PREVENTABLE MORTALITY AND MORBIDITY IN ANÄSTHESIA


(By courtesy of the South African Medical Journal.)

DEATH After Operation,” “Bronchial Tubes Blocked,” “Verdict on . . . Inquest,” “Veteran Succumbs under Anaesthetic,” “New Drug—Evipan,” etc., etc. Such have been the terrorizing headlines recently in several of the newspapers throughout South Africa, and although the inquest verdict given by the magistrate is generally “Death due to misadventure”—no blame attached to hospital or doctors—very incriminating questions are put to the anaesthetist (usually) during the inquest, the result being that his reputation suffers, and certainly anaesthesia is not improved.

Moreover, such alarming reports and sensational publicity are not calculated to help to reassure but tend to have an extremely bad effect on the general public, and certainly do not result in the betterment of this specialized service.

When one deprecates this publicity in connection with anaesthetic deaths, one does not do so with the desire of “hushing up.” This would serve less use than the sensational publicity above mentioned.

One hopes rather for a drastic change in the system of holding inquests in these cases, which at the present time serves no useful purpose whatsoever.

There is gross waste of valuable clinical and pathological material, which, if properly collected and discussed, would be of great scientific and practical value.

When a patient in hospital dies at or soon after some surgical procedure, the system in vogue in South Africa is to report the matter to the magistrate (a layman with usually
no knowledge of medicine), who orders the District Surgeon to conduct an autopsy. The District Surgeon, who is usually very busy and over-worked, conducts the examination to the best of his ability, very often hours and hours elapsing after the death has taken place, and in a public mortuary often far removed from the institution where the catastrophe has occurred.

The only scant information given to him is that the patient died just before, during, or just after the operation, and he is fortunate if the surgeon or anaesthetist is ever present at the autopsy. An enlarged thymus is very often discovered and given as the cause of death, and beyond a more or less superficial examination of the rest of the body, little more is done.

It is not my aim in this short paper to condemn the work of the District Surgeon in these matters. I do not think it really ought to fall to his lot to conduct these examinations, which to my mind should be carried out by the government pathologist, assisted by bacteriologist and biochemist. The examination, too, should be made in the presence of the surgeon and anaesthetist and general practitioner or physician under whose care the patient has been prior to the catastrophe. I do hold, too, that the pathologist who conducts the examination should be in possession of full medical and surgical history of the case, and that the post-mortem be held at the earliest possible moment after death owing to certain inevitable changes which must take place during the hours the body is waiting to be pathologically examined.

As it is, the lot of the pathologist is made difficult owing to the employment of the various means of resuscitation just before or just after death—artificial respiration, injections, intravenously, intracardiac, and cardiac massage, etc., which must alter post-mortem appearances somewhat. In the present system, when the District Surgeon has put his report to the magistrate, the anaesthetist and surgeon and theatre sister are subpoenaed to go before the magistrate, who unfortunately possesses no medical knowledge, but nevertheless has to judge on matters medical. The surgeon is usually asked whether it was a necessary operation and he says, “Oh, yes.” The anaesthetist is asked what anaesthetic
he used and how much of it, and whether the patient was
auscultated before administration of anæsthetic, and he
gives his evidence to the best of his ability, and the theatre
sister is asked what her opinion of the whole affair was, and
whether she saw the doctors doing their best to restore the
patient to life.

The verdict of the inquest usually is one of "Death as a
result of the performance of a necessary operation under an
anæsthetic."

During the proceedings the newspaper reporters take
down the whole evidence verbatim, and the evening news
has sensational headlines with an account of the inquest pro-
ceedings.

Such seems to be the system in South Africa of inquiring
into these unfortunate happenings.

It seems, then, from what has been written that the whole
inquiry is futile and valueless, and renders no service to
anyone, and a modification of the present procedure is
definitely indicated.

I have stressed the importance of a trained pathologist
who must be able to get assistance from a bacteriologist and
a biochemist, and also would stress the appointment, in
these cases, of magistrates with medical knowledge who
would conduct the inquiry with the surgeon, the anæsthetist,
general practitioner or physician who attended to the case
immediately before death, and the ward sister, who will be
able to give valuable information of any peculiarities about
the patient during the time he was awaiting his operation.

It is only after such a method of inquiry that we shall be
able to gain useful information which will stand us in good
stead in preventing anæsthetic fatalities.

No useful purpose is served by the Press publicity of these
cases, and I do blame the Press for inculcating fear into
the public mind. The fear factor is most important and is
one which makes the lot of the anæsthetist and surgeon diffi-
cult, and may even be responsible in many cases for the
death of the patient.

I therefore consider that these inquiries should be held in
camera, and the Press excluded.

In Sir Edward Thornton's report for year ended June 30,
1935, table "R" gives a summary of deaths connected with operations performed in the main hospitals in the Union of South Africa during the last five years, and although the death-rate has fallen it still remains disquietingly high.

Statistics of anaesthetic mortality are on the whole not reliable because they do not take any account of the condition of the patient, nature of the operation, and skill of the individual anaesthetist or surgeon. For example, nitrous oxide-oxygen administered in cases of intestinal obstruction will usually give higher mortality than ether for tonsillectomy.

It is only when proper records are kept of pre-operative physical and mental state of the patient, of the choice of anaesthetic, and amount used, of the conduct of the patient during the operation, and of the period of post anaesthesia, that we will be able to make headway in anaesthesia.

It seems to me that the reason for our high anaesthetic mortality in South Africa is that there is seldom any attempt to evaluate the surgical and anaesthetic risk by the various well-tested methods at our disposal. The anaesthetist does often only see his patient on the operating table, and from sparse details given him he has to decide on the spur of the moment what anaesthetic he will employ. The anaesthetic service in most hospitals is conducted by honorary anaesthetists who usually visit the hospitals at set times, and do not supervise and teach the residents, who, on the other hand, are very often so busy that they do not find time to stand and observe. Ninety-nine per cent of surgical emergencies are anaesthetized by unskilled residents who happen just to be "on call" at that particular time, and very often moribund patients are put on the operating table, whereas a little judicious pre-operative treatment would turn the scales and so help to decrease the operative risk very greatly. The interest of the house physicians in general hospitals ought to be aroused in the charting phase of anaesthesia, and in this way they will learn as much, if not more, about medicine than in the medical wards. There seems great need for reform in the anaesthetic service of our various hospitals, and such reform will certainly minimize the anaesthetic catastrophes of which we are now reading.
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It is interesting to note in passing that better anaesthesia results in startling reduction in the cost per capita per patient in hospital, since better anaesthesia makes for more rapid convalescence and less post-anæsthetic morbidity. Dr. R. M. Waters of Madison, Wisconsin, and Dr. F. P. de Caux of North Middlesex Hospital, London, have both proved this by very carefully working out statistics.

One can stress now the importance of a well-functioning anaesthetic service in a general hospital under the supervision of a well-trained anaesthetist. Satisfactory anaesthesia for all types of operations can be given only under the guidance of an experienced anaesthetist who can give advice at all times, especially in cases where success of operation depends on a well-chosen anaesthetic and careful administration.

There is no doubt that active supervision of the anaesthetic service in our hospitals is essential, and only in this way will the best services be rendered to the patient and surgeon.

Dr. Frank H. Lahey, one of the best-known surgeons in the United States of America, has put the position most concisely:

"Good anaesthesia costs more than poor or mediocre anaesthesia, but the surgeon and the hospital acquiring the advantages of the modern development in anaesthesia will very soon appreciate that they have been more than repaid for the investment in terms of patients' satisfaction, mortality, morbidity, and the surgeon's and hospital's comfort and conscience."

**NEW AGENTS**

Almost every month during the past few years new methods and new drugs have been introduced, and I would stress the importance of submitting new anaesthetic agents to a very thorough and conservative test before adopting them for general clinical use. No new method of anaesthesia or analgesia should ever be tried out unless as safe as the one which it is to displace.

Undue enthusiasm based on limited experience results in very unpleasant happenings. I would refer here to the
derivatives of the barbituric acid which have, during the past few years, come into such prominence as anaesthetics, but I do not intend entering into a discussion of the complex chemical make-up of these agents.

The stages of barbiturate narcosis are conveniently described as follows:

1. The stage of hypnosis usually comes on from one to four minutes from commencement of injection. Patient experiences sensation of mental dullness, sometimes exhilaration or euphoria. On awakening he usually retains no recollection of the events of this stage. The stage of hypnosis may be carried on to anaesthesia by inhalational or regional methods of anaesthesia. This is the greatest usage of the barbiturate to my mind, and this stage of hypnosis is certainly the most valuable from the anaesthetist's point of view, and certainly is not accompanied by untoward effects.

I hold that any increase in dosage of the barbiturate to produce more profound effect leads us to dangerous ground.

2. The stage of inebriation is occasionally manifested where the dosage is greater than that employed for hypnosis. Patient is emotional, responds very acutely to painful stimuli, and it is necessary to employ inhalational method to facilitate matters.

3. The stage of anaesthesia generally is produced by doubling the dosage required for hypnosis, and this stage is one where untoward effects may arise, and one where very careful observation of the patient is necessary, whether short operations are to be performed or more lengthy ones.

I have had a good deal of experience with evipan sodium, used not only as an hypnotic but as an anaesthetic, and although I have not personally used the newcomer pentothal sodium, or thio-nembutal, have seen it used in America and in England. I must confess that as far as I have been able to judge, it has very little advantage over evipan, with which I have had uniformly good results.

I am certainly not an advocate of intravenous anaesthesia in minor or major surgery, and routine substitution of this method for the older and safer and well-tried-out methods is to my mind most undesirable.
There is no doubt that in this form of anaesthesia the anaesthetist does lose control to an extent. He cannot alter the level of anaesthesia at a short notice in the case of emergency, and consequently, should excessive bleeding or some hidden onset of shock result during operation, the patient may be in a dangerously deep plane of anaesthesia.

In chosen subjects there does seem to be excuse for the employment of intravenous anaesthesia for very minor operations of short duration, but in case of major surgery, e.g., of the abdomen, where continuous intravenous anaesthesia is to be employed, I cannot see any advantage over the methods at our disposal.

It seems to me that the surgeon in these cases has to work against time, and such a method of anaesthesia is mere "stunt" anaesthesia, and definitely pandering to the spectacular at the expense of added risk to the patient. I have not been able to see any advantage to the patient, surgeon, or anaesthetist when such a method has been employed for major work. The patient's vital functions are depressed; he reacts in a variable way to the drug; may be very susceptible or extremely resistant; the surgeon is working against time, and at any rate for abdominal work never gets the relaxation he requires, and is not given the operative facility necessary, and is consequently unable to do his operation efficiently and expeditiously, whereas the anaesthetist (even the greatest protagonist of this method) is never quite happy.

"Stunt" anaesthesia is to be condemned as very definitely dangerous and serving no good purpose and just adding to the numbers of anaesthetic fatalities.

The tendency towards pulmonary oedema and bronchopneumonia is enhanced where anaesthetic doses of barbiturates are employed.

4. The stage of over-dose of barbiturate is characterised by profound depression of respiration and circulation. The Council of Pharmacology and Chemistry of the American Medical Association has gone so far as to recommend that the intravenous injection of barbiturates should only be used
for emergencies and for those cases in which oral administra-
tion is impossible.

Another factor which is often overlooked is the cumu-
lative effect of the barbiturates and delayed absorption. Se-
veral fatalities have occurred through injudicious dosage
of the barbiturates in this way.

The tendency in anaesthesia to-day is to come away from
general and to use local anaesthesia with supplemental in-
halation anaesthesia when necessary. I have been somewhat
concerned at anaesthetic "cocktails" which patients receive
to-day prior to undergoing operations. I have known
patients to receive omnopon scopolamine followed by pen-
tothal sodium or evipan followed by spinal anaesthetic or
local, and gas and oxygen just to complete the "cocktail".
It is amazing that the body can deal as effectively as it does
with this mixture, having the added strain of an operation
with which to cope in addition. It is not surprising that we
are to-day seeing more post-operative morbidity than before
owing to the severe depression of vital functions by these
various agents and the severe test of biochemical endurance
to which the body is put.

I am quite convinced that simple methods of premedica-
tion combined with the choice of as non-toxic a method of
anaesthesia as possible, depending on the type of operation
and the pathology present, and also the particular type of
risk with which we are dealing, are undoubtedly the most
satisfactory.

The prevention of anaesthetic mortality and morbidity
thus depends on three principal factors, all of which are
of great importance, and no one plays a lesser or greater
part than another, and all are interdependent.

1. The patient.

2. The surgeon.

3. The anaesthetist, who up to comparatively recently has
been regarded as someone who comes along with rag and
bottle and finds the awe-stricken patient on the operating
table wide awake, looking at the theatre sister brandishing
gruesome instruments in the air. He arrives at the last
moment and leaves the patient to his own devices as soon as the last stitch is inserted.

Our mortality rate and anaesthetic morbidity will remain high until it is realized how important is close co-operation of the surgeon and anaesthetist. I shall deal briefly with—

1. The patient.—Attention to his psyche on the part of the anaesthetist, who introduces himself at least the night before the operation in the case of elective surgery, and orders the necessary premedication. (Where emergency arises this, of course, is not possible.) Scientific preparation of the patient is most important before operation, and placing him in the best possible condition for the mental and physical endurance test he is about to undergo. Attention to psyche does not mean gross over-doping with barbiturates, but rather encouragement and reassurance. A good night’s rest prior to operation, no starvation, purgation, or enemata—these are relics of the past and exhaust and dehydrate the patient and put him into an acidotic state before the surgeon starts.

Scientific preparation in elective major surgery should commence some eight to ten days previous to operation by careful attention to diet, and adequate supply of calcium, mineral salts and iodine; the inclusion of food rich in vitamin A, B, and D (anti-infective) and attention to the mental and physical condition of the patient, thus increasing his resistance in every possible way. It is only by such preparation that we can expect our anaesthetic mortality and morbidity to fall.

2. The surgeon.—There are surgeons and surgeons! Surgeons are the most egotistical of human beings, and one has found in the past that a good many surgeons think that operative facility is all that matters even at the expense of the patient’s welfare.

The anaesthetist is obliged to please the surgeon, otherwise his means of livelihood is curtailed, and he is more or less tied hand and foot. Fortunately, however, there are a few surgeons who do collaborate with anaesthetists, and where this occurs great benefit is derived by the patient, and I am sure better results are obtained. In these times,
when surgical interference is so frequent, very often without due deliberation and judgment, great strain, sometimes unbearable strain is placed on the patient, and millimetres of mercury are added to the blood-pressure of the anaesthetist. I refer here to the operating general practitioner, who does the odd appendix and every now and then decides he will spend the morning removing a gall-bladder.

I attribute our morbidity and mortality to the prolonged administration of anaesthetics to patients whose surgical risk has previously not been evaluated, and great shock-producing operations unskilfully performed accompanied by a great deal of unnecessary trauma.

It seems a great pity that definite rules cannot be formulated as to which members of the profession should be allowed to operate.

3. The anaesthetist—the patient’s guardian angel who, until recently, has been regarded as a necessary evil, is, to my mind, most important. “It is important,” Ross Mackenzie says, “that the modern anaesthetist should be a man of judgment and a good physician, with such knowledge of surgery as will enable him to anticipate the anaesthetic requirement of the surgeon. He is in part a physiologist and a pharmacologist and a biochemist.”

It is the work of the anaesthetist to evaluate the surgical risk, to advise the surgeon as to measures to adopt to improve physical condition of the patient, and to guide him through his time of trouble during the ordeal, and afterwards to watch and prevent any untoward happenings directly resulting from his anaesthetic.

Having evaluated the surgical risk from his examination of the patient, and application of certain indices—e.g., Moot’s index, energy index, also breath-holding test, etc.—the patient can be classified according to classification suggested by the International Anaesthesia Research Society.

A Risk.—Performance of a minor operation upon a healthy subject, i.e. the subject in whom all the various tests of physical fitness are satisfactory.

B Risk.—A major operation performed on a healthy
subject or an operation not dangerous to life performed on an unhealthy subject.

**C Risk.**—A serious operation upon a subject presenting some grave pathological condition.

**D Risk.**—A patient, in urgent danger of death either from some grave disease or its complications, on whom an operation is to be performed.

The final choice of anaesthetic will depend on:

(a) Anaesthetic risk (the least toxic anaesthetic being used in poor risk cases).

(b) On the mental make-up of the patient (*e.g.* in a patient of nervous temperament, lasting psychical trauma will result from injudicious administration of local anaesthesia.

(c) On the surgeon who is to be given the greatest amount of operative facility compatible with safety to the patient.

(d) Certain pathological and regional factors existing influence the choice of anaesthetics—*e.g.*:

1. **Shock and haemorrhage.**—Anaesthetic mortality and morbidity may be tremendously reduced by the improvement of the condition of the patient pre-operatively by blood transfusions. These are the cases where judgment plays an important part. The judicious postponement of the operation for a few hours in the case of severe haemorrhage or shock, during which period continuous intravenous medication is instituted, or even continuous blood transfusions, will result in prevention of fatalities and in addition avoid post-operative complications. Local anaesthesia is probably the best in these cases, and where the blood-pressure is low spinal anaesthesia is contraindicated.

2. **In the cases of severe sepsis** local anaesthesia is contraindicated in and around the septic area, but remote regional anaesthesia with or without gas may be used.

3. **Cardiovascular conditions.**—In my experience the so-called "heart cases" always react very well to anaesthesia,
provided that an over-abundance of oxygen is supplied all
the time. Chloroform, in view of its reputation as a heart-
muscle poison, must be avoided. Where there is decompensa-
tion the anaesthetic risk is very great. Restoration of
compensation must be attempted if there is time before the
anaesthetic is administered and the least toxic form of anaes-
thesia should be employed. Inhalation anaesthesia is best
avoided in these cases. Local anaesthesia is perhaps the
safest of all, but at times—e.g., in case of Cæsarean section
with decompensated heart—I have had uniformly good
results with spinal anaesthesia, even where there has been
gross congestive heart failure. Ether and nitrous oxide-
anæsthesia will cause post-operative complications or death.

Quite recently I had an opportunity of discussing with
Dr. Huberta Livingstone of Chicago this question of
anaesthetic risk in cardiac subjects, and she has written a
most interesting paper on this subject. She regards ethyl-
ene oxygen as anaesthetic of choice in these cases of cardiac
disease; the reason being that with ethylene anaesthesia a
greater amount of oxygen can be used to produce surgical
anaesthesia, thus avoiding the asphyxial element so com-
monly seen in nitrous oxide-oxygen anaesthesia. The choice
of anaesthesia in cases of hypertension, infective endocar-
ditis, angina pectoris, etc., must be made after determining
the amount of myocardial damage.

4. Respiratory diseases.—These present a great problem
and choice of anaesthetic must be made according to the
condition present. Inhalation anaesthesia is best avoided
on the whole and the employment of local anaesthesia seems
to be the method of choice. N₂O and O₂, in view of the
curtailment of oxygen (which, as in the case of heart
disease, is so important), is not ideal. During a recent
clinic tour of the United States of America and Canada,
I was very impressed with the use of cyclo-propane in
chest and lung surgery. The value of this particular
anaesthetic agent in these cases was due to the fact that
anaesthesia was produced by the use of 6 to 11 per cent
of the gas, combined with 94 per cent to 89 per cent of
oxygen. I saw it used with remarkable success in Toronto,
and here, too, I was fortunate to see the use of spinal anaesthesia employed by Dr. Harry Shields in lung surgery. Dr. Shields regards spinal anaesthesia as the anaesthetic of choice in intrathoracic surgery.

I personally have not employed it for this purpose, but being an ardent protagonist of spinal anaesthesia, I shall have no hesitation in employing this method should occasion arise.

I. W. Magill of London, too, who has had more experience of anaesthesia in chest surgery than anyone else in England, expressed to me his satisfaction of the results in these operations performed under spinal anaesthesia.

5. **Renal diseases.**—Here I have found spinal anaesthesia producing uniformly good results. The anaesthetic here is one which will not injure the parenchyma of the kidney, and all inhalation methods except, perhaps, nitrous oxide-oxygen throw severe strain on these tissues. Nitrous oxide-oxygen does not give the operative facility which spinal anaesthesia does. Patients who are suffering from renal disease associated with prostatic enlargement do very well with a combination of sacral (epidural) anaesthesia, 40 c.c. of a 2 per cent solution of scurocaine combined with local infiltration of the abdominal wall where the prostate is to be removed. In some of these selected cases low spinal anaesthesia gives good results, but in my experience the most satisfactory results have been obtained by a combination of the above-described methods.

6. **Thyro-toxicosis.**—This condition is becoming increasingly more common in South Africa, and is one in which the anaesthetic aspect has interested me greatly. The two factors of importance in connection with this condition are:

1. The psychical imbalance of the patient.
2. The extent of myocardial involvement.

Both these have to receive every consideration before the operation, and when the choice of anaesthetic is made, I do not know of any condition where there is greater necessity for the anaesthetist, surgeon and physician (if the patient can afford all three) to be in careful collaboration,
because decision to operate at inopportune time may result in catastrophe. Thyro-toxic patients require careful pre-anæsthetic medication in view of their highly nervous state; require careful medical treatment from cardiac aspect, and great experience and careful technique and judgment on the part of the surgeon. Rough handling of the gland and lack of judgment as to how much to do at one sitting and inadequate pre-operative care and pre-anæsthetic medication may result in high mortality.

I have in my practice concentrated on the aspect of premedication, combining it with local anæsthesia, and have obtained uniformly good results, but lately have employed the Hewer-Crile technique, which consists of omnopon scopolamine, avertin, combined with local anæsthesia.

It may be necessary, where traction is being exerted on the trachea, for the patient to receive 80 to 85 per cent nitrous oxide with 20 to 15 per cent oxygen.

I maintain that a careful combination of the above-named agents will give good results. In the earlier part of my paper I expressed the horror of the anæsthetic "cocktail" with which patients are served at times, but there does seem genuine excuse for giving a thyro-toxic patient a "cocktail" in view of the many difficulties with which one is faced in these cases. It has been stated by Kendall that thyroxin and avertin are antagonistic, so that one is justified in the choice of this particular agent. (Contraindication, however, in sub-thyroidism.) I have found that the more toxic the thyroid patient, the more difficult it is to produce mental rest, with the result that it is of paramount importance to have mental quiescence. Synergistic analgesia based on Buergi's hypothesis is of great value here. I have had excellent results following Crile's method of "stealing" the goitre, i.e. not telling the patient when the operation is to be; but Joll of London does not believe in concealing from the patient the time of the operation, and holds that it comes as a bigger shock suddenly to regain consciousness and find the neck painful and tied up with bandages. Joll's anaesthesia consists of slight premedication (except in very thyro-toxic cases) combined with local
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anaesthesia (not cervical block) and intratracheal nitrous oxide-oxygen 85 per cent/15 per cent.

I was most interested to find that all his thyroid cases were intubated, his reason being that neither his nor the anaesthetist's peace of mind was disturbed during the operation. My only objection to this method is that nearly every patient after thyroidectomy has some degree of sore throat and tracheitis which must be much aggravated in the routine use of the intra-tracheal tube.

Dr. Frank Lahey of Boston, who has had no small experience of goitre work, and with whom I came into contact, has of late employed cyclo-propane more or less as a routine in goitre work, with very excellent results—the advantages here being, too, the use of very high percentages of oxygen. Drs. Lincoln Size and Philip Woodbridge, who are on the staff of the Lahey clinic in Boston, are most enthusiastic about the use of cyclo-propane in goitre surgery, and have not found any unpleasant occurrences with its use.

7. Acidotic States (Diabetics, etc.).—Nitrous oxide-oxygen or spinal anaesthesia are the methods of choice.

8. Anaemias.—The severe anaemias as found in the primary blood diseases demand the less toxic of all anaesthetic agents, nitrous oxide-oxygen, to be the choice.

9. Operations involving cautery.—Great care is to be exercised in these operations in the use of explosive anaesthetic agents. The agents which are non-explosive are nitrous oxide-oxygen, chloroform, local anaesthesia, barbiturates, so that we have quite a wide choice. The addition of oxygen to explosive anaesthetic agents makes them more explosive. Explosive agents are ethyl chloride, ether, ethylene, cyclo-propane, and must not be employed where cautery is in use.

Faulty endoscopic lamps have been responsible for explosions, and every precaution should be taken in choosing a non-explosive anaesthetic where cautery or endoscopic lamps are to be used. It is commonly stated that the exhalations from a patient under ether anaesthesia are
innocuous and inexplosive. The sooner this statement is taken out of various textbooks, the better. Most of the explosions in England have resulted from the employment of ether in cases where cautery or faulty endoscopic instruments have been used, and consequently, with the more common employment of these methods, we may expect accidents if great care is not exercised.

Static electricity does not effect South Africa as it does North America. I was most interested to see in Chicago the elaborate precautions in "grounding" the patient, the anaesthetist and the anaesthetist's apparatus. These elaborate precautions are very necessary where explosive anaesthetics are used, and where static electricity is such a menace. In time to come, I suppose, we shall have to cope with these difficulties.

10. Menstruation.—I do not believe that a menstruating patient, except in surgical emergencies, should be subjected to an anaesthetic in the case of elective major surgery in view of the alteration of the psyche of the patient at this time, and also in view of the fact that very few women are in the best physical condition.

11. Pregnancy.—Pregnancy is no bar to the administration of an anaesthetic, provided that the patient is not saturated with the anaesthetic, and that no cyanosis is produced. It is as well to avoid chloroform, but ether is quite well tolerated, as is spinal anaesthesia or gas, always remembering the danger of cyanosis to the child especially.

I have dealt with the pathological factors influencing the choice of anaesthesia and thus reducing mortality and morbidity, and I propose to deal with some of the regional factors which also influence this choice.

12. Ear, nose and throat operations.—(a) Mastoid operations: For these very light anaesthesia indeed is required, and in my experience ether does seem to produce congestion and increased bleeding. Nitrous oxide-oxygen does the same. I have employed without untoward happening minimal amounts of chloroform, at the same time giving oxygen continuously per nasal catheter. It may be
argued that it is dangerous to employ this most dangerous of all anaesthetics in the presence of such a toxic condition, but these operations in the hands of able surgeons are so speedily performed, especially in the absence of undue bleeding, that I have felt justified in these cases in employing this agent.

(b) Septum and Turbinate Operations. — These are usually performed under local anaesthesia or a combination of local with intratracheal ether, but here again this may increase congestion and bleeding.

(c) Tonsils and adenoids.—Anaesthetics for tonsil and adenoid operations vary according to the type of operation performed. I have for some considerable time employed endo-pharyngeal insufflation of ether, using a gag of the Boyle-Davis type and pumping the ether over by small motor.

Adequate relaxation of the throat is obtained and such operative facility is given that the operation for dissection of tonsils takes very little longer than the old guillotine method.

I am quite convinced in my own mind of the absolute necessity for relaxation of the soft palate during the curettage of adenoids, the operation for the performance of which I regard of far greater importance than tonsillectomy itself.

I do not believe that pure gas anaesthesia will approach anywhere near giving the operative facility given by endotracheal insufflation of ether for the performance of these operations.

The guillotine operation for tonsils can quite efficiently be carried out by the use of ethyl chloride (open or closed). I have found that far superior to ethyl chloride for these particular cases is the employment of di-vinyl ether or vinethene, which is superior to ethyl chloride in so far that it does not produce the spasm which one so very often sees with ethyl chloride and gives much greater operative facility and results in less bleeding.

Local anaesthesia, of course, has found favour with a
good many surgeons, and with adequate premedication, I do not think much objection can be raised against it.

*Quinsy and retro-pharyngeal* abscesses are best anaesthetized by local anaesthesia. I believe that it is dangerous to use ethyl chloride or chloroform, and ether may produce edema of the glottis where there is any respiratory obstruction. I have had unpleasant experience of intravenous anaesthesia in these cases, and must whole-heartedly condemn such methods.

*Laryngeal operations.*—Very often tracheotomy is performed and gas anaesthesia or ether may be administered into the trachea through the wound.

*Bronchoscopy* may be performed under local anaesthesia, as also intubation of the smaller bronchi.

*Æsophagoscopy* may be performed under endotracheal anaesthesia.

*Cleft-palate and hare-lip.*—In these cases endopharyngeal insufflation of ether through the nasal tube or intubation (oral or nasal) of intratracheal catheter; administering gas oxygen with minimal ether is a very satisfactory method of anaesthesia. The use of the Dot modification of the Boyle-Davis gag or Dennis Brown gag facilitates matters greatly for the surgeon and the anaesthetist.

*Surgery of the head and neck.*—Minor operations are done safely with local anaesthesia and even major proceedings may be done with local combined with satisfactory premedication. Endo-tracheal ether is very satisfactory and safe for these cases. Avertin has been used too, but for posterior fossa tumours, where there is already difficulty with the respiration, it may not be advisable to employ Avertin in view of its further depressant action.

*Plastic surgery about the face and head* is efficiently carried out with intratracheal anaesthesia, and it was really during the Great War that intratracheal received such an impetus on account of its usefulness in these cases.

*Thyroid surgery.*—We have had uniformly good results in thyroid surgery employing local anaesthesia combined
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with adequate premedication. Nothing is more important in reducing the mortality in surgery of hyperthyroidism than the anaesthesia and the anaesthetist. Ether must be banned owing to the post-operative vomiting which may ensue, thus still further imbalancing metabolism. Nitrous oxide-oxygen anaesthesia (solely), owing to the limitation of oxygen, is not desirable. I have pointed out that the employment of cyclo-propane in goitre work has been much advocated in the United States of America owing to the high percentage of oxygen which can be employed. The anaesthetist plays a great part in the reduction of mortality in hyperthyroidism because on his decision the surgeon depends on how much to do and when to stop.

Thoracic surgery.—I have had to do very little anaesthesia in thoracic surgery, and I think this is due largely to the fact that physicians do not realize what surgical advances have been made in this particular branch of surgery. I have used evipan sodium continuously in a few cases of thoracoplasty, and have found it quite safe and effective, and it was interesting to me to find, when discussing the aspect of anaesthesia of these cases with Dr. Pol Coryllos, one of the best-known chest surgeons in the United States of America, that he employs evipan sodium routinely in these cases, and performs in the region of 14 thoracoplasties a week. Thoracoplasty is carried out quite well under local or gas anaesthesia. In empyema thoracis the anaesthetic of choice is local, giving no unpleasant after-effects. In so far as actual lung surgery is concerned, the ideal anaesthetic seems to be not definitely determined. I cannot speak with experience on these cases, but I have been most struck with the work of Dr. Harry Shields of Toronto, who demonstrated his method of spinal anaesthesia to me for cases of lobectomy and pneumonectomy. Cyclo-propane anaesthesia, due to the high percentage of oxygen which can be used, is most popular in these operations, but the disadvantage is the fact that the cautery cannot be employed. Needless to say, where both thoracic cavities are opened, positive pressure, endo-tracheal anaesthesia is essential to avoid fatal bilateral pulmonary collapse.
I cannot omit to mention the work of Dr. Ralph M. Waters of Madison, who has instituted the method of directing anaesthetic gases into selected bronchi and shutting off the affected lung or lobe of lung by means of a special catheter with inflatable cuff, which he has designed in conjunction with Dr. Guedel, now of Los Angeles (Waters' method of closed endo-bronchial anaesthesia).

Abdominal surgery. (a) Upper abdominal surgery, including gall-bladder, gastric and duodenal operations; (b) lower abdominal surgery, including appendicitis, colonic surgery, gynaecological and rectal surgery.

There is only one anaesthetic in the case of gall-bladder disease, including surgery of the biliary tract, in good risk cases, that is, spinal anaesthesia. No other anaesthesia gives such surgical comfort as will this form of anaesthesia. In poor risk cases local anaesthesia may be employed, e.g. in cholecystitis, especially in the aged.

Gastrectomy and gastro-interectomy are done with greatest facility and with least shock with a combination of local and splanchnic according to the Finsterer technique, and acute emergencies in the upper abdomen stand this form of anaesthesia very well too.

Coming to the lower abdomen, the choice of anaesthesia in acute appendicitis is without any doubt spinal anaesthesia. It produces no shock, affords operative facility which no other anaesthetic will give, and prevents the generalized dissemination of the condition. For prolonged operations—e.g. on the cecum or colon, Wertheim operations—spinal anaesthesia will give most satisfactory results. It may be combined with light gas anaesthesia to maintain the blood-pressure by virtue of CO₂ accumulation, but this is not really necessary if one, at intervals during the operation, administers a steady stream of 10 per cent CO₂/90 per cent O₂.

I have administered in the region of four to five thousand spinal anaesthetics, and am convinced that it is the anaesthetic of choice in these selected abdominal conditions. The particular preparation which I have been using during the last 18 months is a Bayer preparation, Decicaine L, a light
solution the specific gravity of which is 1.001 and the dosage given according to the nature and duration of the operation. I have found that spinal anaesthesia can be made to secure minimum danger, discomfort and pain, together with maximum convenience, provided that due attention is paid to detail of administration of the anaesthetic and great care is taken to make the patient as comfortable as possible after administration, and preventing overstretching of paralysed muscles by adequate support, especially in the small of the back.

I am not an advocate of spinal anaesthesia for trivial conditions, and am opposed to its employment for those minor conditions in which some other anaesthetics may be employed.

Sacral anaesthesia does very well for pile operations and for dilatation of the urethra and for any procedure in the saddle area of the perinæum.

Urogenital surgery.—For prostatectomy, sacral and local produce least disturbances in these patients. Low spinal anaesthesia in selected cases, too, gives good results.

Fractures.—Fractures may be anaesthetized by local means quite effectively, injection of the local anaesthetic into the haematoma according to the technique of Professor Bohler. Failure to produce adequate anaesthesia in these cases may result in about 6 per cent due to loculation of the anaesthetic.

Extremes of age.—The choice of anaesthesia in extremes of age depends on the type of operation to be performed, but in these cases the least toxic anaesthetics are employed.

Local anaesthesia, generally regarded as unsuitable in the case of children, can be quite effectively employed at times if the confidence of the child is first secured. I have given a child of four a local anaesthetic for an extensive skin graft, giving him a penny sucker with which to amuse himself throughout the operation.

I have also employed spinal anaesthesia in quite young children with intestinal obstruction with success, and have, too, used it in quite old people in selected cases. In aged
subjects who are prone to bronchitis, ether is contra-
indicated, as is over-dosage with the slowly excreted bar-
biturates, but ether is very useful and safe in children.

I do not know of any better anaesthetic for operation for
congenital pyloric stenosis than 10 c.c. of 1 per cent solution
of novocaine infiltrated in the line of abdominal incision.

Contrary to what has been written and said about local
anaesthesia being unsuitable and too toxic for children, I
maintain that in children of all ages local anaesthesia can be
employed very satisfactorily if there are no definite contra-
indications, e.g. sepsis.

If a small dose of barbiturate is administered in these
cases where local anaesthesia is employed, it will mitigate
the toxicity of the novocaine, and thus add to the
safety.

With regard to premedication in children, I feel that it is
just as important to employ as in adults. The barbiturates
on the whole do not give uniform results, but the employ-
ment of morphia plus hyoscine in dosage according to age
of child has, in my experience, given satisfactory results.
Children 1 to 2 years, for example, are given 1/40 grain of
morphia with 1/500 of hyoscine. Children 12 to 16 years 1/12
morphia with 1/200 hyoscine. With such premedication
atropine is unnecessary, because hyoscine has the same de-
hydration effect.

Dental anaesthesia.—From the aspect of the dental
surgeon local anaesthesia is the method of choice, and I
have not met any dentist who would not prefer this method
for the conquest of pain.

He has the co-operation of the patient; the posture of the
patient is the one in which he does his daily work, and he
can take his time (such an important factor). I have one
criticism to make, and that is that only in extremely rare
instances are patients premedicated.

The average patient will only visit the dentist when forced
to see him, and I maintain that every patient, young or old,
before visiting the dentist, even where minor dental pro-
cedures are to be carried out, should have some sedative
tablet. If this were more generally done, I am quite con-
vinced that dental decay would not be so rife, because time
and again it must have been the experience of every dentist
to find that patients through sheer nervousness have
allowed teeth to decay to such an extent that there has been
no option but to do wholesale extractions. I have, too,
been called to give anaesthetics for dental extractions where
teeth have been perfectly sound, but the patient has in-
sisted on having extraction done to avoid the painful pro-
cEDURE of filling of teeth. It is my feeling that if
premedication were sufficiently used for the extraction of
teeth we might be able to avoid anaesthetic mortality and
morbidity arising out of these cases, because every general
anaesthetic involves a certain risk.

General anaesthesia for dental extraction may be pro-
duced by inhalational agents or by intravenous methods.

Chloroform, in view of its traditional unsafety, is contra-
indicated. Ethyl chloride and nitrous oxide-oxygen, in my
opinion, are only useful in those cases in which a few teeth
(or a single tooth) are to be extracted and where undue
difficulty is not anticipated (if it is possible to predict this
in dentistry).

There is no question about nitrous oxide-oxygen being
the safest of all anaesthetics, but in my opinion ether can be
made just as safe and can be used to produce ideal anaes-
thesia for dental extraction.

I have administered nitrous oxide-oxygen and have seen
it administered by the best exponents in the world, and
am of opinion that it does not approach ether anaesthesia
from the aspect of production of operative facility in the
way of relaxation of jaw and affording enough time for a
quiet atraumatic extraction operation. Pure nitrous oxide-
oxygen anaesthesia (unsupplemented by ether) does not
give uniform and persistent good operative facility, but
rather allows only for the "smash and grab" dental opera-
tions which, however, I think are fortunately becoming
rarer.

It may be argued that patients wake up very quickly
after nitrous oxide-oxygen—this is a definite disadvantage
to my mind. It takes a little longer for recovery with ether
anaesthesia, but the recovery period may be shortened by
the post-anæsthetic administration of CO\textsubscript{2} and O\textsubscript{2} which, in addition, is a prophylactic against post-operative lung complications when judiciously used.

The criteria used in evaluation of the anæsthetic and operative work in general surgery must be employed in regard to dental operations, and the practice of patients walking off the street into a dentist's rooms and having wholesale extractions without any previous preparation must be condemned.

One cannot conclude a discussion of prevention of anæsthetic mortality and morbidity without making reference to the value of the use of CO\textsubscript{2}. It is of value in induction period where it makes an ether induction a very pleasant affair, and in all anæsthetics the induction period should be made as pleasant as possible. It is of value in cases where premedication has resulted in shallow respiration.

During the maintenance of anæsthesia administration of CO\textsubscript{2} is most important in the prevention of shock, and during recovery period CO\textsubscript{2} may help in the denarcotization of the patient as well as in the treatment of shock and the prevention of post-operative pulmonary complications. Injudicious administration of CO\textsubscript{2} post-operatively, however, where there is much bronchial secretion may give rise to lung complications due to the blocking of small air passages, and thus great care must be exercised in its use in these cases.

**Summary.**

The prevention of anæsthetic mortality and morbidity depends on:

1. Pre-operative evaluation of the anæsthetic risk and the charting phase in anæsthesia, which results in early detection of deterioration of the patient during anæsthesia.

2. The modification in the method of inquiry into anæsthetic deaths resulting in the collection of valuable information and accurate statistics.

3. In the subjection of new agents to a very thorough
test before using them to displace older and safer and well-tried-out methods (special reference to barbiturates).

4. Co-operation between patient, surgeon, and anaesthetist.

5. In dental anaesthesia adequate premedication with the use of ether as the ideal anaesthetic agent.

6. The judicious use of CO$_2$ for the prevention of morbidity arising out of anaesthesia, e.g. shock, failure of the respiratory and cardiovascular mechanism, and for the treatment of post-anaesthetic pulmonary complications.