H. P. Dean³ has lately made a study of the effect of pressure upon the cortical substance in different regions, and finds from his experiments some marked changes in the temperature of the two sides of the body consequent upon it. This is interesting in connection with pressure from sub-dural hæmorrhage.

Mr. Jonathan Hutchinson⁴ records a case in which a man was treated for a wound of the scalp who afterwards became comatose. Among the symptoms he presented, it is especially noted that there was a difference of temperature on the two sides of the body, chiefly in the upper extremities, the left being described as "warm, rather hot," and the right as "decidedly cold" to the touch. No accurate thermometric record is given, but there seems to have been quite a clear difference between the two arms. At the *post-mortem* examination a thick clot of blood was found in the sub-dural space on the *left* side, which had caused considerable pressure upon the cortex of the left hemisphere.

In commenting on this case, Mr. Hutchinson remarks, "The symptoms of increased heat in the one arm was of some value in the almost complete absence of other indications by which to judge as to which side was injured."

It should be noted here, however, that it is a question whether there was actually *increased* temperature of the left upper extremity, the one on the same side as the pressure on the cerebral cortex, or whether there was *diminished* temperature on the right arm, or on the side opposite to the pressure.

Dr. Gross,⁵ speaking of the diagnosis between sub-cranial and intra-arachnoid (sub-dural) hæmorrhage, says, "In both conditions there are more or less marked coma, dilated pupils, slow, full, and laboured pulse, hemiplegia, *with diminution of the temperature of the opposite limb*, and slow, noisy, stertorous breathing."

¹ Paralysis, Cerebral, Bulbar, and Spinal, p. 154.

² Etudes Cliniques et Thermométriques sur les Maladies du Système Nerveux. Paris, 1872.

³ Journal of Pathology, vol. i. p. 46.

⁴ London Hospital Reports, vol. iv. p. 22.

⁵ American Journal of Medical Science, vol. lxvi. p. 49.

This accords with Dr. Bastian's view of cases of hemiplegia following on intra-cerebral hæmorrhage, given later on.

In Case No. I. mentioned above, there was a difference of no less than 1.8° F. in the temperature as taken in the right axilla compared with that taken in the left.

Unfortunately I did not learn of the high temperature early enough in Case No. VIII. to ask for the temperature to be taken simultaneously on both sides of the body, but it is likely from Dean's experiments on animals that such cases as this, where there is a definite disturbance created on one side only of the brain, that the temperature may be also likewise unilaterally affected. There is still difference of opinion amongst physiologists, and also amongst neuro-pathologists, as to the probability of the existence of "heat-centres" in the brain, though the weight of evidence seems to be for their presence.

Ott,¹ who has paid much attention to the subject, states that his experiments lead him to the conclusion that in the brain proper there are at least four areas which appear in some way to be associated with heat regulation. These are:—

1. About the fissure of Rolando.
2. About the fissure of Sylvius.
3. In the corpus striatum.
4. In the anterior part of the optic thalamus.

The two former of these have a direct bearing on many cases of surgical injury, and Case No. VIII. is especially interesting when viewed in the light of the possibility of a "heat-centre" in the region of the motor area. Hale White² strongly supports the view of a "heat-centre" in the corpus striatum, if nowhere else, both from clinical and experimental data.

Ferrier,³ on the other hand, seems inclined to discredit the existence of "heat-producing centres" distinct from those centres which appear to influence the motor and vaso-motor apparatus in a general sense.

We therefore yet have to explain the precise cause of the elevation of temperature which undoubtedly occurs in certain cases where there has been a lesion of the cerebral cortex, especially about the fissure of Rolando and the frontal lobes. Is it due to actual increase in the heat production of the body generally, or in the side of the body opposite to the lesion? Or is it dependent upon the loss of action of an inhibitory centre? Or is it merely the result of vaso-motor disturbances? It is

¹ Brain, January 1889, p. 433.

² Journal of Physiology, 1890, and Guy's Hospital Reports, vol. xlii.

³ "The Functions of the Brain," p. 88, *note*.

for the elucidation of such questions that further detailed clinical observation as well as experimental research is needed.

The elaborate and careful experiments of H. C. Wood¹ tend to prove that there is in most cases an actual increased production of heat after certain injuries to the central nervous system in animals, altogether apart from any inflammatory changes.

In connection with this point it is interesting to note that Bastian² puts forward that it is his opinion, from the clinical observation of a large number of cases of intra-cerebral hæmorrhage, that there is a distinct difference in the temperature of the two sides of the body, especially in that of the upper limbs. In the early stages of hemiplegia he believes that often the temperature taken in the axilla of the non-paralysed side (*i.e.*, the same side as the lesion) is sub-normal, and that the higher temperature in the axilla of the paralysed side is only so in contrast to the opposite sub-normal temperature, and he expresses his belief that the alteration in temperature is due to vaso-motor irritation, and thinks these phenomena go to prove that the influence of the supreme vaso-motor centres is direct and not crossed.

However this may be, it does not seem to account for those cases where it would seem that there is a definite local increase in the production of heat.

How the cerebral injury brings this about has yet apparently to be shown. Those who regard the initial fall of temperature which often occurs after head injuries as the result of shock, will probably think that the subsequent rise is partly due to reaction; and no doubt in many cases it may be, but this will by no means explain those cases of marked hyperpyrexia quoted above. In these there must, one would think, be some definite disturbance in the actual regulation of the heat mechanism of the body.

Battle,³ in his third lecture at the Royal College of Surgeons on "Some Points relating to Injuries of the Head," records fourteen cases of head injury, all of which were followed by a high temperature, the highest given being 110° F., and the *post-mortem* records show that in many cases there was laceration of brain substance, especially about the under surface of the frontal lobes, as in Case VI. above, and about the apex of the tempero-sphenoidal lobe, which he thinks had been caused by *contrecoup*. He also believes that many cases of middle meningeal hæmorrhage, which are not fatal within twenty-four

¹ "Fever: A Study in Morbid and Normal Physiology," 1880.

² *Op. cit.*, p. 155.

³ British Medical Journal, 1890, vol. ii. p. 141.

hours, may also be followed by a rise in the general body temperature. He concludes by saying, that if there be an excessive rise of temperature, there is probably sub-dural hæmorrhage or laceration of the brain substance. Whenever there is an extravasation of blood, some of the possible resulting rise in temperature might be due to the absorption of free fibrin ferment, which is known to have marked pyrogenic properties; but if this were so, there ought, one would think, to be a greater or less rise in every case where there is extravasation of blood; and this is by no means the case.

The *post-mortem* records of cases where there has been a considerable rise of temperature nearly all show that there had been laceration, or at least bruising of some part of the cortex, and Case VIII. may be taken as experimental evidence of cerebral injury, producing a remarkably high temperature, following almost immediately upon the lesion.

Besides laceration, it would also seem that pressure alone is sufficient in certain cases to bring about a rise in temperature, as has been shown both by experiment and the clinical report of cases.

The condition of an abnormally *low* temperature after head injuries is even less often alluded to by writers than that of high temperature, and is therefore probably of decidedly less frequent occurrence.

No doubt in certain cases there is a very marked degree of shock, with a great fall of temperature, which may never rise again before the patient's death; but whether there is an actual prolonged diminution in heat-production dependent upon injury to the central nervous system, I am unable to say or to give any recorded cases.

A case of Le Gros Clark's, quoted by Gant,¹ presented a remarkable fall to 87.4° F. soon after a head injury, and remained so for one and a half hours subsequently; but the record is very brief, and makes no attempt at an explanation.

Having briefly reviewed the subject of alterations in temperature after head injuries, I can only hope that this paper, avowedly very imperfect and fragmentary, may lead to further research in what is an interesting and, it may be, important feature of such cases.

¹ "Science and Practice of Surgery," 3rd edition, vol. ii. p. 204.

