effluent by passive ducting to the atmosphere or ventilation ducting but concern was felt about the potential resistance, bulk and vulnerability of long tubing and the possibility of back pressure generated by high wind velocities.

Active scavenging appeared to have greater general potential and in some areas appeared a necessity. An experimental prototype injector scavenging system (British Oxygen Company Ltd) was tested with a Magill breathing system, fitted with the BOC collector valve and a corrugated exhaust tube hanging down to the floor. The breathing system was supplied with 1% halothane in a 10 l/min fresh gas flow and respiration was simulated. The entrainment tube was inserted up the dependent corrugated tube as far as the collector valve, the corrugated tube thus acting as an open-ended reservoir. Entrainment was at 20 l/min for an injector oxygen supply of 6 l/min. Turning on the injector after 30 minutes reduced pollution markedly (Fig 5), but not completely because the reservoir was too small.

A later experimental prototype used a storage bag incorporating a two-way valve to prevent over-distension or collapse, and an injector consuming 2 l/min of oxygen, but in clinical use the anæsthetist was distracted by concern over the proper functioning of the storage bag. A large rigid open-ended reservoir is now under consideration.

It would probably be prudent to collect and remove anæsthetic effluent and the method preferred may depend on local circumstances. Passive ducting may be acceptable but in pædiatric and dental chair anæsthesia active scavenging may be necessary. It is doubtful whether 'do it yourself' systems (Best 1971, Pitt 1972, Boyd 1972) will prevail, but a generally acceptable British system has yet to appear on the market.

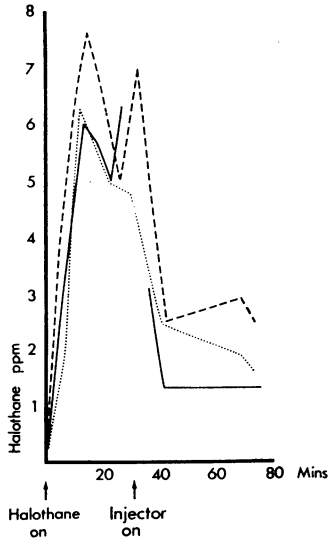

Fig 5 *Halothane pollution measured at three representative sampling points in an operating theatre, before and after turning on a prototype injector scavenging system*

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Measuring the Effects of Environment upon Performance

I know very little about anæsthetics, but my experience of measuring performance in other fields of stress may be of help in indicating some techniques by which one could reasonably hope to achieve the following aims in relation to anæsthesia: (1) To assess the level of anæsthetic vapour which could impair efficiency in the surgical operating theatre. (2) To indicate how many hours or days must pass before those who have undergone anæsthesia can be considered capable of resuming normal life with faculties unimpaired.

Anæsthesia impairs our ability to be aroused by both exogenous and endogenous stimulation. So does sleep. Loss of sleep, by mechanisms of which we are still remarkably ignorant, biases the body towards this state so that, even though there may be a need to remain awake, the body may periodically or even more continuously be 'less awake' than it would be normally. We find this state of reduced waking arousal difficult to characterize or measure physiologically, but we can detect its presence by suitable performance tests. The nature of these tests has been determined and their sensitivity refined by a series of laboratory studies of sleep deprivation, the last of which I shall describe briefly below. What I propose, simply, is that if these procedures can reflect moderate degrees of sleep reduction it is reasonable to hope that they may do the same for

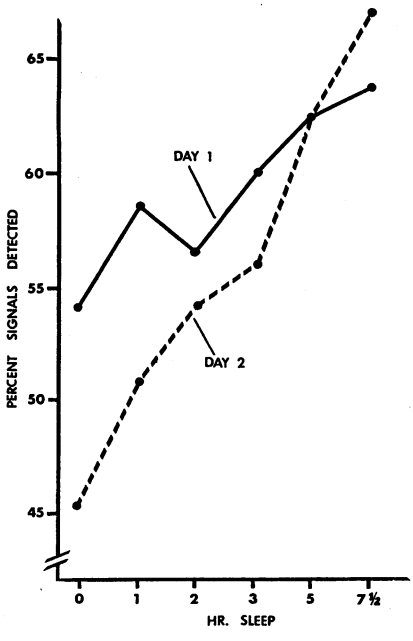

Fig 1 *Percentage of signals detected in the vigilance task as a function of hours of sleep taken on one night (Day 1) and on two successive nights (Day 2)*

moderate levels of anæsthetic poisoning which may be beyond the range of present methods of physiological detection. The practical implications are obvious.

In our research over the last fifteen years we have gained some insight into the factors which characterize an activity which will be vulnerable to loss of sleep (Wilkinson 1965). It will not, as might have been expected, be one of the higher intellectual functions, like complex, rapid decision-taking in an executive post, or like playing chess, but rather a task which is repetitive, prolonged, and relatively lacking in incentive. A few years ago we developed two tasks which represent a distillation of these features and used them to assess, not total loss of sleep, but merely reduced sleep of an order that is quite usual in everyday life and work. This experiment has been described previously (Wilkinson 1969).

Young men were tested for about 14 hours a day, with appropriate breaks for meals and so on, two days a week for 6 weeks. Each week the sleep of each man was reduced voluntarily to either 0, 1, 2, 3, 5, or 7½ (normal) hours on both nights preceding the two successive days of experimental work. For much of the work days the men alternated two one-hour tasks, one of vigilance and the other of routine addition. Figs 1 and 2 show how performance on these tasks was impaired by reduced sleep after one (Day 1) and two (Day 2) nights on the particular sleep ration. Significant decrement in efficiency ($P < 0.05$) occurred with 2 hours' sleep or less on one night and with 5 hours or less on two successive nights.

What were these tasks which proved so sensitive? The vigilance presented the man with short tones every 2 seconds buried in background noise. Very occasionally and unpredictably one of these tones was slightly shorter than usual. These signals were to be detected and reported by pressing a key. The second task was one of routine addition, comprising a book with pages of sums. In each sum five 2-digit numbers had to be totalled and the answer inserted in the usual way.

Of these two tests the addition is the least dependent upon apparatus, but the vigilance is the more rewarding in terms of the information it provides regarding behaviour. By the use of suitable mathematical procedures, falling under the head of theory of signal detection (Tanner & Birdsall 1961) it is possible to extract two independent parameters, one which reflects the man's ability to discriminate obscure and occasional events and the other his criterion for deciding just how clear a signal has to be before he will report it. The latter index may be closely linked to his level of motivation or application.

The sensitivity of these two tests has led to requests for them from people working both on sleep and on environmental stress generally. As a result we have had to prepare them and make them available as standardized tests. This means that the materials are readily available (a set of 13 prerecorded tapes in the case of vigilance, 39-page printed books in the case of the addition),

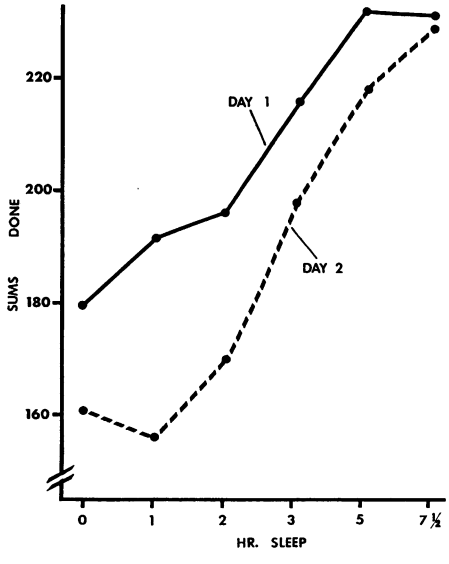

Fig 2 *Number of sums completed in the addition task. Details as for Fig 1*

and so are detailed instructions on how to administer the tests, score, and analyse them. More details have been given elsewhere (Wilkinson 1970), or can be obtained from the author on request.

I give some examples of experiments in which these tests have been employed by various laboratories. In studies of sleep, particularly in the USA, they have been used to assess the effects of disturbed sleep due to noise (Herbert & Wilkinson 1974), heat, and occasional awakenings (Herbert in preparation), and sleeping at unusual times of day or night (Taub & Berger 1973). A particularly interesting development is their employment to detect incipient hypersomnia, a state more prevalent than is commonly supposed (Phillips *et al.* 1973). Apart from sleep, other 'stresses' which have been examined include clinical doses of tranquillizer, barbiturate (Bye *et al.* 1974), and excitatory drugs (Bye *et al.* 1973), warm climate (McCance *et al.* 1971), nutrition (Crowdy & Wilkinson in preparation), and vibration (Wilkinson & Gray 1974).

A disadvantage of the procedures I have described is that they need time if they are to be effective, though probably not as long as the 14 hours a day used in the study I have described. At least 4 separate hours of testing on each task, including the necessary preliminary practice, are recommended. Currently we are attempting to develop more convenient ways of assessing states of lowered arousal due to environmental stresses. One method is to use the present tests to validate shorter and more subtle procedures, if they can be found. Second, by defining periods of lowered arousal by behavioural criteria the present tests make it possible to intensify the search for the physiological concomitants of this state, which if found could perhaps more easily be used as indicators of drowsiness in operational situations.

But these are good intentions. What have been achieved and are currently available are two procedures which, crude though they may be, can be applied in many situations. We of the Medical Research Council who are concerned, among other things, with the study of behaviour in relation to medicine, are available to advise upon all aspects of administering these performance tests if it is felt that they may have a contribution to make towards determining dangerous levels either of anæsthetic vapours in the operating theatre or of postoperative anæsthetic traces in patients.

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