NITROUS OXIDE-CURARE ANESTHESIA
UNSUPPLEMENTED WITH CENTRAL
DEPRESSANTS

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In a previous communication (Ruben and Andreassen, 1951) it was stated that it was possible and satisfactory to use only pethidine and curare as supplementary agents to nitrous oxide anaesthesia for major operations, thus avoiding the administration of barbiturates. Applying what is considered a more rational nitrous oxide technique, outlined in a paper by the author (Ruben, 1953) a study was undertaken to evaluate to what extent the use of this nitrous oxide technique may result in avoidance of supplementation apart from the use of relaxants. As a consequence morphine was also omitted in the premedication, which consisted of scopolamine or atropine. It was felt that the role played by a relaxant could more easily be studied when no other supplement was in use.

Forty patients, mostly for major operations, were anaesthetized according to these principles. Nitrous oxide was used in a non-rebreathing system using 20 to 23 per cent of oxygen in the flow delivered from the machine. The rather small number of cases forming the basis for this report is balanced by the consistency of the results, which was good enough to give a clear picture of what was possible with this anaesthesia.

Eighteen of the operations were upper laparotomies, 14 were lower laparotomies, and the rest were thyroid and orthopaedic operations. The average duration of anaesthesia
was 164 minutes (longest 455 minutes, shortest 70 minutes). The average dose of d-tubocurarine was 13.9 mg. per hour. In 7 cases gallamine triethiodide was used as the relaxant agent, with an average dose of 66 mg. per hour. Atropine and neostigmine were given in almost every case at the end of the anaesthesia. Apart from occasional hiccoughing, always of short duration, the anaesthesia was satisfactory for the surgical procedure. No other complications attributable to the anaesthesia were encountered during or after the operation.

An anaesthetist entering the operating theatre without knowing which type of anaesthesia was being administered would not have been able to tell the difference from the common thiopentone-pethidine supplemented technique. Most of the time the patient lay quietly on the table. When stronger stimuli were applied, dependent on how curarized was the patient, and the strength of the applied stimulus, the patient could sometimes be seen to move a finger or frown. The reaction was always limited to the time of stimulation.

If the stimulus lasted a long time and no further dose of relaxant was given, then it was observed quite frequently that the reaction ceased—possibly due to adaptation. The amount of relaxant used was, incidentally, of the same order as when supplementation was with central depressants. The patients tolerated extremely well the controlled respiration which in most cases was used during part of the anaesthesia. They even tolerated without adverse effects prolonged continuous positive pressure breathing of the order of 15-20 mm.Hg, which was sometimes used as a test. This seems to indicate that the compensatory circulatory mechanism was still functioning, whereas it is known that patients anaesthetized with other techniques and agents would be likely to suffer a deterioration of the circulation as a
consequence of this procedure. The reaction to blood loss during the operation was interesting. While haemorrhage up to a certain limit did not affect either the blood pressure, the pulse pressure or the pulse rate, an additional bleeding might change this stable picture rather suddenly, indicating that shock was imminent. A comparatively small transfusion, judged to be almost equivalent to the last small blood loss (about 100 ml. for example) was then able to restore the blood pressure and pulse rate to their previous values. This shows a degree of flexibility of the circulatory system unusual in the anaesthetized patient. It is often stated that too light an anaesthesia results in an increase in blood pressure and/or an increase in pulse rate (Stephen, 1952). This has not been observed in this study, even when the patient was reacting with movements to stimuli, although the pulse and blood pressures were followed very carefully during the whole anaesthetic period. In one case pre-operatively where there was a lowered blood volume, the patient after premedication of 0.5 mg. scopolamine, on admission to the operating theatre showed a lowering of the arterial blood pressure from 160/110 to 80/50. This might indicate that the administration of scopolamine is not without effect on the compensatory mechanisms of the circulatory system.

It seemed also that the omission of central depressants maintained fully the reactions of the anaesthetized patient to hypoxia and carbon dioxide excess. The importance of this may be of practical value, as there is good evidence to believe that some of the changes seen in the postoperative period are caused by the unphysiological effects of prolonged carbon dioxide excess during anaesthesia (Miller et al. 1950). Cyanosis during this anaesthetic combination (using approximately 21 per cent of oxygen) will appear very easily if either the respiratory minute volume is
decreased or atelectasis should occur during the anaesthetic procedure. Apart from revealing a lowered oxygen uptake, this also indicates that there may be accompanying carbon dioxide accumulation, whereas a higher oxygen percentage might have hidden this complication. The general clinical impression of the well-being of the patients after this form of anaesthesia may very well be due to these facts.

Immediately after discontinuing the anaesthesia at the end of the operation the patient wakes up, and exhibits an awareness and clarity of mind of quite a different degree to that usual after supplemented nitrous oxide anaesthesia. An indication of how fast the patient eliminates the anaesthetic is that in practically every case he complains almost instantly of pain from the site of the wound. Also, the patients are able to walk with assistance from the operating theatre to their bed. This is even the case after lengthy upper abdominal operations. Thus it has been possible to get every patient out of bed on the day of operation, unless surgical conditions made this inadvisable. The importance of getting out of bed quickly in the prevention of post-operative atelectasis, embolism, gas distension and general debility is generally accepted.

The test we employed to see if most of the relaxant effect had disappeared was to let the patient raise his head and maintain it lifted for about 5 to 10 seconds. If he was unable to do that, then more atropine and neostigmine were administered until this effect was obtained. That ability to perform this test did not, in fact, indicate that the patient was entirely free of relaxant effect was seen from the decreased power in the lower extremities, which the patient presented while walking from the table. This was the real reason why it was necessary to assist the patient on his way from the operating theatre. This debility had
usually quite disappeared before one hour after the end of anaesthesia.

Observations showed the importance of the relaxant for the nitrous oxide anaesthesia itself. Whether real or not, the patient seemed to be much deeper "asleep" with the addition of d-tubocurarine than without. This could be observed during induction, when the relaxant was first added, as well as at the end of the anaesthesia, when the administration of neostigmine to the patient, stabilized with nitrous oxide, apparently lightened the anaesthesia. Also it was seen that the administration of relaxants during application of a stimulus modified the response to it. Whether this indicated a deeper anaesthesia, a breaking of the reflex arc, or was just a suppression of the reaction to stimuli it was not possible to determine precisely. An observation which it has been possible to make during this form of anaesthesia, because the patient was not infrequently maintained at the borderline of reaction, supports the view that anaesthetic depth is a relative term. When the eyelash reflex was tried before, during and after a stimulus was applied, it could be seen sometimes that this was present during, but not before or after the stimulus at the operative site.

In all but one case there was total amnesia to the whole procedure. Objective inquiry immediately on awakening gave in every case the answer that the patient had slept well, without dreaming, and that he was very surprised to hear that the operation was finished. In one case, where the patient thought that he could remember part of the operative procedure, this did not seem to annoy him to any extent. Also in this case there were no changes in blood-pressure or in pulse rate during the course of the anaesthetic. This particular patient showed no response to stimuli during the whole procedure. He was breathing
spontaneously for most of the time, so that total curariza-

tion does not seem to be the explanation for this occur-

cence.

No absolute contra-indications to this method of anaes-
	hesia have been found. It is apparent that cases in

which relaxants are contra-indicated or where pre-existing

hypoxia necessitates an essentially higher oxygen percent-

age than 20, this form of anaesthesia should not be used.

SUMMARY AND CONCLUSIONS

An investigation was carried out to see whether it was

possible in nitrous oxide-oxygen anaesthesia to limit sup-

plementation to a relaxant and to avoid entirely additions

of central depressants. It was found possible in every case

to secure an anaesthesia that was satisfactory to the patient,

the surgeon and the anaesthetist. In fact the picture of this

anaesthetic could not be distinguished from nitrous oxide

anaesthesia, where supplementation with barbiturates and

pethidine is used. It therefore seems as though this supple-

mentation is mostly used to " cover " the weak effect of the

gas during the saturation period and perhaps sometimes also

to add to the effect of the gas when it is used at a lower

partial pressure than in this series of cases. It was, however,

also the impression that the use of the relaxant itself

was part of the reason why other supplementation could be

discarded. Yet, the amount of relaxant used was of the

same order as when central depressants were employed.

As a result of this study it is concluded that in suitable

cases this method of anaesthesia should be taken into con-

sideration as a worthwhile alternative to other methods.

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Nitrous Oxide-Curare Anaesthesia

REFERENCES