AWARENESS DURING SURGERY—A NEW APPROACH

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SUMMARY

With modern light anaesthesia the problem of awareness during surgery has defied analysis, because no physical sign reliably signals the conscious level. A test has been developed which entails direct communication with the patient at the end of surgery, noting the earliest moment after withdrawal of nitrous oxide at which he makes the appropriate response to a verbal request, the “time to correct response” (TCR). This test showed premedication with lorazepam 4 mg/70 kg to be significantly better than morphine 10 mg for ensuring unconsciousness when the main anaesthetic agent was nitrous oxide, in two groups of patients undergoing abdominal surgery ($P < 0.01$). All patients who had lorazepam were able, on request, to hold up the head a few minutes after surgery. Thus the benefits of light anaesthesia were retained whilst ensuring unconsciousness.

The virtues of opiates as a supplement to nitrous oxide are well known, but problems remain. Unpleasant recall of surgery occasionally happens with low dose regimes (Blacher, 1975; Wilson, Vaughan and Stephen, 1975), whilst greater doses sometimes lead to potentially lethal depression of breathing after surgery (Adams and Pybus, 1978). Both problems continue to be reported, verbally and in print, with all opiates including fentanyl. No infallible way of tailoring the dose to the individual has been devised and a Lancet editorial (1973) concluded: “Assessing the level of consciousness in a paralysed patient is a matter in which even the most experienced may occasionally be deceived.” The beginner may be sorely tried.

It seemed worth testing lorazepam because, unlike morphine, it is an effective hypnotic in doses which do not depress breathing. The patient is drowsy but rousable. He is already part of the way towards sleep, so that adding nitrous oxide might render even the resistant patient unconscious. In a previous study (Cormack, Milledge and Harming, 1977) we compared the respiratory effects of lorazepam and morphine, whilst the present study compares the same drugs in their effects on consciousness, using a new test presented recently to the Anaesthetic Research Society (Cormack, 1978).

PATIENTS AND METHODS

Two groups of fit adults were studied in 10 pairs roughly matched for age, sex and type of operation (usually hysterectomy).

<table>
<thead>
<tr>
<th>Average doses and other details of the two groups</th>
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<tr>
<td>Bristol method</td>
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<td>Mean age (yr)</td>
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<td>Mean wt. (kg)</td>
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<td>Premedication</td>
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<td>Myoneural blocker</td>
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<td>$P_{aCO_2}$ (kPa)</td>
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The TCR test has been used in more than 500 patients and a detailed analysis is in preparation. In essence, after antagonizing the relaxant, nitrous oxide is turned off and the lungs ventilated with oxygen at the same minute volume as before. The patient is asked to open his mouth. If there is no response laryngoscopy and suction are carried out. This is repeated at 0.25-min intervals until the appropriate response is obtained.
RESULTS
After morphine the mean TCR was 0.8 min, whereas after lorazepam it was 1.9 min (fig. 1), this difference being significant at the 1% level by either parametric (paired $t$) or non-parametric (Wilcoxon) tests. Consciousness returned more abruptly in the morphine group and typically the patient was unrousable one moment, but alert and co-operative 15 s later. After lorazepam the transition was more gradual and even after full co-operation was obtained some drowsiness remained.

The brain nitrous oxide concentration cannot have changed appreciably in less than 15 s, allowing for mixing and circulation time, therefore responses in this period indicate awareness under anaesthesia. By this criterion three in the morphine group were awake, although none had any recall of this. Even the final laryngoscopy was not remembered, the first event recalled being the oxygen mask put on in the recovery ward. In the lorazepam group none was awake under nitrous oxide and amnesia persisted for some hours after operation.

The lorazepam findings have since been confirmed in more than 100 patients, the mean TCR being 1.8 min for operations lasting up to 3 h. However, in 10 patients having longer operations, of 3–8 h, the TCR was significantly shorter. Thus long operations may require a topping up dose of lorazepam, and this is being studied.

DISCUSSION
Choice of criterion. The unreliability of physical signs as a guide to the level of consciousness is becoming increasingly clear. Not only may florid signs occur in deeply unconscious patients, but the opposite is also true. It seems we are left with direct communication as the only meaningful test. If the patient makes the appropriate response to a verbal request, that is unlikely to be a reflex; it argues a degree of consciousness, however attenuated it may be.

There is nothing new about this approach. From John Snow onwards it has been used by many of the pioneers. The only new feature of the TCR test is timing the moment of waking. In effect this gives an index of the amount by which the nitrous oxide concentration must be reduced before consciousness can return. Thus it is quantitative, and the importance of this is explained below. Awareness without recall is also not a new finding and has often been reported with relaxant techniques. Its frequency can be estimated by the TCR test.

Design of the experiment. Much thought was given to the problem of making the trial double-blind. In the end this did not seem essential, because sedation and pain were not being measured, only an objective sign. If asked to open his mouth the patient either complies, or not, and there is little scope for observer bias. The experiment, as described, can be verified by any anaesthetist in his routine work.

The longer waking time after lorazepam cannot have been the result of differences in the dose of thiopentone, or morphine supplement, because both were deliberately reduced in the lorazepam group. The morphine supplement was given as a single dose before surgery started, therefore its blood concentration would be least at the end, which applies also to the premedicant and thiopentone. It follows that if the patient was unrousable at the end, even with strong stimulation, the likelihood of his being awake before this is remote.

Awareness. The merits of the Bristol method are well established. Serious respiratory depression does not occur and naloxone is not used because the morphine dose is restricted to a value similar to that which has proved safe, over 50 years, in the wards. However, in the last 1000 cases anaesthetized by the author, unpleasant recall has occurred twice. Technical error was excluded and the patients appeared truthful. To react by increasing the dose of opiate would reduce safety after operation without necessarily solving the problem. Even a three-fold larger dose, with increments given in response to physical signs, did not always prevent unpleasant recall of surgery (Holmes, 1976).
However, a hypnotic premedication has greatly reduced the likelihood of awareness, despite a smaller dose of morphine. This conclusion was by no means obvious from the physical signs, such as reflex movement, but clear-cut from the TCR test. Moreover, the difference was apparent from quite a small sample, which illustrates the main purpose of the technique. By providing a quantitative, if approximate, estimate of the level of consciousness in each patient the TCR test greatly increases the sensitivity of comparisons between anaesthetics. Without such a test the statistical problems are daunting. Unpleasant recall is rare with all established methods, so with this yard-stick there is no alternative to large samples. For example, to improve on his previous results with the Bristol method (2 failures/1000) the author would have to show zero frequency in at least 5000 patients to be statistically convincing (by Fisher’s exact test). Hence the slow pace of research in this field over the past two decades. In contrast, the TCR test makes it possible to conclude, from a small sample, that if unpleasant recall is uncommon with the Bristol method it must be rare almost to the point of exclusion with the lorazepam version.

To find the exact frequency, if any, of awareness with a new technique still requires a large sample. However, even if a large sample showed the occasional highly resistant patient to be awake under the combination of nitrous oxide and lorazepam, then unpleasant recall remains improbable because of the potent and prolonged amnesic action of this drug.

Amnesia. Some anaesthetists have hesitated to use lorazepam, precisely because of its amnesic effect. All our patients might be awake and, if recall of surgery were the sole guide, we would never find out. The TCR test allays these fears and shows the reality to be quite the opposite. It shows that a standard anaesthetic, which has given good results for decades, quite often creates an amnesic state rather than complete insensibility, but if the same technique is used after the standard premedication has been replaced with lorazepam the amnesic state may be converted to full unconsciousness.

Furthermore, with the lorazepam method the patient is awake before leaving the anaesthetist. It thus provides a compromise between the main opposing doctrines. On the one hand, the Bristol, Liverpool and related methods give very fast waking, but unpleasant recall occasionally happens. On the other hand, some have favoured a step back towards deeper anaesthesia by, for example, adding 0.5% halothane continuously to 70% nitrous oxide. This probably reduces the frequency of unpleasant recall—although this is far from certain (Moir, 1976)—but the patient is often unconscious for more than 20 min on leaving the anaesthetist. Lorazepam avoids both disadvantages.

The unique properties of nitrous oxide (Eger, 1974; Barth and Büchel, 1975) should make it the cornerstone of modern anaesthesia, but its popularity has suffered from its occasional failure adequately to anaesthetize the resistant patient and many, understandably, are given deeper anaesthesia than is in their best interests. Thus a supplement which made nitrous oxide, not just thoroughly safe, but also thoroughly reliable, would be welcome. For this role lorazepam is surely a strong contender, for this and other reasons (Cormack, 1979; Dundee et al., 1979).

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REFERENCES
RESUME
Avec l'anesthésie légère moderne, le problème de la connaissance pendant une intervention chirurgicale a défie l'analyse, parce qu'aucun signe physique ne signale d'une manière fiable le niveau de l'état de conscience. On a mis au point un test, qui met en cause la communication directe avec le patient à la fin de l'intervention, en prenant note du premier moment auquel celui-ci fait une réponse appropriée à une question verbale, après le retrait du protoxyde d'azote; on a dénommé ce test TCR (time to correct response, soit: temps nécessaire pour obtenir une réponse correcte). Ce test a fait ressortir que la prémédication à l'aide de lorazépam (4 mg/70 kg) était nettement meilleure que la morphine (10 mg) pour s'assurer de la perte de conscience, lorsque le principal agent anesthésiant était le protoxyde d'azote et lorsqu'on l'a appliqué à deux groupes de malades subissant une intervention à l'abdomen (P < 0,01). Tous les malades auxquels on avait administré du lorazépam ont été en mesure de soulever leur tête quelques minutes après l'intervention et lorsqu'on le leur a demandé. On a donc conservé tous les avantages d'une anesthésie légère, tout en étant assuré d'un manque de connaissance.

WAHRNEHMUNGSFÄHIGKEIT BEI OPERATIONEN—EINE NEUE AUFFASSUNG

ZUSAMMENFASSUNG
Bei moderner Leichtnarkose war das Problem der Wahrnehmungsfähigkeit während der Operation nicht zu analysieren, weil sie durch keine verlässlichen physischen Signale angezeigt wurde. Nun wurde ein Test entwickelt, bei dem es zu direkter Kommunikation mit dem Patienten am Ende der Operation kommt, wobei der früheste Augenblick nach Entzug von Stickoxyd festgehalten wird, zu dem der Patient die entsprechende Reaktion auf eine gesprochene Anweisung zeigt—die “Zeit bis zur korrekten Reaktion” (TCR). Dieser Test ergab einen eindeutigen Vorteil von Vorbehandlung mit 4 mg/70 kg Lorazepam gegenüber 10 mg Morphium, was die Sicherung der fortdauernden Bewusstlosigkeit bei Stickoxyd als Hauptnarkosmittelt betrifft; der Test wurde an zwei Gruppen von Patienten mit Unterleibseingriffen (P < 0,001) durchgeführt. Alle Patienten waren mit Lorazepam in der Lage, auf Aufforderung den Kopf einige Minuten lang hochzuhalten—schon wenige Minuten nach der Operation. So waren die Vorteile einer leichten Narkose beibehalten, und gleichzeitig Bewusstlosigkeit sichergestellt.

CONOCIMIENTO DURANTE INTERVENCIONES QUIRURGICAS—UN NUEVO ENFOQUE

SUMARIO
Con la anestesia ligera moderna, el problema del conocimiento durante las intervenciones quirúrgicas desafió el análisis, puesto que ninguna señal física indica de manera confiable el nivel del conocimiento. Se desarrolló una prueba que incluye la comunicación directa con el paciente al final de la intervención, observándose después de la remoción del óxido nítrico el primer momento en que responde de manera adecuada a una pregunta verbal, el “momento de respuesta correcta” (MRC). Esta prueba demostró que la premedicación con 4 mg/70 kg de lorazepam da mejores resultados que los obtenidos con 10 mg de morfina, para asegurar la pérdida de conocimiento, cuando se usa el óxido nítrico como agente anestésico principal en dos grupos de pacientes sometidos a cirugía abdominal (P < 0,01). Todos los pacientes a quienes se administró lorazepam pudieron, cuando solicitados, levantar la cabeza unos minutos después de la operación. Entonces, se mantuvieron las ventajas de una anestesia ligera toda vez que se aseguraba la pérdida de conocimiento.