An Address ON SLEEP AND SLEEPLESSNESS.

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(Abridged.)

If sleep has more often provided a theme for the poet than for the physiologist the reason is not far to seek, for it contains enough mystery yet to give play to roaming fancy. For most of us there is something so inevitably right in the nightly respite from mental activity that we do not pause to consider its meaning until perhaps one night its lulling charities fail us. Then we are brought face to face with problems still, many of them, awaiting solution. What do we know of sleep in terms of physiology? How far can that knowledge help us in the treatment of insomnia?

PHYSIOLOGY.

Actually the physiologists have not been idle; the fact that their conclusions on the whole have been of negative value is a fair measure of the difficulty and complexity of the problem. The essence of sleep is in the central nervous system, and consists of a complete cessation of conscious activity together with a greatly diminished capacity to react to environmental stimuli. With this are associated certain phenomena in the other bodily systems, and these, because they are more readily available for study, have chiefly engaged the physiologists' attention. The result has been a tendency to lose sight of the central fact, and to attempt to explain this in terms of the associated phenomena.

A theory of sleep which has obtained some credence is based upon the observation that in the sleeping state there is a fall of blood pressure and a diminution of the pulse rate. The suggestion is that at the end of the day the vaso-constrictor centre becomes fatigued. The systemic arterioles dilate, the blood pressure falls, the supply of arterial blood to the brain drops below the point necessary to maintain the activity of the cortical nerve cells, and sleep therefore supervenes. In support of this theory it has been adduced that in animals and in man pallor of the cerebral cortex may be observed at the onset of sleep, but there is so much conflicting evidence upon this point that it cannot be taken as a basis for argument.

Against the theory stand observations which show that in man the nocturnal fall of blood pressure and pulse rate occur independently of the sleeping state. Thus a man lying awake at night has a lower blood pressure than one asleep during the day.

There are, however, more serious objections to all theories of sleep based upon the idea of cerebral anaemia. It is true that cerebral anaemia, as from a severe haemorrhage, may lead to stupor, but is this directly comparable with sleep? I think not. A fundamental feature of true sleep is its restorative effect upon the higher mental faculties, an effect which is completely lacking in clinical experience of such anaemias; as, indeed, might be expected, seeing that the cerebral cortex is the most highly specialized of all tissues, and would naturally, therefore, require during the restorative sleep period a maximal rather than a minimal share of the cleansing stream.

The body temperature shows a diurnal rhythm similar to that of the blood pressure. In a person accustomed to nocturnal sleep it reaches its minimum at about 3 a.m., and this nocturnal fall persists even if the subject of investigation is awake and active. If he changes his habit and sleeps regularly by day instead of night, gradually the temperature curve is reversed, and at the end of about six weeks the reversal is complete, so that the fall is diurnal. If now the subject returns again to the habit of

nocturnal sleep, the temperature rhythm is gradually readjusted, taking about six weeks to regain the normal swing.

It appears, then, that the habit of going to sleep for a particular period of the twenty-four hours, if persisted in long enough, will initiate a corresponding periodicity or rhythm in certain bodily systems, and that this rhythm once established tends to persist on its own account independently of the sleeping state.

The diverse functions involved, and the tendency to persistence of the rhythm once established, make it extremely probable that these associated phenomena depend upon reflex centres established at a comparatively low level in the central nervous system. The effective stimulus to these centres is a combination of many conditions, of which sleep is the most important, the others being of the order of light, temperature, noise, and so on. Even in the absence of sleep, at first the other conditions are adequate to set the reflex in motion—just as, even in the absence of food, the ringing of the bell will cause a secretion of saliva in a dog accustomed by previous experience to bell and food in combination. The physiological changes which result doubtless have an effect in facilitating the regular onset of sleep for a fixed period of the twenty-four hours. The man who is transferred from day to night duty is at first still inclined to be wakeful by day and sleepy at his former bedtime.

The condition of sleep closely resembles those pathological conditions known to us as stupor or coma (according to their depth) caused by the cerebral anaemia resulting from compression of the brain, or by the action of various poisons upon the nerve cells (for example, uraemic and diabetic coma). There are, however, certain features which serve to distinguish natural sleep from pathological stupor:

1. The effect of sleep is restorative, in contrast with that of pathological stupor, from which the patient emerges in a dazed condition, with mental faculties dulled.
2. The onset of sleep is relatively rapid.
3. The awakening from sleep also is a rapid process as compared with the recovery from stupor.
4. There exists in the healthy person a remarkable ability to select by experience certain stimuli for which the threshold is relatively lowered so that they rapidly result in waking, whilst for other stimuli of equal or greater volume and intensity the threshold may be relatively raised. The most striking example in my own experience has been that of learning to sleep soundly in a shallow dug-out behind which an 18-pounder field gun was firing at frequent but irregular intervals, whilst, on the other hand, the shriek of an approaching shell at dangerous proximity would bring me in an instant to the full possession of my faculties.

Of the commoner and more homely examples one may take the ability gradually acquired by the child to respond to the stimulus of a full bladder, or that of the mother waking on the instant to her infant's cry. Such habits of conditioned awakening may be gained or lost after quite brief experience. Thus it is easy enough for some persons, and in some circumstances, to make the sound of the alarm clock a condition for a hasty leap out of bed; while for others, or in other circumstances, the same stimulus after a moment's waking may act as a profound soporific.

Less striking, but very important, as I shall hope to show in dealing with insomnia, are the conditioned stimuli which may be used to induce the sleeping state.

THE NATURE OF SLEEP.

From these observations I believe we may draw some conclusions as to the nature of sleep. The rapid onset and rapid awakening, and especially the capacity to graft conditioned stimuli upon the acts of sleeping and waking, suggest a reflex mechanism. The notion of a reflex centre presiding over sleep has been long entertained by physiologists.

A reflex centre implies an afferent and an efferent pathway with a receptor mechanism at the one end and effector at the other. The effector mechanism in this case must be one of inhibition. Inhibition of what? Certainly inhibition of the function of conscious mental activity, and therefore of cortical activity. It appears likely that this inhibition

is achieved by a blocking of the pathways along which afferent impulses are normally streaming to excite the cortical cells. Such inhibition of afferent impulses at a stage lower than consciousness is, of course, well known. The simplest instance, perhaps, is that of the child with congenital strabismus who has learned to use either eye alternately but is incapable of binocular fusion. Given an apparatus by which the image of a bird is thrown upon one retina and that of a cage upon the other in such a way that the normal person sees the bird in the cage, the alternator sees *either* bird *or* cage—never both together; the reception of one image reflexly inhibits that of the other. In some such way we may suppose that the sleep centre, under adequate stimulation, cuts off afferent impulses from the cortical cells until they, from lack of stimuli, become inactive—inactive, that is, so far as the anabolic phase is concerned; during sleep, we have good reason to suppose, the phase of anabolism leads to restoration of their functions.

Such a conception of sleep as due to a cutting off of the cortical cells from stimuli is not only in accord with the rapidity of onset and awakening and the restorative effect of the sleeping state, but provides an explanation for the difference between sleep and stupor.

The resemblance between these two conditions is due to the cessation in both of cortical (conscious) activity. In stupor this is due to a direct effect upon the cortical cells, whose function is impaired owing to lack of oxygen or the action of poisons. There is, therefore, not only loss of consciousness but loss of potential consciousness. In sleep, on the other hand, the cortical cells are only inactive because they are protected from stimulation; consciousness is lost but potential consciousness is unimpaired. This difference has an important bearing upon the use of narcotics.

So far we have been considering only the efferent side of the postulated reflex arc. On the afferent side the adequate stimulus is probably a fatigued state of the cortical cells themselves, which is usually associated with a sense of weariness and the desire for sleep. This leads normally to a series of voluntary actions directed to the elimination of external or internal stimuli. Of these actions the most important is the assumption of the resting posture in which the muscles are relaxed and proprioceptive stimuli from them and from the joints are reduced to a minimum. Other measures, such as withdrawal from light and noise, are of secondary importance, but may acquire an additional value as conditioned stimuli. In fact, a great variety of conditioned stimuli may be developed which in proper sequence and combination facilitate the sleeping reflex. On the other hand, the association with the pre-sleep period of unwonted stimuli may serve to prevent the development of the reflex.

As to the localization of this hypothetical sleep centre, it has been suggested that it lies either in the walls or floor of the third ventricle or lower down in relation to the Sylvian aqueduct. The evidence adduced is the frequent association of pathological drowsiness with lesions in this neighbourhood.

A CLASSIFICATION OF INSOMNIA.

As a provisional classification of the insomnias I would suggest the following:

A. Insomnia due to Disease directly involving the Sleep Centre: The classical example is in certain cases of encephalitis lethargica.

B. Insomnia due to Overexcitability of the Cortical Nerve Cells as the Result of Intoxication or Anaemia.—This is seen in the course of many infections, in the preliminary stages of uraemia, lead poisoning, etc., and in minor degrees of cerebral compression, as from cerebral oedema after a head injury.

C. Insomnia resulting from the Presence of Unwonted Stimuli which Inhibit the Sleep Reflex.—This is the largest and most important group. There is a variety of stimuli which are able to withstand the reflex inhibition upon which sleep depends, to break through this barrier to the cortical cells, and to excite these to activity. Their power to achieve this depends (1) upon their intensity, (2) upon the degree to which the sleep reflex has been rendered prepotent, either by cortical fatigue or the strengthening effect of conditioned stimuli. The most familiar causes of this group are:

1. **Muscular Posture and Tension.**—It is impossible to sleep and remain sleeping in the standing posture. Even at the end of 115 hours' continuous insomnia, when the desire for sleep was imperative, Kleitman and his co-workers found that the onset of sleep could be prevented by moving about.

2. **Pain** (including discomfort, as, for instance, from irritation of the skin or extremes of temperature).

3. **Emotional Excitement.**—At this point it becomes extremely difficult to pursue my argument in physiological terms. We must recognize, however, that an emotion, whatever its physiological origin, is a potent stimulus to conscious activity, and chief among the emotions in this respect is fear.

THE TREATMENT OF INSOMNIA.

Drugs.

The essential feature of the sleeping state is inactivity of the cortical cells concerned with conscious activity. This is also the essential feature of toxic stupor. According to our theory, however, the distinction between the two states is that in sleep the cortical cells are inactive because they are shut off from afferent stimuli: in stupor their activity is abolished by the direct action upon them by a toxin. This bears an important relation to the use of narcotic drugs, whose action is also directly upon the cortical cells, and is, of course, toxic. It is possible with the aid of narcotics to induce stupor by paralysis of the cortex without endangering life, because the vital reflex centres are relatively immune to their action. It is possible thus to induce the semblance of sleep even against heavy odds in the shape of discomfort and anxiety.

But this is not the real thing: the restorative effect is lacking; and the patient therefore does not wake properly refreshed. You will remember in this connexion Othello's sleepless night after the seeds of suspicion had been planted in his mind, and Iago's greeting:

"Not poppy, nor mandragora,
Nor all the drowsy syrups of the world,
Shall ever medicine thee to that sweet sleep
Which thou ow'dst yesterday."—*Othello*, Act iii, Sc. 3.

No one, however, would deny that narcotics are of the greatest value in the treatment of insomnia. And this for two reasons: First, the toxic effect of insomnia upon the cortical nerve cells may be more severe than that produced by the drug. It is a well known fact that insomnia may lead to depression of the higher mental faculties, and eventually to coma and death. In the second place, small doses of narcotics often facilitate the onset of true sleep. I do not propose to go into detail of drugs and their doses. Bromide alone, or in combination with chloral; paraldehyde for a quick action; sulphonal for delayed effect; medinal as a useful all-round narcotic; the coal-tar analgesics and opium for pain or discomfort, comprise the therapeutic stock-in-trade.

Habit Formation.

Of the value of conditioned stimuli in facilitating sleep I have already spoken. Most of us have acquired a ritual of some kind—perhaps unconsciously—which stands us in good stead when sleep is threatened; it includes the whole business of undressing and getting into bed; the habit of reading in bed is often a part of it. For this reason I think that an invalid, whenever it is practicable, should sit up in a chair just before bedtime while his bed is made, so that he may not altogether miss the experience of going to bed.

Unfortunately, when sleeplessness has persisted for any length of time the old rituals lose their value, and may even facilitate insomnia. Then is the time to initiate new rites, beginning by moving the patient, if not into another house, at any rate into a fresh bedroom. The ritual may consist of some such sequence as the following: a warm bath, into bed, a cup of warm milk or an equivalent, then a solemn plugging of the ears with cotton-wool, perhaps five minutes' reading by the bedside lamp, and then lights out. The sleeping draught, if any is prescribed, may be taken before or with the warm drink. As a finishing touch, I recommend the repetition by heart of some soporific verse. Keats's Ode to Sleep, in my experience, is unsurpassable in this respect. Such a ritual must be persevered in if it is to be efficacious.

Muscular Relaxation.

Sleep, as we have already observed, is incompatible with any great degree of muscular tension, and there are some individuals who are kept awake largely by their inability to relax their muscles. The tendency for the sleepless person being to toss and turn, it is important that he should learn that this in itself is fatal to sleep, and that the wisest plan is to lie perfectly still. Even though this may demand a certain amount of effort and self-control, it will often induce sleep.

The efficacy of this principle in treatment has been shown to me most clearly in certain cases of encephalitis lethargica in children, where motor restlessness has been the most prominent symptom of the insomnia. After the preliminary rites of warm bath, sleeping draught, and ear plugging, the child is tightly rolled in a long sheet which is fastened with safety-pins, the arms being included so that he is immobilized. The results in some cases have been striking—for instance, a sleep of nine hours with the pack, as compared with a maximum of four and a half hours when the other measures alone were employed.

Beyond this, there is an art in muscular relaxation, as anyone may prove by attempting to allow one of his limbs to be absolutely passive in the hands of another person. It is an art which patients can be taught to acquire limb by limb until they can themselves practise complete bodily relaxation. The soporific effect of this exercise is sometimes of great value; it may be taught by an instructed masseuse, and may be usefully included among the final stages of the bedtime ritual.

Details of Treatment.

The insomnia due to disease of the sleep centre, such as I believe occurs in encephalitis lethargica, is, in my experience, the most difficult of all to treat. In many cases, as the normal sleep time comes round, the cortex appears to pass into a condition of great overexcitement, and this occurs night after night for many weeks with the greatest regularity. It is tempting to believe that in these cases reflex inhibition has been converted by the disease into reflex excitation, and that the cortical cells are thus being abnormally bombarded with afferent stimuli. A combination of drugs and ritual, if persisted in for a long time, sometimes appears to be effective, and immobilization, as already described, is valuable in patients with great motor restlessness. But these cases are, on the whole, disappointing.

The toxic and infective group of insomnias should be treated on the same lines. Here the direct effect of the toxins upon the cortex is, as a rule, reinforced by sources of pain and discomfort. Opium therefore is the most useful drug, and, in cases which are likely to be of short duration, may be used freely. In the chronic cases small doses of medinal combined with aspirin are useful. It is in dealing with this group of cases, however, that it is most important to remember the poisonous nature of the narcotic drugs. The ritual therefore should be made use of as far as possible, and the dose of drugs kept low.

The third group of insomnias—that in which sleep is prevented by unwonted stimuli—offers most scope for treatment. Pain and discomfort must be treated by local measures, and, if necessary, with drugs—*aspirin* or *opium*. The treatment of muscular tension as a factor in insomnia has already been discussed.

We have finally to deal with emotional disturbance. The emotions which have most power to disturb sleep are naturally those which are painful. Paramount are fear and anxiety. We may further distinguish between the open and hidden emotion.

A. An emotion which is present to the waking mind—a declared worry with all its associated memories hinders the onset of sleep.

B. An emotion which has in the waking state been prevented from exciting conscious activity (that is, in the psychological sense, a repressed emotion) may cause insomnia in either or both of the following ways:

(1) Either the subject finds himself thinking furiously upon some indifferent subject in order to prevent the repressed worry from reaching consciousness, and so is unable to go to sleep; or

(2) He may go to sleep, but is awakened by the repressed emotion forcing its way into consciousness, often in the shape of a dream or nightmare.

The distinction between these two forms of worry—the superficial and the deep—seems to have been present in the mind of Keats when he wrote in his *Ode to Sleep*:

"Then save me, or the passed day will shine
Upon my pillow, breeding many woes;
Save me from curious conscience, that still lords
Its strength, for darkness burrowing like a mole."

In the latter type of case, in which insomnia is due to repressed anxiety, much can be done by means of judicious analysis and psychotherapy. Free ventilation and frank discussion of the underlying emotional conflicts is the essence of successful treatment.

The open worry, as a rule, is short-lived and resolves itself. Being of an occasional nature it may be justifiably treated with drugs. A whisky and soda at bedtime is often sufficient. It is most important, however, that sleeplessness of emotional origin should be taken in hand early, for the habit of insomnia is readily acquired, and we are then apt to encounter as a perpetuating cause of sleeplessness the anxiety about sleep. The patient goes to bed with the fear that he will not sleep, and this fear, gathering around it thoughts of the morrow's duties, successfully inhibits the sleep reflex and excites cortical activity. This fear must be treated from the start with absolute reassurance. As a cause of unpleasant symptoms the importance of insomnia must be minimized in the patient's sight. Finally, in a case in which this particular anxiety appears to be mainly responsible for the trouble, the patient may be given an effective draught—a drachm and a half of paraldehyde or $7\frac{1}{2}$ grains of medinal, with the assurance that he will have a good night's sleep. If this follows, the same draught or cachet should be placed by his bedside on subsequent nights, with instructions that he should take it, *without hesitation*, if he is unable to sleep. If the case has been judged correctly this line of treatment succeeds. The presence of the drug by the bedside in itself allays the anxiety, and the patient sleeps soundly without taking it. After a few nights of this kind he ceases to bother about the drug, and as far as his insomnia is concerned may be considered cured.

In the treatment of the emotional insomnias bedtime ritual and muscular relaxation are both of value; the former may also be made a vehicle for reassurance; the latter is most useful in those individuals whose anxiety reflects itself in muscular tension. But the narcotic drugs are also essential in the majority of cases. That they should be at the same time more beneficial and more permissible in this than in other types of insomnia is intelligible in the light of our theory. Here we have the sleep reflex prevented by stimuli arising within the nervous system at a high level of cerebral integration. The cells in which these stimuli arise are therefore themselves susceptible to narcotic drugs in much the same degree as those cells which we have supposed to be concerned with consciousness.

Drugs may therefore be given regularly, at first in sufficient doses to ensure sleep, while at the same time the other therapeutic measures of psychotherapy, habit formation, and relaxation are employed with the object of re-establishing the natural rhythm. After the patient has had a succession of four or five good nights the dose is gradually reduced, the other measures, of course, being continued. In employing this method of treatment we are liable to encounter one of two difficulties—the patient is liable, on the one hand, to develop anxiety lest he become a drug habitué, or, on the other hand, when he finds that his dose is diminished, he may be kept awake by the renewed fear that to-night he will not sleep. This difficulty may be met by explaining to the patient from the first the rationale of the treatment and telling him that the dose will be reduced without his knowledge. This is easily done if the medinal is given in cachets. The size of the cachet and the amount of its contents are kept constant by replacing the medinal subtracted by sodium bicarbonate. The patient may thus be allowed to go on taking the cachets until he can be told he has now been sleeping soundly on nothing but sodium bicarbonate for several days. Or the cachet may be incorporated as a part of the bedtime ritual for some time longer before the disillusionment is completed.