

A SIMPLE STUDY OF AWARENESS AND DREAMING DURING ANAESTHESIA

BY

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SUMMARY

An investigation is described into the problems of recall and dreaming under light anaesthesia with nitrous oxide, muscle relaxation being provided by tubocurarine, and the anaesthetic technique being, as far as possible, standardized. Tape-recorded music of two types was used to test the patient's ability to hear and, in addition, the nature and quality of dreams was investigated. There was no evidence that patients were able to hear the tape-recordings and there was no evidence of "awareness" during the operative procedure. Dreaming occurred in 44 per cent of the patients and details of the dreams were recalled in some two-thirds of these. Hypocapnia did not protect against dreaming. Patients who showed marked movement during the operative procedure were more liable to dream than those who did not; the significance of this movement is discussed. In this (unpremedicated) group of patients nearly half described waiting for surgery as the most unpleasant feature of their surgical experience, and postoperative pain was the major complaint in a further 20 per cent. The third commonest of the major complaints was related to requests to lift the head, etc., when unable to do so in the time immediately after operation, and this finding would seem to have some minor practical significance. Unpleasant dreams were the fourth commonest major complaint.

There have been many reports of patients being able to recall events when it was thought that they had been rendered fully unconscious by anaesthetic agents. It is also well known that dreaming can occur during surgical anaesthesia, and that these dreams can be peculiarly unpleasant.

Awareness during anaesthesia is no new problem. Descriptions of the use of diethyl ether in the early days of anaesthesia show that induction frequently took some 1–2 minutes only; administration of the vapour was then discontinued, and operations lasting a minute or more could be performed painlessly. It might well be thought that with this technique there was not enough time to produce adequate surgical anaesthesia, and, indeed, some memory of surgery was not uncommon (*Lancet*, 1847).

As techniques improved the problem of awareness during anaesthesia dwindled into insignificance, except in dental practice where it remained important. The whole problem, however, reappeared with added prominence, shortly after the introduction of the muscle relaxant

drugs (Winterbottom, 1950). With these agents it is theoretically possible for a patient to be awake but incapable of indicating his distress because of muscle paralysis. This paper describes a simple investigation into this problem in adult patients, using a technique in which anaesthesia is maintained with nitrous oxide alone, without opiate premedication and without additional volatile anaesthetic agents or analgesic drugs, full muscle relaxation being provided by large doses of tubocurarine. This sort of technique, it has been suggested, involves the greatest risk of awareness (Waters, 1968).

There are semantic difficulties in this subject; it must, therefore, be stated that awareness has been taken to mean the ability to recall, with or without prompting, any events which occurred during the period at which it was thought the patient was fully unconscious. There can, of course, be difficulties in determining whether such experiences are genuine or imagined, but

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fortunately in this series this was not a problem which arose frequently. Dreaming is more difficult to define, but it has here been taken to mean any experience (excluding awareness) which a patient was able to recall and which he or she thought occurred between induction of anaesthesia and the first moment of consciousness after anaesthesia. This is also a difficult subject for investigation since the patient is not usually able to say exactly when dreaming occurred, for example, whether on the operating table or on the trolley returning to the ward. Furthermore it is not always possible to separate dreaming from hypnagogic phenomena.

METHOD

Anaesthetic technique.

No premedicant drugs were given to the patients on the day of operation, but some received oral promethazine (25 or 50 mg) the night before. Induction of anaesthesia was with thiopentone sodium (2.5 per cent), a dose of up to 250 mg being administered rapidly with or without atropine 0.6 mg. Tubocurarine (30–45 mg depending on the clinical judgement of the anaesthetist) was given either immediately before or after the induction dose of thiopentone. The mask was applied to the patient's face as soon as possible after the anaesthetist had given the thiopentone and tubocurarine. Positive pressure ventilation was established as soon as practicable using a mixture of nitrous oxide (6 l./min) and oxygen (2 l./min), the gases being delivered by the circle circuit of the Boyle Mark II or Mark III type.

Endotracheal intubation was effected as soon as muscle relaxation was considered to be adequate (i.e. within 1–3 min), a cuffed oral endotracheal tube being used. Before surgery was commenced the nitrous oxide in the fresh gas flow was reduced to 5 l./min and ventilation was maintained by mechanical ventilator previously filled with anaesthetic gas; incremental doses of tubocurarine were given as required.

At the end of the operation the neuromuscular block was reversed with neostigmine 5 mg, atropine 1.2 mg having been given 1–2 min beforehand. The concentration of nitrous oxide in the fresh gas flow was kept constant until spontaneous ventilation was resumed when it was reduced to

50 per cent (nitrous oxide 5 l./min, oxygen 5 l./min).

When spontaneous ventilation was considered to be well established the administration of nitrous oxide was discontinued, and the patient was allowed to breathe oxygen for a minute or so before the endotracheal tube was removed.

Pulmonary ventilation was kept constant throughout the anaesthetic, the tidal volume and frequency being determined by the anaesthetist conducting the case. The anaesthetist also decided, on clinical grounds, whether or not to include the absorber in the circuit. It was found, however, that in most patients (table I) the blood carbon dioxide tension was below 30 mm Hg. In order to provide a group of patients in whom the blood carbon dioxide tension was somewhat higher, a small concentration (2–3 per cent) of carbon dioxide was added to the fresh gas flow in some cases, the absorber, of course, being kept out of circuit.

The anaesthetist kept a record of the patient's pulse rate, blood pressure and degree of movement; he also noted the times of administration of drugs and any relevant activity in the theatre.

The degree of movement shown during anaesthesia was subsequently assessed by another anaesthetist by scrutinizing the anaesthetic record. On this basis movement was graded from 0 (little or no movement) to 3 (considerable movement during almost all of the anaesthetic).

Auditory stimuli.

A number of patients received auditory stimuli by a tape-recorder, using earphones of the stethoscope type. The stimulus was commenced just before endotracheal intubation was effected, and continued until spontaneous respiration was recommenced. The volume of sound provided was sufficient to be just comfortable to the anaesthetist conducting the case when he applied the earphones to himself.

In a preliminary survey eight recordings were used (church bells, farmyard noises, light orchestral music, piano music, market voices, bird song, "pop" music and choir music). Each recording lasted for 1 minute and could be repeated for as long as was required. Each patient was presented with one, and only one, of the recordings throughout the duration of anaesthesia.

TABLE I

Average values for weight, age, operation time, movement (arbitrary units, see text), Pco₂ and pH for the entire series are given above. Average values (with range in brackets) are given below for pH, Pco₂, movement (arbitrary units) and duration of operation for all those who dreamed (i.e. both non-detailed and detailed dreams, groups 1 and 2 respectively), those who recounted detailed dreams only (group 2) and those who did not dream (group 0).

Weight (kg)	(56)	=	63.9	Movement	(57)	=	1.2		
Range			50-89	(arbitrary units)					
Age (yr)	(57)	=	48.3	Pco ₂ (mm Hg)	(55)	=	24.6		
Range			20-77	pH	(54)	=	7.533		
Operation time (min)	(57)	=	88						
Dreamers (1 and 2)				Dreamers (2 only)		Non-dreamers (0)			
	No. of cases	Range in brackets		No. of cases	Range in brackets		No. of cases	Range in brackets	
pH	24	7.528 (7.339) (7.665)		16	7.52 (7.339) (7.665)		30	7.55 (7.279) (7.709)	
Pco ₂ (mm Hg)	24	25.5 (14.6) (43.4)		16	25.3 (16.4) (43.4)		31	24.0 (15.0) (50.9)	
Movement (units)	25	1.4 (0-3)		16	1.8 (0-3)		32	1.1 (0-3)	
Duration of operation (min)	25	76 (32-166)		16	87 (32-166)		32	99 (42-230)	

The result of this survey indicated that possibly the choir music and the piano music were identifiable. In a further survey it was found that, if the patient heard the stimuli *before* the operation, and was told that while he was waking up he might hear one or other of them, there was considerable anxiety on the part of those who were to be included in the trial, and this attempt was abandoned.

The main investigation was performed on fifty-seven patients. As in the preliminary survey, consent for inclusion on the trial was obtained in every case. The patients were asked if they would

object if somebody came to see them in the post-operative period and questioned them about their experiences. They were not told that a recording would be played to them while they were asleep but that they might hear one of two sounds when they were waking up.

In this series the tape of the choir music was played to twenty-one patients when apparently asleep, the tape of the piano to seventeen. No tape was played to nineteen patients; this group forming a control series. The basis for selection was a table of random numbers.

Acid-base estimations.

Samples of arterialized venous blood (Brookes and Wynn, 1959; Harrison and Galloon, 1965) were taken half an hour after the induction of anaesthesia and subsequent samples were taken later during the procedure. pH estimations were made using Radiometer equipment (Radiometer Corp., Copenhagen), blood carbon dioxide tensions being determined either by interpolation (Siggaard-Andersen et al., 1960) or by the use of the carbon dioxide electrode, or by both methods.

Interviews.

A few minutes after the end of the operation, when the patients were conscious and appeared to be rational, they were asked casually if they had dreamed. If the answer to this question was in

TABLE II

Gratings of movement (see text and table I) compared with incidence of dreaming.

	Total	Movement group			
		0	1	2	3
Dreamers (2)	16	2	4	5.5	4.5
Dreamers (1)	9	4.5	3.5	0	1
Non-dreamers (0)	31	9.5	13.5	4	4

Dreamers (2) are those who recounted detailed dreams, dreamers (1) those who were unable to describe detail. If statistical comparison be made between the incidence of detailed dreaming in the movement groups 0 and 1 (representing patients who showed no movement or little movement) and that in 2-3 (representing patients who showed moderate or marked movement) it is found that there is a significantly greater incidence of detailed dreaming in the latter (high movement) group ($P < 0.01$).

the affirmative the patient was then asked to give details about the dreams. Interviews were subsequently conducted in the wards on two occasions: the first 24–48 hours and the second 7–8 days after operation. These two interviews in the wards were conducted either by a clinical psychologist or by one of two anaesthetists. The interviewer had not been present in the theatre and was unaware of whether one of the two tapes or nothing had been played.

The same routine was used for each of the two interviews. After a brief explanation of the purpose of the interview, the interviewer commenced by asking three simple questions viz.:

- (1) "What was the last thing you remembered happening before you went to sleep?"
- (2) "What is the first thing you remember happening on waking?"
- (3) "Did you dream or have any other experiences whilst you were asleep?"

Extracts from the two tapes were then played and the patient asked whether he associated either of them with the operation. The degree of certainty of the patient's answer was ascertained, as (i) quite certain, (ii) fairly certain, (iii) think so, and (iv) only vague.

The interview was then concluded by asking two further questions:

- (1) "What was the worst thing about your operation?"
- (2) "What was the next worst?"

Patients.

A total of sixty patients was investigated but three of these had to be eliminated, two because they had received premedication and the third because he received an appreciably larger dose of thiopentone (375 mg) than the others in the series.

The operations were selected from general surgical and gynaecological operating lists; the duration of anaesthesia was between 40 and 230 minutes.

RESULTS*

Average values for weight, etc., are given in table I.

* Copies of the detailed results can be obtained from J.E.U.

Awareness of the surgical procedure.

With one exception no patient complained of being aware of the operative procedure; there was no recall of pain, touch, sight or auditory stimuli (voices or the noise of surgical instruments) referable by the patient to the operation.

The exception was a nervous and emotional man of 57 who contended that he had been awake during a previous anaesthetic. When questioned about dreaming at the end of the anaesthetic in the present series he stated that he was conscious and in pain, but he did not subsequently repeat this complaint when he was interviewed in the ward. He was one of three patients who said that they were aware of the face-mask being applied after the injection had been given, and one of the two patients who claimed to be aware of pharyngeal suction at the end of the operation. His description was somewhat inconsistent and he clearly confused the current anaesthetic with the previous one. It is not possible to say with certainty whether his recollection of pain was imagined, remembered from the previous anaesthetic, or genuine.

Memory of induction of anaesthesia.

All the patients remembered the intravenous injection or remembered being told that they were going to sleep when the drugs were delivered by an intravenous infusion which had been set up previously; as might be expected this end-point was usually very clear-cut. Three patients remembered the face-mask being applied, though this did not excite comment and does not appear to have been an unpleasant experience. One patient, however, who did not remember the mask being applied to her face, had a sensation of being unable to breathe immediately after the intravenous injection, and this she described as "dreadful". Induction of anaesthesia in this case was with thiopentone 200 mg, preceded by tubocurarine 40 mg, both drugs being given directly into the vein and not through an intravenous infusion. The anaesthetist commented that there was undue delay between the administration of the thiopentone after the tubocurarine. It might be added that in over half the cases the tubocurarine was given before the thiopentone in this way.

Memories of waking up.

One patient on awakening remembered a tube being in her mouth, and being unable to speak. Two patients remembered pharyngeal suction. Before leaving the theatre suite (10–20 min after anaesthesia had been discontinued) all patients were able to respond to simple commands, lift their head, etc., and were able to reply, apparently intelligently, to the question about dreaming. Despite this, however, in the subsequent interviews on the wards it was found that the patients for the most part had no memory of these events; frequently their first memory was of being back in bed in the ward.

Tape recognition.

In the interviews in the wards twelve of the patients in the series claimed to be able with absolute or considerable certainty to identify the tape recording which had been played. Four of these chose the correct tape, four recognized the opposite tape to the one which had been played, and four recognized a tape when no tape had been played. There is thus in this series little evidence that the tape recordings played could be recalled.

Dreams.

There was a poor correlation between the results obtained from questions about dreaming immediately after anaesthesia and those obtained in the interviews subsequently in the wards. Some of those patients who claimed to recollect detailed dreaming immediately after anaesthesia subsequently denied all knowledge of dreams when interviewed in the wards. Conversely, several patients who denied knowledge immediately after being awakened were able to remember detailed dreams at the subsequent interviews. The two ward interviews, however, generally gave similar results and, as it would seem probable that only dreams retained and remembered are of importance, the account which follows will be taken from the interviews which took place in the ward. A patient was considered to have dreamed if he described dreams in either of the ward interviews.

Of the fifty-seven patients in the series, twenty-five (43.8%) dreamed. Of the thirty-two females, eleven admitted to dreams, and of these seven were able to describe them in detail. Of the

twenty-five males, fourteen dreamed, and nine were able to describe detail. The difference between male and female is not statistically significant at the usual confidence levels. There was similarly no significant correlation between the incidence of dreaming and the length of operation, though there was some indication that dreaming was more likely when the operation was longer.

Analysis of the acid-base data provided by those who had dreamed (both detailed and non-detailed dreams) and the group of non-dreamers failed to show a significant difference (table I). Even when the blood carbon dioxide tension was very low (e.g., 14.6 mm Hg) dreaming with detailed recall could still occur. Conversely dreaming did not necessarily occur when the blood carbon dioxide tension was raised above the normal resting level (e.g., 50.9 mm Hg). It must be remembered that information on the patient's acid-base state is not comprehensive, being confined to data from occasional samples.

When the movement scores of the two groups were compared, however, a significant difference did emerge (table II). There is a higher proportion of those who had dreams in the high movement groups (2 and 3) than in the groups which showed little or no movement during their operation (group 0 and 1) and this difference is statistically significant ($P < 0.01$). Nevertheless it is worth noting that dreaming could occur when there was little or no movement on the table.

In those patients who did not receive tape-recorded music through the earphones there was a higher incidence of dreaming involving conversation, and this difference is significant ($P < 0.05$): the overall incidence of dreaming and the incidence of unpleasant dreaming, however, was the same whether the patients were played music or not.

Most of the dreams remembered were of concrete situations in which the dreamer thought he had participated; for example, one patient dreamed of a party in a public house in which there was a generous supply of gin and the anaesthetist was the landlord. Four patients dreamed of situations in which intake of alcohol featured, and three had dreams involving previous anaesthetics.

Eight patients had dreams of abstract nature,

though in three of these there were additional concrete features. The subjects of these dreams were generally of a religious or philosophical nature; for example, conversations with the God-head were recorded and the mystery of death and the secrets of the universe were unfolded—but the patients had great difficulty in communicating about their experiences. These dreams were generally unpleasant, and in three cases they were described as the worst feature of the patient's visit to the theatre.

In seventeen of the cases in this series atropine 0.6 mg was administered with the induction dose of thiopentone. The possibility that the administration of atropine might be connected with the incidence of awareness has been suggested by Crawford and associates (1969) who were working with obstetric patients. This series of non-obstetric patients provides no evidence of a causal relationship between dreaming and the administration of atropine: 47 per cent of those receiving atropine admitted to dreaming, and one of these patients considered the dream to be the most unpleasant experience of the surgical procedure; of those patients who did not have atropine administered to them 42.5 per cent dreamed and of these two considered that their dreams were the most unpleasant feature of the operation. There was also no evidence that promethazine given the night before the operation influenced the incidence of dreaming.

Worst experiences.

When asked to indicate the most unpleasant feature of their visit to theatre twenty-six patients (46 per cent) in the series volunteered pre-operative waiting and apprehension, twelve (21 per cent) gave postoperative pain, four (7 per cent) the distress at being asked to do things in the time immediately after operation and being unable to do so (e.g., lifting the head), and three (5 per cent), as mentioned before, the dreaming associated with the operation. It is, of course, possible that the importance of dreaming has been exaggerated since the interview of its nature reminded the patient of any dreams.

DISCUSSION

It must be pointed out that the present series does not provide conclusive evidence that patients

were not aware during the time that they were thought to be asleep. It is at least theoretically possible that in some patients there was awareness of the surgical procedure, but that this awareness was suppressed. This does not seem to be likely; all the patients appeared to be at ease when interviewed about their surgical experiences, and were interested and co-operative. They showed no signs of the kind of emotional upset and tension which one might have expected had they been subjected to an experience as unpleasant as that of being operated upon while conscious.

Tape recordings were played as there is considerable evidence that under some circumstances patients under the influence of anaesthesia can hear (Rosen, 1959; Levinson, 1965; McIntyre, 1966; Terrell et al., 1969). It is possible that the tape recordings used in this series were not sufficiently memorable, and that positive results would have been obtained either with other sounds, or with fragments of significant conversation. It was thought, however, that the use of significant conversation in these circumstances was hardly justified as an experimental procedure. Though no recall of conversation was found in the series, it is just possible that the higher incidence of dreams involving conversation found in the group who did not have tape-recorded music played to them was due to conversation in the theatre being "built into" the dreaming pattern.

It is well known that the majority of dreams that occur in normal sleep are forgotten when the patient wakes up. It will be realized that it is possible that dreams in this series have been made more memorable by stimulating memory of the dreaming process at the first interview or indeed in the operating theatre. In at least some of the cases the dreams might have been forgotten a week after the operative procedure.

In this series three patients (5 per cent) stated that the dreams which they had experienced were the most unpleasant part of their visit to the operating theatre and of the immediate post-operative period. Surprisingly, perhaps, these extremely unpleasant dreams were not of a concrete nature; they did not involve people or places specifically, but were concerned with transcendental factors which the patient, as mentioned before, found extremely difficult to describe

adequately. A further 7 per cent of the series also had unpleasant dreams though these dreams were not their primary complaint.

Hypocapnia is a factor causing central nervous depression and has indeed been described as "a flexible adjunct to anaesthesia" (Geddes and Gray, 1959). It would, therefore, not be surprising if it were found that those who experienced dreams had a higher blood carbon dioxide tension than those who did not. This series has failed to show any conclusive correlation between the incidence of dreaming and the blood carbon dioxide tension; dreaming could occur when the blood carbon dioxide tension was very low. It would seem, therefore, that with the technique used in this series, passive pulmonary hyperventilation does not protect against the possibility of unpleasant dreams.

The correlation found between the incidence of dreaming and the observed movement of the patient on the operating table during the surgical procedure is not entirely surprising but involves difficulties in interpretation. It might be thought that patients who are moving during the surgical procedure are in a state of partial arousal and that, for this reason, the patient who is showing movement is more likely to dream. It is also, however, quite compatible with the observed results that patients who were dreaming started to show signs of muscular activity for this very reason, a phenomenon which is known to occur in normal sleep.

The incidence of movement during the surgical procedure is difficult to quantify. It is also difficult for an anaesthetist set on producing a standardized technique to know precisely when an incremental dose of muscle relaxant should be given; this tends to lead to considerable variation in the extent to which movements were tolerated.

It is difficult to obtain correct information from patients about their intake of alcohol and central depressant drugs. Insufficient information was obtained in this series to enable even a tentative correlation between the intake of alcohol and drugs and the incidence of dreaming. Nevertheless it can be said that it is quite possible for a total abstainer who takes no drugs to have detailed dreams during anaesthesia, and for a heavy drinker to have none.

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UNE ETUDE SIMPLE DE LA CONSCIENCE ET DES REVES DURANT L'ANESTHESIE

SOMMAIRE

Les auteurs décrivent une étude des problèmes du souvenir et du rêve sous une anesthésie légère au protoxyde d'azote, avec relâchement musculaire par tubocurarine et une technique d'anesthésie, standardisée dans la mesure du possible. Deux types de musique enregistrée ont été utilisés pour examiner la capacité du malade d'entendre, et la nature et qualité des rêves ont aussi été étudiées. Il n'y eut aucune évidence que les patients étaient en mesure d'entendre les enregistrements, ni d'une "conscience" au cours de l'intervention chirurgicale. Quarante-quatre parmi les malades ont eu des rêves et environ deux tiers des sujets se sont rappelés des détails de leur rêves. L'hypocapnie n'empêcha pas de rêver. Les malades avec des mouvements marqués durant l'opération avaient une plus grande tendance à rêver et la signification de ces mouvements est discutée. Parmi ce groupe de patients (sans prémédication) presque la moitié a déclaré qu'attendre le début de l'opération était la partie la moins agréable de leur expérience chirurgicale, et la douleur postopératoire était la plainte majeure chez encore 20 pourcent. La troisième des plaintes graves fréquentes avait trait aux demandes de lever la tête, etc., quand le malade n'y parvenait pas immédiatement après l'opération, et cette observation pourrait avoir une signification pratique majeure. Des rêves désagréables étaient la quatrième plainte grave fréquente.

EINE EINFACHE UNTERSUCHUNG ÜBER BEWUSSTSEIN UND TRÄUMEN WÄHREND DER NARKOSE

ZUSAMMENFASSUNG

Es wird eine Untersuchung beschrieben über die Probleme des Erinnerns und Träumens während einer leichten Narkose mit Stickoxydul, wobei die Muskelrelaxation durch Tubocurarin hervorgerufen und die Narkosetechnik so weit wie möglich standardisiert war. Zweierlei Tonbandmusik wurde verwendet, um die Hörfähigkeit des Patienten zu testen. Ausserdem wurden Art und Charakter der Träume untersucht. Es liess sich kein Beweis erbringen, dass die Patienten fähig waren, die Tonbänder zu hören und es gab keinen Beweis für ein "Bewusstsein" während der Durchführung der Operation. Bei 44 Patienten traten

Träume auf und etwa zwei Drittel von ihnen erinnerten sich an Einzelheiten der Träume. Hypoknapnie schützte nicht vor Träumen. Patienten, die während der Durchführung der Operation starke Bewegungen zeigten, neigten eher zu Träumen als Patienten die dies nicht taten. Die Signifikanz dieser Bewegungen wird diskutiert. In dieser (vorher nicht mit Arzneimitteln behandelten) Gruppe von Patienten beschrieben fast die Hälfte das Warten auf die Operation als das unangenehmste Merkmal ihrer Operationserfahrung und postoperativer Schmerz war die Hauptbeschwerde bei weiteren 20 Prozent. Die dritthäufigste Hauptbeschwerde bezog sich auf das Verlangen, den Kopf usw. zu heben, wenn sie in der Zeit unmittelbar nach der Operation dazu nicht fähig waren und dieser Befund scheint eine gewisse praktische Bedeutung zu haben. Unangenehme Träume war die vierhäufigste grössere Beschwerde.

BOOK REVIEWS

Plasmaersatzmittel (Plasma Substitutes). By Horst Lutz. Published by George Thieme Verlag Stuttgart, 1969. Pp. viii+78; 11 tables; 16 figs. Price: DM 12,80.

This small monograph surveys the various types of plasma substitutes. Beginning with a history of their development and a discussion of the dangers and problems of blood transfusion, it then deals with preparations of whole plasma and of its isolated fractions like albumin, plasma proteins, and gamma globulin. This is followed by the dextrans (for which the designation "plasma expander" is reserved), the gelatine derivatives and the crystalloid solutions. For each preparation a description of its manufacture is given as well as its physico-chemical properties, its elimination from the body, its possible side effects and the indications for its use. For completeness, some substances now rarely employed are mentioned.

It is emphasized that the dextran and gelatine solutions have their main function as "first aid" blood volume substitutes as they do not require special preparation, storage or testing, do not deteriorate over many years, are thus immediately applicable and, therefore, can carry a shocked patient over the period needed to arrange for the specific treatment he may require. Methods for the control of the circulation during infusion therapy are then described.

As only the German brand names of the various preparations are given, the use of the booklet in clinical practice will be limited though it can serve as a survey of the substances available for the treatment of shock, haemophilia or for organ perfusion.

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Modern Problems of Blood Preservation. International Symposium held at the Department of Immunohaematology and Blood Transfusion, University of Frankfurt/M., March 17-18, 1969. Edited by W. Spielmann and S. Seidl. Published by Gustav Fischer Verlag, Stuttgart. Pp. 217; 126 figs., 46 tables. Price: DM 68,00.

This book records the papers presented at a symposium in March 1969, devoted to work on the problems of prolonging the storage of blood. Between 5 and 35 per cent of all blood is wasted because the cells are not used within 21 days, yet at other times supplies are inadequate. Conventionally stored blood has inherent drawbacks, either due to metabolic changes during storage or due to the continued presence of unwanted elements such as viruses and white corpuscles. Considerable effort has been applied, therefore, to the problem of extending the storage life of blood, and to storing cells and plasma separately.

The editors claim that all the leading scientists in this field attended the conference. It is unlikely, therefore, that this publication will find a wide audience, although it contains papers on a most extraordinary range of subjects, from the metabolic pathways of red cell membranes to American experience with deep frozen blood in Vietnam. Anyone working in this specialized field is likely to be fully aware of all the relevant work and, judging from the references, it is generally available elsewhere. Some papers give the impression of being edited tape transcripts, and stilted English and frequent spelling mistakes make for difficult reading on occasions. At over £8 for 215 pages between paper covers it cannot be recommended as a rewarding investment for hospital or anaesthetic department libraries.

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