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EFFECTS OF HEAT IN IRAQ.

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UNDER wartime conditions it frequently happens that medical officers serving abroad are unwilling to write papers about their medical experiences because they have been unable to study the literature concerning their subject. The writer hopes that the publication of this paper may be considered justifiable in view of the large number of cases of heat effects seen, under varying conditions, and in spite of his admitted ignorance regarding what has already been written and his lack of proper records.

MATERIAL.

The cases on which this paper is based were seen in two Indian Combined General Hospitals situated in the plains of Iraq during the summers of 1941, 1942 and 1943. The exact number of cases seen is not known as no proper record has been retained for the years 1941 and 1943. For the period June to September, 1942, however, records have been kept and during this time cases labelled heat effects numbered 594—533 British and 61 Indian. Many of these were characterized only by a short attack of pyrexia and whether they were correctly diagnosed as effects of heat is a matter which is open to question and will be discussed later. During the other two years rather fewer cases were seen, but the proportion of Indian to British was about the same. The proportion of severe cases among the Indians was higher than among the British.

Conditions varied during the three years concerned, the most important changes being as follows:—

(1) During 1941 and 1942 the writer was working in a hospital situated at a port, and in consequence many of the cases seen were admitted from, or had recently been on board, ships. In 1943 the cases were seen in a hospital situated in a desert station.

(2) The first hospital consisted mainly of a very solidly-built stone building with thick walls and big verandas and the wards in this building, though reasonably cool by day, were very hot at night. The beds of the second hospital were partly in temporary buildings with thin walls, without verandas, and partly in tents. The tented wards were Y-shaped, each arm of the Y consisting of 6 or 7 E.P. I.P. tents and being sunk four feet into the ground.

It was found that the thick-walled wards were unsatisfactory because, though cool by day, they were very hot indeed by night. The tented wards were reasonably satisfactory being cool at night though very hot during part of the day. The thin-walled wards were fitted with air-cooling devices of only moderate efficiency and were the best. The ideal, of course, is a satisfactorily air-conditioned ward which will remain cool during the whole twenty-four hours but if this cannot be obtained it seems better that the patients should be comfortable at night so that they can sleep even if this involves their being very hot during part of the day. It was the absence of any real "let up" during the twenty-four hours that made the thick-walled wards so unsatisfactory.

(3) One of the most interesting changes which took place was the increase in our knowledge and understanding of these cases during the period. This increase was slower than it might have been because the summer of 1941 was an unusually cool one. The writer on looking back cannot but believe that some of the deaths in the early part of the period would not have taken place if he had had a greater understanding of the many ways in which effects of heat can be manifested.

ÆTIOLOGY.

It would appear that an individual suffers from effects of heat either because his heat regulating mechanism becomes exhausted and fails, allowing his temperature to rise, or because he loses a great deal of water and salt by sweating, fails to make good the loss by increased intake and becomes dehydrated and short of chlorides. Whether there are other chemical changes of importance is a question into which the writer does not propose to enter. Shortage of chlorides is the important one from the diagnostic point of view because a rough test for the urinary chlorides can so easily be made.

These are the mechanisms through which effects of heat are produced, but there are many contributory causes.

(1) *Climate*.—Obviously the higher the temperature and the damper the atmosphere (which allows less cooling by evaporation) the more likely cases are to occur. It is perhaps not always realized how much difference slight changes in humidity and wind conditions make. In the summer of 1942 it was often necessary for the writer and his commanding officer to discuss whether the hospital had enough empty beds; if there was a south wind (which led to increased humidity), or very little wind, many more admissions had to be allowed for.

(2) *Length of Time in a Tropical Climate*.—No helpful figures regarding this point could be obtained but it was thought that men newly arrived in the tropics were more liable.

(3) *Physical Exertion*.—Many examples of patients becoming affected during or after a march were met with. Men who had to do a march, even a short one, soon after disembarking when they may have been lacking adequate food, drink and sleep, were particularly vulnerable. On one occasion a batch of five severe cases, one of which proved fatal, was admitted following a march of $1\frac{1}{2}$ miles performed by a small Indian unit soon after leaving their ship.

(4) *Fluid and Salt Intake*.—No figures regarding this can be produced but there can be no doubt that a large intake of salt and water helps to prevent the occurrence of cases.

(5) *Other Disease*.—The majority of the cases seen had no other disease present. Quite a number, however, had been recently in hospital for other conditions and any condition producing a temperature can be a predisposing cause. Effects of heat were seen following or during attacks of pneumonia, malaria, diarrhoea, sandfly fever, urinary infection and other diseases. It is of the utmost importance to remember that effects of heat may arise during the course of any illness. Constipation appears to be an important predisposing cause.

(6) *Exposure to the Sun's Rays*.—This in itself does not appear to have any ætiological importance and no evidence was found which supported the existence of so-called sunstroke, i.e. a condition produced by the sun's rays as opposed to its heat.

(7) *Previous Attacks*.—In 1942, 2 per cent of the cases had been admitted to hospital before for the same condition. In view of troop movements and the situation of the hospital

this figure is probably abnormally low. Most of the men admitted more than once suffered from inability to sweat properly.

(8) *Psychological*.—No evidence was found which suggested that anxious individuals were particularly liable to suffer from effects of heat. The impression was obtained that they did not as a rule become severely ill, presumably because they reported sick or collapsed sooner than their fellows.

(9) *Ship Travel*.—Many cases were admitted directly from ships' hospitals, and many of them were very gravely ill. It appeared that "heat" patients treated in ordinary ships' hospitals did very badly.

TYPES OF CASE AND CLINICAL FEATURES.

When the writer went to Iraq in April, 1941, his ideas about heat effects were roughly as follows. There were two conditions produced by a high atmospheric temperature; the first was a very dangerous condition known as heat stroke characterized by hyperpyrexia and coma; the second was a troublesome though usually harmless condition called heat exhaustion characterized by dehydration and lack of salt. Experience showed that these ideas were exceedingly inadequate and that the true state of affairs was more complicated.

As has been noted already there are two mechanisms which produce effects of heat—loss of temperature control and shortage of water and salt. In any one case either or both of these factors may be at work, and the actual type of case produced seems to depend on how great an effect each factor is having. Thus every stage of case may be seen from the classical heat stroke with hyperpyrexia and coma to the classical heat exhaustion with a subnormal temperature, dehydration and salt lack.

Four varieties of cases will be described.

(1) *Acute Heat Stroke*.—The patient is admitted in a semi-conscious or unconscious condition and the rectal temperature is found to be 106 or over. There may be muscular twitchings, cyanosis or convulsions.

He may be extremely restless and almost always is while he is being cooled down.

When he starts to recover he often vomits. It is usually found that the temperature comes down fairly easily with treatment but that he remains unconscious after it has been brought down to a reasonable level. How long he remains unconscious depends mainly on how long he was ill before treatment was started, but most recover consciousness in a few hours. During convalescence these patients are often exceedingly pale although not anæmic. Mental abnormality, inability to sweat, and a slightly raised temperature may persist for weeks.

They may have been perfectly well until a few hours before their illness or they may have been off colour for a day or two and have noticed inability to sweat or frequency of micturition.

One patient of the writer's was semi-conscious and unable to swallow for a week. Two months later he left Iraq *en route* for the United Kingdom and was then well except that his speech was slightly abnormal and his cerebration was slow.

(2) *Heat Exhaustion*.—At the other end of the scale comes the case whose condition is due entirely to dehydration and salt lack. Here the patient is extremely lethargic and often drowsy. His tongue is dry and his urinary output low (or in a severe case absent), but in spite of this he will not be bothered to drink unless he is made to. His blood-pressure is low, perhaps 104/60 in a mild case or 95/40 in a severe one. In some cases it is found that the systolic pressure is reduced and the diastolic normal. He may have convulsions, and heat cramps may occur. The urinary chlorides in this type of case are reduced or absent. It is convenient to note here that in 1942 it was found that the urinary chlorides of all heat effects cases were normal in 22.5 per cent, diminished in 43.3 per cent and absent in 34.3 per cent. The silver nitrate test was used.

(3) *The Subacute Case*.—Many examples of this type of case were seen and they caused a great deal of trouble. The temperature is commonly about 103 to 104 but may be lower. In the milder cases the temperature and symptoms due to it are the only clinical features but

the fever may continue for as long as two weeks. In the more severe cases there may be vomiting, muscular twitchings, convulsions or abnormal behaviour varying from the very slightest disorientation to the most violent mania. In many of the severe subacute cases the temperature is normal for some days after the onset and then rises gradually to 104 or 105.

Many cases are remembered individually in whom the first sign was a change in behaviour. Some of these were already in hospital with some other condition, and the medical officer's attention would be drawn to them by the Sister saying that so and so "is strange in his manner." Examination then showed that so and so had a vacant expression, was somewhat disorientated and failed to answer any but the most simple questions. As a rule his further progress depended on how he was treated. If he was given immediate vigorous treatment for heat effects he recovered; otherwise he did not. In 1941 and 1942, 4 or 5 patients were sent for admission in the first place as mental patients.¹ Some of these were Indians whose behaviour was maniacal. The temperature of these patients might or might not be raised, but they were all suffering from subacute effects of heat.

In several instances the first obvious indication of trouble was the occurrence of a fit. In the first patient of this kind seen, the diagnosis was missed and the disease proceeded untreated to its logical conclusion—death. The lesson was learnt and subsequent cases were treated with more respect. In a few cases the symptom for which they were admitted was vomiting and, whether or not the trouble was originally due to heat, they quickly developed effects of heat.

(4) *The Short Fever Type of Case.*—Medical officers who have worked overseas are familiar with the patient who has a temperature for a few days and then recovers without giving any indication of the cause. It is the writer's contention that many of the cases of this type which he saw in Iraq were in fact mild effects of heat. The evidence in favour of this view is that they showed none of the features of sandfly fever (though patients with sandfly fever were seen), or of any other disease, and that the number admitted at any one time depended on the weather. There was no doubt at all that far more of these patients were admitted on the bad days than on the less hot days, and during the winter the number of them was small. On one occasion a unit medical officer told the writer that "the sandflies had been usually busy in his unit during the previous two days." It was true that the unit had had an abnormally large number of short fever cases but none of them looked like sandfly fever, and weather conditions during those two days had been particularly bad owing to an almost complete absence of wind. An additional argument is that as these short fever cases are rare in winter and common in summer the cause must be some factor which is present in summer and not in winter. Sandflies?—but most people would agree that the majority of these cases are not sandfly fever; mosquitoes?—they are not malaria or dengue; flies?—but flies in Iraq are much less numerous in the hottest part of the summer, when these cases are most numerous, than they are in the early and late summer. We are left with two possibilities: either the cases are due to some unknown disease carried by an insect or they are due to climatic changes, i.e. heat.

It would have been interesting to have seen the effect of placing a proportion of these patients straight into really cool rooms, but owing to the shortage of really cool rooms it was never possible to carry out a properly controlled test on these lines.

It should be emphasized that the writer is not suggesting that all short fever cases with no signs of any particular disease should be labelled effects of heat. He is merely contending that the majority of the short fever cases which he saw in Iraq in summer time were due to heat.

It is convenient at this point to consider what should be regarded as a normal individual's temperature in a very hot climate. The writer's conclusion is that the normal temperature of a patient in hospital is the same as it is in a temperate climate, i.e. well below 98.4°. As

¹ This was frequently noticed in India. It was pointed out by Major J. Bennett, in 1924, that such cases were occasionally sent for a psychiatric opinion. The editor has seen a few such.—Ed.

regards apparently healthy men doing their ordinary work it was found that Indians doing physical work had temperature of 98.4 or below, but that in Europeans doing sedentary work the temperature was quite often above 98.4 and might be as high as 99.6.

Nomenclature.—It is suggested that the term “acute heat stroke” be used only for those cases with hyperpyrexia; that the term “subacute effects of heat” be used as was suggested in Iraq for those cases showing a continued moderate fever or a short fever associated with other features due to heat; that the term “heat pyrexia” be coined and used to describe the short fever case without other features; and that the term “heat exhaustion” be used to indicate the case without fever where the main feature is dehydration and salt lack. Cases, however, often show a mixed character.

DIAGNOSIS.

Certain general points regarding the investigation of the cases seen must be made.

(1) All the febrile patients had blood slides examined for malaria parasites and usually this was repeated several times. All the severely ill afebrile patients also had blood slides examined. All the patients whose temperature lasted for more than four days had total and differential white counts, urine examinations, stool examinations and blood cultures. In the long continued fever, urine and stool cultures and agglutination tests were also carried out. Sometimes chests were X-rayed and lumbar punctures performed. In some cases quinine was given as a diagnostic measure, in spite of negative blood slides. There is no doubt that the investigation of the febrile patient was, as is usual in military hospitals overseas, very thorough.

(2) The diagnosis of the heat stroke cases was easy. None of the cases had palpable spleens and the blood slides were all negative. There seems no particular reason why a patient with any febrile disease, e.g. pneumonia, should not get heat stroke but in fact all the patients seen with hyperpyrexia proved to have no other disease besides heat stroke.

(3) Subacute Effects of Heat: This depended on the lack of indication of other disease shown by physical examination and investigations and the response to proper treatment. The cases of this type who died showed no sign of other disease at post-mortem. The exhausted dehydrated appearance combined with drowsiness or mental change of many of these patients was very characteristic. It is particularly important to realize that often the severe subacute cases have a normal temperature at the beginning of their illness and for some days afterwards.

(4) The diagnosis of the short fever case has already been discussed.

(5) Heat Exhaustion: The low blood-pressure, the low urinary output, the usually absent chlorides and the exhausted appearance present a characteristic picture.

In general, regarding the diagnosis of all types of case, it may be said that it is usually fairly easy to decide that a man is suffering from the effects of heat. Whether he is also suffering from some other disease may be doubtful for a time. Further observation and the effect of treatment will decide the matter.

PROGNOSIS.

During the three years there were about 24 deaths: 12 of them occurred in 1942 and of these a record has been retained. It is considered that some conclusions can be drawn from a consideration of these 12 cases.

(1) Six had hyperpyrexia at some stage in their illness.

(a) A British soldier, aged 44, was admitted one afternoon with a temperature of 103. He seemed no worse than many other patients of the same type but during the night he was suddenly found to be in coma with a temperature of 110 (rectal). His temperature was quickly brought down to 102, when cooling measures stopped, but it continued to fall until it reached 97. He died the next afternoon. He was an obese, flabby individual.

(b) A young Indian, exact age unknown, was admitted to an M.I. Room outside the hospital about 17.00 hours in a comatose condition with a temperature of 111. He had been alone in his tent since midday and was not well then, so that it is not known how long

he was unconscious before being discovered. He was treated for 1½ hours in the M.I. Room and then sent to hospital, the temperature having been brought down to 103. He died soon afterwards.

(c) A British soldier, aged 46, had had heat-stroke with hyperpyrexia in another hospital and was transferred a week or two later by which time temperature was nearly normal and he seemed reasonably fit. He spent two days in a hospital barge and arrived moribund.

(d) An obese ship's officer aged 45, who was said to drink too much, developed a temperature of 108 on board ship eight hours before he could be landed. His temperature was lowered on board but he died an hour or two after admission.

(e) An Indian, aged 29, developed hyperpyrexia after a short march and had to be treated for some hours in a place without proper facilities before he could be transferred to hospital. He died two hours after admission.

(f) A young British soldier, age unknown, developed hyperpyrexia on board ship and had to be treated in the ship's hospital for two days before being admitted to the shore hospital. He died twelve hours after admission.

The rest of these 12 cases were examples of "Subacute effects of heat" and with almost all of them there was delay, either before or after admission, in realizing the true nature and seriousness of the condition and there was consequently delay in starting proper treatment.

Examples are as follows:—

(a) A young British warrant officer was admitted to hospital with M.T. Malaria; he was diagnosed at once and treatment begun with quinine. His temperature came down quickly but when it had been normal for two or three days it was suddenly noticed one afternoon that his expression was vacant and he could not talk properly. He gradually got worse, the temperature rose to moderate heights, and the next day he had a fit and died. Recurrence of malaria was thought to be excluded by negative blood slides and the lack of effect from two intravenous injections of quinine. He had had two days' treatment with atebirin when the symptoms started but the early onset and the fatal result appeared to rule out atebirin intoxication.

(b) An almost identical case was seen in a young British soldier who had had an operation for piles two weeks previously.

(c) A British soldier, aged 25, was admitted because of vomiting. He had been travelling in a road convoy and had not been well for several days. He was moderately dehydrated, had a lowered blood-pressure and appeared hysterical. After two days in hospital a drip was started but he died soon afterwards. It was felt afterwards that the seriousness of his condition was not realized quickly enough.

From a consideration of these cases taken in conjunction with the many other more successful cases the writer considers that it is true to say that it should be the exception for a healthy young man who develops even the most severe forms of effects of heat to die provided he can be brought quickly to a place where he can be properly treated.

Certain other points in connexion with prognosis can be stated.

(1) Mental changes, whatever the temperature, constitute a most dangerous sign and demand vigorous treatment.

(2) Vomiting is a dangerous sign except in patients who are beginning to recover from heat stroke, and then, provided it only lasts a short time, it is a sign of improvement.

(3) Obesity and an age of more than 40 worsen the prognosis.

(4) A patient with heat stroke should never be regarded as past hope until he is dead. There is no other condition in which a patient can look so ill and yet recover.

(5) It may be more dangerous for a man to have severe subacute effects of heat than it is for him to have heat stroke. The reason for this is that heat stroke is an obvious emergency and receives vigorous immediate treatment whereas subacute effects of heat may not. Also the subacute case in the later stages is more resistant to treatment than acute heat stroke.

(6) A man who has had severe effects of heat must be very carefully treated for many weeks afterwards.

It is not possible to give useful figures regarding the length of stay in hospital of the cases in 1942 because most of the more serious ones were either transferred to other hospitals to

complete their convalescence or were evacuated out of the country. The average stay in hospital of the short fever type of case was 7.7 days. In 1943 the average stay was about one day longer.

TREATMENT.

A discussion on treatment can be conveniently divided into three sections: first antipyretic; secondly treatment directed towards the replacement of salt and water; and thirdly additional treatment.

(a) *Antipyretic Treatment.*—In a case of heat stroke, the first essential is to have a well planned "drill" with which everyone concerned is familiar so that treatment can be started without a moment's delay and not interrupted. If the heat-stroke centre is even two hundred yards from the reception room treatment should be started in the reception room and carried on in the ambulance which conveys the patient to the heat stroke centre. The cooling treatment adopted by the writer was to lay the patient naked on a bedstead or Indian charpoy covered with a blanket (not a mackintosh which collects water) under a ceiling fan. Table fans beside him created further draught and the whole skin surface was kept wet with ice-cold water. No additional cooling treatment, e.g. ice-cold enemata or swabbing the skin with ice, was employed because it seemed probable that the most effective cooling mechanism is the evaporation of cold water from the skin. The giving of an enema also has the very real disadvantage that after it has been given there is no accurate method of taking the temperature in an unconscious patient whose skin is wet. The rectal temperature was taken at intervals perhaps every five or ten minutes at first, every fifteen or twenty minutes later. Drastic cooling measures were stopped when the temperature had been lowered to a reasonable level. The exact level depended on the original temperature. Thus if the original temperature had been 110, treatment was stopped when it reached 104; if the original temperature had been 106 it was lowered to about 102. The danger of lowering the temperature too quickly appears to be a real one, and the writer saw one patient (whose case is described above) where death may have been due to this cause. After drastic cooling measures have been stopped the practice was to dry the patient, place a dry blanket underneath him and leave him on his bed either uncovered or with only a sheet over him. It is sometimes recommended that the patient should be wrapped in blankets in order to start him sweating. This was tried once or twice but the results were felt to be unsatisfactory, as the temperature usually rose again. This treatment was carried out in a heat-stroke centre—a room or building with artificial air cooling. In the centres used by the writer the temperature varied between 70° and 90°, depending on climatic conditions and the number of persons in the room. After perhaps ten hours in a case of moderate severity the patient may be expected to appear fairly normal except that he still has a moderate pyrexia, e.g. 103. It may be some weeks before the temperature is really normal, and during the whole of this time the man should if possible be kept in an air-cooled room.

Patients suffering from subacute effects of heat should be placed in a heat-stroke centre and cooled by sponging but the antipyretic treatment need not be so drastic. The effect on these patients is sometimes dramatic, the temperature which has perhaps been present for several days dropping at once, but if a patient goes back to his general ward too soon it goes up again. This was seen repeatedly, when patients had to be sent back to the ward too soon to make room in the heat-stroke centre.

The short fever cases could not as a rule be accommodated in the heat-stroke centre and their anti-pyretic treatment consisted of sponging twice a day. The heat-exhaustion patients with little or no fever improved markedly when placed in a cool ward.

(b) *Fluid and Salt Replacement.*—Extra salt was given to all patients who could swallow it without vomiting. After a certain amount of trial the method used was to give four grams three or four times a day in a glass of water. It was thought that this method was better than adding salt to all drinks because with the latter method some patients were discouraged from drinking, whereas when salt was given three or four times a day as a medicine,

and the urinary chlorides gradually became normal, the patients felt something had been achieved and their morale improved.

As much cold water and fruit juice as possible was given to patients who could swallow, and in any severe case intake and output charts were kept. No case, however mild, was discharged until his urinary chlorides were normal.

Short fever cases almost never required intravenous fluid, and only those heat-stroke cases who remained unable to swallow for more than a few hours were given intravenous drips. The majority of the subacute cases and the heat-exhaustion cases received intravenous saline drips. The decision to give a drip in any case depended on its severity, the blood-pressure, the urinary chlorides, the oral intake and the urinary output. A case treated in an ordinary ward was more likely to need a drip than one treated in the heat-stroke centre. The amount of fluid given by intravenous drip varied from 3 pints to about 20. It is said that it is easy to drown a patient by giving too much fluid. Only one case was seen in which it was clear that too much fluid was given; this man developed renal failure and it was not realized in time that his oliguria was due to this and not to continued dehydration. This patient died.

The fluid given was almost always 0.9 per cent saline with or without 5 per cent glucose. When much fluid has to be given it is probably wise, as has been recommended, to change the solution to one containing less salt.

(c) *Additional Treatment.*—(1) Oxygen: This was given to some 10 severe heat-stroke cases, with apparent improvement in two. In one of these in which there was cyanosis and convulsions the improvement was dramatic, the cyanosis disappearing at once and the convulsions soon afterwards.

(2) Quinine: 6 gr. of quinine were given intravenously to all heat-stroke cases. Although none of these ever showed any sign of malaria this practice is probably a good one.

(3) Lumbar Puncture: A number of diagnostic lumbar punctures were carried out. Neither in these nor in three cases in which it was performed as a method of treatment was any benefit apparent.

(4) Venesection: The writer has no experience of this in the treatment of heat effects.

(5) Exercise: It was considered important that all cases should be made to take a certain amount of exercise before being discharged. (Owing to local conditions almost all the mild cases were discharged to duty and not sent to convalescent depots.) Whenever possible the patients were given "set" walks to do, e.g. "twice round the main block." It was thought that the mild discipline involved and the fact that improvement was made more obvious had a good effect on morale.

SUMMARY AND CONCLUSIONS.

(1) A description is given of the investigation and treatment of effects of heat cases seen in two military hospitals during three summers in the plains of Iraq.

(2) The immediate and predisposing causes are discussed.

(3) The clinical features are described and the suggestion is made that effects of heat cases can be divided into four types, which might be named: acute heat stroke; subacute effects of heat; heat pyrexia; and heat exhaustion.

(4) It is suggested that many of the short fever cases seen in Iraq were due to heat.

(5) The importance of the subacute effects of heat case is stressed.

(6) Treatment is discussed under three headings: antipyretic; fluid and salt replacement; additional treatment.

In conclusion it may be said about effects of heat that the physician is called upon to treat few conditions in which immediate accurate diagnosis and early correct treatment are so likely to save lives.

I have pleasure in thanking my Commanding Officer, Colonel R. E. Rees, for permission to submit this article for publication.