THE PATTERN OF ANAESTHESIA IN A GENERAL HOSPITAL

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An accurate knowledge of the existing pattern of clinical practice is essential for the proper assessment of therapy, the design of research, the planning of medical education, the efficient use of medical manpower and the design of and financial provision for new hospitals. In the field of anaesthesia the pattern of practice in large busy hospitals is most easily and accurately revealed by a study of carefully kept records. More immediate reasons for keeping an accurate anaesthetic record have already been set out (Mushin et al., 1954). Briefly, they are to help the anaesthetist and the patient at the time of administration of the anaesthetic, to aid the patient and the medical team in postoperative care, for anaesthetic and other research, and for administrative purposes.

It is difficult at the present time to get an overall picture of the pattern of anaesthesia as practised in hospitals in this country, other than by guessing at its general outline from publications in the literature. Unfortunately these sometimes tend to give a distorted picture because of the emphasis placed on the unusual. British anaesthetists tend to fall short of an otherwise high standard of practice by a reluctance to accept the keeping of a clinical record as an integral part of anaesthetic practice. Even teaching hospitals seem unable to give more than a crude estimate of the extent to which various drugs are being administered by their anaesthetists (Green and Mungavin, 1964).

Good records are not only of benefit to patients, but also to the hospital administrator. The objectives of the administrator and the clinician are not dissimilar. The sooner the patient returns to health and makes way for another patient, the better both the administrator and the anaesthetist are pleased. If the duration of stay or patients in hospital is shortened and if more patients can be restored to health by surgical operations each year, without any loss of safety or clinical expertise, both are pleased. It is, however, important for the anaesthetist to know if possible to what aspect of his work, if any, such improvement is due. Unless the details of his work are available for analysis, any attempt at studies of this sort are difficult or impossible.

In addition, many anaesthetists administer drugs to their patients, without a prescription or other record. It is of some interest to anaesthetists in general and, more immediately, to the Committee on the Safety of Drugs to know the extent to which drugs are used by anaesthetists and of any adverse reactions which may follow them. It is not possible to learn all we should about this until there is a much improved standard of clinical recording by anaesthetists.

The method of recording the data on which this paper is based has already been described (Mushin et al., 1954). Briefly, in the Teaching Hospitals of Cardiff the anaesthetist makes his clinical observations on a self-coding anaesthetic sheet, which was devised to suit our own convenience and interests. This information is stored on Hollerith punch cards which are prepared directly from these records by the Statistical and Records Departments of the Medical School and Hospital. A check is made to ensure that every patient who has had an anaesthetic and who stays at least one night in the hospital is included. The seven years between 1958-64 are presented, because although recording started in 1949 it was not until 1958 that all the anaesthetic records of the Teaching Hospitals in Cardiff were fused into one system.

The anaesthetic team, which serves the teach-
ing hospitals and a number of large and a number of specialized hospitals in the vicinity, consists of between twenty and thirty individuals. About half of them are in the junior grades. Over the seven years over fifty different individuals administered anaesthetics in these hospitals.

As a matter of principle there are no authoritarian anaesthetic directives in Cardiff. Registrars in the various grades are supervised, guided and criticized continually. Nevertheless, however much advice they may seek from the consultants who are always available to help them, a decision about the details of the management of a case which has been delegated to them must often be made on the spot. The consultant anaesthetists in their own work are, naturally, clinically responsible only to themselves. The pattern of anaesthetic work in our hospitals, therefore, reflects the opinions and thoughts of a large group of individuals, who continually bring in ideas from other parts of the country, as they are appointed, who regularly read the journals, and who frequently employ new methods as they are described, and over whom immediate clinical influence is exercised mainly by example, discussion and constant interchange of ideas within the department.

This paper gives a somewhat limited picture of the changing practice of anaesthesia in our hospitals over recent years. The emphasis in this paper is on the usage of anaesthetic agents, which represents some of the more dramatic changes, but many other and important aspects of anaesthetic practice have remained unmentioned or only discussed briefly. Great changes have taken place, for example, in the preparation of patients for operation, and in the wide range of fluid and drug therapy employed during operation, often based on the monitoring of physiological functions. These and many others reflect an increasing understanding and preoccupation with the physiological as well as the pharmacological basis of anaesthetic practice.

The teaching hospitals concerned have nearly 800 acute beds with all the surgical specialties represented, and a maternity hospital with over 2,000 deliveries per annum.

The total number of in-patient operations per annum has been rising steadily from some 8,000 in 1958 to 11,400 in 1965, a remarkable increase of some 5 per cent per annum or 40 per cent overall (fig. 18). During the time concerned the characteristics of the patient sample have remained remarkably constant when analyzed by surgical operation, age, and sex. Most of the patients were in the middle adult years. However, the greatest number of operations in any one year of life occurred in children of up to 1 year old (fig. 1).

**FIG. 1**

Distribution of patients anaesthetized (1963).

**THE GENERAL USAGE OF THE MAIN ANAESTHETIC AGENTS AND COMBINATIONS**

The definitions of the terms used are as follows:

- **Halothane**: any combination containing halothane;
- **Ether**: any combination containing ether (excluding those containing halothane);
- **Trichloroethylene**: combinations of trichloroethylene with or without an intravenous barbiturate, nitrous oxide and oxygen, or intravenous pethidine, excluding any combination with halothane or ether;
- **Nitrous oxide**: combinations of nitrous oxide and oxygen, with or without an intravenous barbiturate, or intravenous pethidine.

In 1958 over 50 per cent of the patients were given various combinations of trichloroethylene. Trichloroethylene as an additive to nitrous oxide and oxygen was then in common use, and the administration of pethidine alone as a supplement to nitrous oxide, oxygen and trichloroethylene was already declining from 30 per cent in 1958 to less than 10 per cent in 1964. Nitrous
oxide and pethidine was a combination which made an important impact in the post-war years on the conduct of anaesthesia. The method was pioneered in Britain in 1949 in this department, and although it had a brief ten years of life, it familiarized anaesthetists once again with the virtues of nitrous oxide, and enabled them to appreciate to the full the enormous benefits which the newly introduced relaxants could bring. It gradually became apparent that a little added vapour of, say, trichloroethylene enabled more accurate control over anaesthesia to be obtained, and did all that pethidine did, without the risk of cardiovascular depression if the dose of pethidine had been misjudged. On the horizon in 1958, and in the ascendant, was halothane, and from a 5 per cent usage in that year it rose in an astonishing manner to an overall use of over 80 per cent by 1964, with, of course, the virtual abandonment of the other vapour anaesthetics.

The pattern is repeated when the use of anaesthetics is further analyzed by such factors as age and the site of operation. Although there are differences due to these factors, the overall changes are in the same direction.

Children (fig. 3).

In 1958 over 75 per cent of the children under 1 year received ether, and so did nearly the same proportion of those under 4 years. By 1964 over 90 per cent of all the children were given halothane, while ether was used in less than 5 per cent. This process was even more marked in the older children. In any one year, halothane was used more freely in the older children than in the younger ones. It seems to have taken about a year for the anaesthetists to gain confidence and for the use of halothane in the babies to catch up with that in the older children. From the way the two halothane lines are approaching each other it looks as though very soon every child under the age of 5 will be anaesthetized with combinations containing halothane.

Neurosurgery.

The site of the neurosurgical operation is still an important factor in determining the anaesthetic used, though it seems to be becoming less so. Anaesthesia for spinal operations is shown in figure 4. In 1958 a laminectomy was evidently considered as being different, from an anaesthetic
point of view, from a craniotomy. The patients were less ill, the surgical procedure much quicker, the risks of likelihood of serious haemorrhage less, and perhaps the effect of less skilled anaesthetists not so obvious to the operator. Trichloroethylene was popular, being given to over 50 per cent of these patients for laminectomy. The nitrous oxide group accounted for 23 per cent, and the ether group for 20 per cent. Over 90 per cent, therefore, of all the patients having these operations in 1958 had nitrous oxide with either pethidine, trichloroethylene or ether in various combinations. However, while the use of nitrous oxide remained fairly steady for a few years, trichloroethylene, ether and nitrous oxide have almost disappeared in favour of halothane (fig. 4).

In the case of anaesthesia for craniotomy operations (fig. 5), the pattern reflects the greater concern to reduce the intracranial pressure. In 1959 a change in anaesthetic staff greatly reduced the use of trichloroethylene. At one point 70 per cent of these patients had nitrous oxide. Controlled respiration gradually became popular and supplanted the usually depressed spontaneous breathing. Nowadays controlled respiration is almost universal for these cases and halothane as the supplement is evidently preferred to any other. By the time 1964 was reached there was no difference between the anaesthetic usage in craniotomy and laminectomy—an entirely understandable and reasonable state of affairs.

Obstetrics (fig. 6).

In 1958, the most popular anaesthetic for Caesarean section was ether. By 1961, nitrous oxide had taken its place, and for two years was used on nearly 80 per cent of these patients. Trichloroethylene seems to be coming back and in 1964 was given to over 40 per cent of these patients. The addition of a trace of vapour perhaps enables a little more control to be exercised over the effects of anaesthesia on the mother and the baby, and the apparent revival of trichloroethylene may indicate that less "hangover" is produced than when pethidine is the main supplement. There is little use of halothane, and this
reflects its generally accepted unsuitability on the basis of its uterine relaxing powers.

Relaxants are now used in virtually every Caesarean operation (fig. 7). Mostly the relaxant is either suxamethonium in single or repeated doses or in combination with tubocurarine. Tubocurarine by itself is rarely used, since intubation is easy with suxamethonium and nothing more in the way of relaxant may be needed in an easy section. Gallamine is not used at all in these cases, presumably because of the evidence that it passes the placental barrier more easily than curare.

However, when non-Caesarean obstetric operations are considered (fig. 8), consisting of such procedures as manual removal of the placenta and the application of forceps, then a different pattern is seen. Evidently the same caution about halothane is not felt here because halothane usage shot up at one point to nearly 60 per cent, and in 1964 still accounted for a third of the anaesthetics. The increased use of halothane in non-Caesarean over Caesarean operations is probably because a rapid inhalation induction is frequently

![Graph](image1)

**FIG. 6**
Use of anaesthetics in Caesarean section (Tri=trichloroethylene).

![Graph](image2)

**FIG. 7**
Use of relaxants in Caesarean section.

![Graph](image3)

**FIG. 8**
Use of anaesthetics in obstetric surgery not including Caesarean section (Tri=trichloroethylene).
required and because some degree of uterine relaxation is sometimes deliberately induced to aid the obstetrician. Ether, which formerly was used for nearly three-quarters of these patients, has fallen but is still preferred in over 15 per cent of these cases. Trichloroethylene is used in another 25 per cent, as is nitrous oxide. Cyclopropane (not shown) is now hardly used at all.

For Caesarean section practically every patient is now given a relaxant of some sort. For the other obstetric procedures relaxants are used but only in about two-thirds of the patients, though their use is increasing. The factors responsible for the lower usage of relaxants are the lesser degree of relaxation required, the emergency nature of many of these anaesthetics, the lesser use of intubation, and the greater use of halothane.

**Abdominal surgery (fig. 9).**

In abdominal surgery, in 1958, nitrous oxide with, of course, relaxants was used in some three-quarters of operations. This has now fallen to only 20 per cent and is still declining. Halothane has rapidly taken its place. Trichloroethylene, which was used as an alternative supplement to pethidine, especially in lower abdominal operations seems not to be hardly ever used. The limited use of trichloroethylene reflects the frequency of controlled respiration using carbon dioxide absorption. A difference existed at one time between anaesthesia for upper abdominal and lower abdominal operations, but this has disappeared.

**Cost of halothane and trichloroethylene.**

The striking way in which halothane now dominates the anaesthetic scene has had its reverberations in the financial sphere, and there can be few anaesthetists who have not had alarm signals from their hospital finance departments over the cost involved. Figure 10 shows the results of a somewhat crude analysis of the relative costs of halothane and trichloroethylene. However, it should be borne in mind that in considering the overall cost of a surgical operation, halothane, even at 9s, a patient, is small compared to the cost of such things as the ligatures.
and sutures, the dressings, and the drainage and other tubes, to say nothing of the cost of the medical and nursing team and of the many other items involved (Murray Wilson, 1966).

Relaxants.

Figure 11 shows the overall use of relaxants. There is evidence of a tendency for their use to decrease. This can only be due to the increased use of halothane. Over the years can be seen the gradual rise in the use of suxamethonium to very nearly a third of all patients, with the gradual decline in the use of both gallamine and, to some extent, of tubocurarine. The proportion of patients having a relaxant and being given an antidote has remained roughly the same—about half of those given gallamine, and about three-quarters of those given tubocurarine. A very interesting change is the rising use of combinations* of suxamethonium with either gallamine or tubocurarine. The curve of these combinations seems to have flattened out and we regard this with satisfaction. Too little is still known about the possible interactions when these different types of relaxant are administered within a short time of each other.

Of course, ventilation is always assisted in some way, whenever it seems to be insufficient and this

* "Combinations" refers to the administration of suxamethonium followed later in the same patient by gallamine or tubocurarine.
of stay in hospital, are quite precise. The validity of the other, the complication rate, is open to a little dubiety.

The mortality rate after operation is a matter of figures which speak for themselves. No anaesthetist will deny the possibility of some connection between anaesthesia and survival from an operation.

With regard to the duration of stay of patients in hospital, the main hospital factor which determines this is the welfare of the patient, and certainly not financial pressure. The duration of stay in hospital can be regarded as a sensitive index of the speed of recovery from an operation and therefore as a good indicator of the extent to which recovery was beset with complications.

Mortality.

The overall mortality within the hospital of surgical patients in terms of deaths per hundred operations is shown in figure 13. There appears at first sight to be a general decline from 3.1 per cent in 1958 to 2.2 per cent in 1965. However, the mortality rates for the years preceding 1958 were not ascertainable with accuracy and the fluctuations in mortality rate shown may have been random, rather than indicating a significant change. If this were so it would be surprising when considered against the background of dramatic change in anaesthetic practice over the period. The peak in mortality rate in 1964 is due, as will be seen later, to a sharp rise in the death rate of infants under 1 year consequent on an expansion of paediatric neurosurgery.

When the mortality is analyzed further to determine the number of deaths occurring on each postoperative day, certain features are revealed (fig. 14). Firstly the highest death rate occurs during the first week. About 50 per cent of all postoperative deaths occur within the first six days. Anaesthesia probably has more influence on the likelihood of mortality or recovery during these first few days, when any untoward effects from anaesthesia are not only apparent but are more likely to be fatal. It is, however, not possible to detect any clear trend of change in the death rates occurring in the first week after operation though it seems as though in the first three days that the rate may be falling. Once this first week is past, the death rate per day has not changed over the years and this probably represents those cases in which treatment had no ultimate effect on the natural fatal course of the disease itself.

When the mortality is analyzed for age, the two highest groups are old people and babies (fig. 15). The rise in the curve for infants represents the expansion in paediatric surgery in the last few years to which reference has been made. The considerable difference in mortality
between those at the extremes of life and those in the middle adult period, confirms the need for careful assessment of the risks before pressing anaesthesia and surgery on the former.

Naturally, the mortality is higher in those patients classified pre-operatively as "bad" or "moribund" than in those considered to be in a better pre-operative state of health, but the extent of the difference as shown here (fig. 16) may not be sufficiently realized. The mortality rate has fallen in all three groups, the most striking improvement being in the bad-risk cases. It is in this high-risk group that better pre-operative preparation and anaesthesia and surgery is more likely to show lower mortality figures.

A crude analysis relating death in hospital (fig. 17) to the anaesthetic administered can appear to indicate alarming correlations. It seems at first sight from this graph as though cyclopropane and ether had specially dangerous potentialities. However, although the general pattern of anaesthetic usage is similar for patients with varying pre-operative assessment, ether and cyclopropane were in fact used more frequently in the "bad/moribund" group than in the other two.

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**FIG. 15**

Death rate in each age group.

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**FIG. 16**

Deaths and pre-operative state of patient.

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**TABLE I**

*General condition of patient (means of years 1958, 1961 and 1964).*

<table>
<thead>
<tr>
<th>Anaesthetic</th>
<th>Good %</th>
<th>Impaired %</th>
<th>Bad or Moribund %</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halothane</td>
<td>41.4</td>
<td>56.4</td>
<td>2.2</td>
<td>5050</td>
</tr>
<tr>
<td>Ether</td>
<td>51.3</td>
<td>45.6</td>
<td>3.1</td>
<td>320</td>
</tr>
<tr>
<td>Trichloroethylene</td>
<td>53.2</td>
<td>46.3</td>
<td>0.5</td>
<td>1893</td>
</tr>
<tr>
<td>Cyclopropane</td>
<td>34.8</td>
<td>52.8</td>
<td>12.4</td>
<td>121</td>
</tr>
<tr>
<td>Nitrous oxide</td>
<td>33.5</td>
<td>65.2</td>
<td>1.3</td>
<td>1858</td>
</tr>
<tr>
<td>Others</td>
<td>39.6</td>
<td>55.9</td>
<td>4.5</td>
<td>159</td>
</tr>
</tbody>
</table>
Table I shows this more clearly. In the case of ether, and even more so in cyclopropane, a higher proportion of patients given these anaesthetics were “bad/moribund”, and in the case of cyclopropane, a much smaller proportion of patients were in the “good” group. There was, therefore, some degree of selection of ether and cyclopropane for the poorer-risk patients.

Duration of stay in hospital.
The duration of stay of patients in hospital has steadily gone down and concurrently a greater number of people have been operated on each year. The number of beds has remained unchanged. Figure 18 is a dramatic picture and is one that has both excited and dismayed us. Excitement because it must represent, to some degree, better surgical results in which anaesthesia undoubtedly plays a vital part; treatment thus becomes available to a larger section of the population, with consequent reduction in waiting time before admission to hospital. Dismay, because this picture must represent an increased demand for anaesthetic services not matched by an equivalent increase in staff; anaesthetists already in short supply are thus still harder pressed.

Recovery room.
The recovery room has improved patient care in the immediate postoperative period and it might well be one of the contributing factors leading to the shorter patient stay in hospital. The first recovery room was opened in 1961. After an initial year of surgical suspicion, within two years it accommodated 75 per cent of patients operated on. Now the room is utilized fully, but because of the steady rise in the number of operations, only 66 per cent of patients pass through it. If this room were enlarged there is little doubt that the figure would soon rise to nearer 90 per cent.

Postoperative complications.
The general term “postoperative” is used because with very few exceptions it is often difficult, if not impossible, to be quite sure whether the anaesthetic or the operation, or both, was the main causative factor connected with the particular complication. There is another difficulty. In any method of reporting in which the observations are mechanically sorted, there is need for a precise definition for each fact recorded, and for a limit to be imposed on the number of complications which can be included. Individuals are bound to vary both in the energy and frequency with which they see their patients in the postoperative period and in the conscious or unconscious selection of complications to record on a basis of their relevance to anaesthesia.

While, therefore, some of the information which has been accumulated is presented, no claim is made that it is other than crude material open to the objection referred to, or that any very important conclusions should be drawn from them. Nevertheless, the number of patients operated on each year is so great, and over seven years the figures for complications are so consistent, that some small notice can be taken of them.
The number of fish that are caught depends on the size of the mesh of the net. The mesh of our net for catching complications in Cardiff is fairly small and if the anaesthetists have erred, it is probably on the side of over-recording.

The number of patients who developed complications has remained fairly steady over the years, with respiratory ones being the commonest (fig. 19). An analysis of the respiratory and circulatory complications shows what has been known for a long time, that the site of operation is an important factor. This is marked in the case of respiratory complications (fig. 20), but the same pattern is shown for the cardiovascular ones. Here, too, the upper abdominal operations are followed by more than the other sites.

Is the incidence of complications associated with particular anaesthetics? Now that the pattern of anaesthetic use seem to be more or less the same in most branches of surgery, the answer seems to be "no", and this is borne out by the figures for three common operative sites. In perineal surgery (fig. 21) the rates are low and much the same for various anaesthetics. The same

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**Fig. 19**
Postoperative complications.

**Fig. 20**
Postoperative respiratory complications.

**Fig. 21**
All complications: perineal operations (Tri=trichloroethylene).

**Fig. 22**
All complications: lower abdomen (Tri=trichloroethylene).
is true for the lower abdomen (fig. 22). In the case of upper abdomen (fig. 23) the rate is higher, as has already been seen.

\[\% \text{PATIENTS WITH COMPLICATIONS]\]

\begin{center}
\begin{tabular}{|c|c|c|c|c|c|c|}
\hline
1958 & 59 & 60 & 61 & 62 & 63 & 64 \\
\hline
H\textsubscript{2}O & 40 & 30 & 20 & 10 & 0 \\
HALOTHANE & 30 & 20 & 10 & 0 & 0 & 0 \\
\hline
\end{tabular}
\end{center}

\textbf{FIG. 23}

All complications: upper abdomen.

Most of the information presented is precise and beyond doubt. Stay in hospital, death and when it occurred, what drugs were administered, site of operation, and many other matters are clear facts. The correlation between them and any untoward events, or indeed with any clear benefits, are matters for reasoning, but at least the facts provide a basis. Without them impression must be rife. Knowledge of the pattern of anaesthesia in a large hospital such as ours with a team of anaesthetists of all grades, may serve as a yardstick against which individual anaesthetists can compare their own personal practice. This is the first step towards self-criticism and fruitful communication with one's colleagues.

\textbf{ACKNOWLEDGEMENTS}

We record our thanks to Mr. J. Morgan and the staff of our Records Department for their enthusiastic cooperation, and to Mr. E. K. Hillard, L.I.B.S.T., of the Department of Anaesthetics, for drawing the graphs.

\textbf{REFERENCES}


\textbf{BOOK REVIEW}


Drs. Norris and Campbell are to be congratulated because they have dared to attempt a comprehensive primer in a specialist field, and because they have so nearly succeeded. In the section of this book which is devoted to anaesthesia, the information is clearly set down and although the authors have been didactic enough to avoid confusion, opposing views, for instance in the section describing anaesthesia for intestinal obstruction, have been adequately represented. In the section on anaesthetics it would be difficult to suggest alternative approaches which would significantly improve the content. This reviewer particularly enjoyed the chapter describing the administration of a general anaesthetic and prevention and treatment of complications during anaesthesia. The extent of the pre-anaesthetic examination suggested is laudable but one wonders whether it is realistic even in teaching hospitals.

There are, however, one or two points in the section on intensive care which might be modified in subsequent editions. The authors suggest that "tracheostomy tubes are usually changed at least every forty-eight hours". Some units change their tubes at much longer intervals, for instance every few weeks, and the difference probably reflects the efficiency of the humidification of inspired gases. Again, to suggest that a ripple mattress will reduce the chance of bed-sore implies that bed-sores are encountered, and this probably means that the patients are not being turned often enough.

In the Respiration Unit at Oxford no special treatment is directed to the skin except social cleanliness and two-hourly turning from one lateral position to the other day and night. One (small) bed-sore has occurred in fourteen years' treatment of paralyzed and often incontinent patients.

The bulk of the section on intensive care is sound, and the book as a whole can be recommended to students and residents to whom it is specifically directed.

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