Special Article

Forty years onward

R.A. Gordon

The intent of this communication is to review briefly the changes which have occurred in the sciences and practice of anaesthesia during my career in the specialty. This gives me license to reminisce, which may provide a sentimental journey for those of my generation. It will be evident that the constraint of space dictates that much of this must be in general rather than particular terms. Changes in medical knowledge and practice occur for the most part in an evolutionary rather than a revolutionary way and, for physicians actively engaged in practice, change over the years tends to be absorbed and to pass unnoticed. Only when one makes a conscious attempt to compare the present with an earlier era does the magnitude and direction of change come into focus. In this paper I shall draw such a comparison and will then review the changes which have taken place in the specialty of anaesthesia during my 45 years of experience in a variety of roles in the profession and in the specialty.

The first surgical anaesthetic of record in Canada was given in Quebec City sometime before February 20, 1847, approximately four months after Morton's demonstration in Boston. In spite of this early beginning and the notable contributions of Canadian anaesthetists such as Webster, Johnston, Brown, Shields and Bourne, during the early decades of this century, before 1940 there were not more than a dozen anaesthetists in Canada who confined their practice to anaesthesia. Moreover, except for the adoption of regional anaesthetic methods and particularly spinal anaesthesia during the first two decades of the century, introduction of several new inhalation agents such as ethylene, cyclopropane and divinyl ether and the early tentative use of intravenous agents, anaesthetic practice had changed very little during the first 90 years.

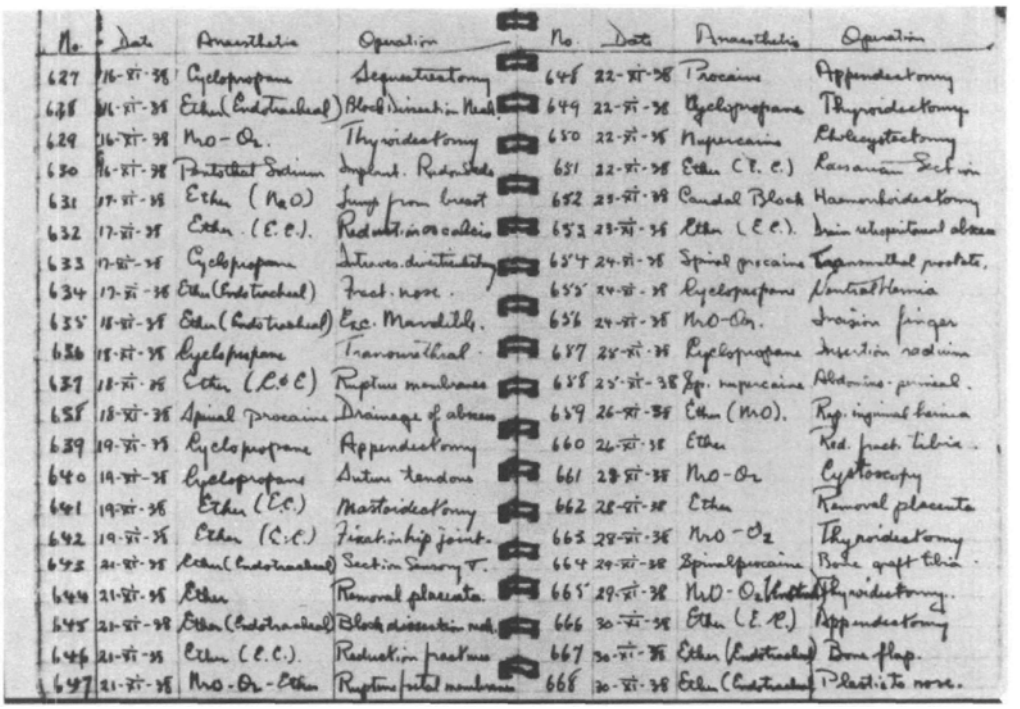
When I commenced the study of anaesthesia 45 years ago a resident anaesthetist was a novelty in teaching hospitals and the specialty was so little regarded by the rest of the profession that a senior surgeon of that time in Toronto, on being informed that one of my contemporaries was applying for a house appointment in anaesthesia, reacted by saying "But he was a good student! What on earth does he want to do that for?" When I did my anaesthetic training it never occurred to me that I would be able to make a full-time career of the practice of anaesthesia; and then came the opportunity which so many of my generation shared, of doing full-time anaesthesia in the armed forces between 1939 and 1946. We found the specialty could provide an all-absorbing life work, with innumerable problems to be solved and an endless chain of questions to which we must find answers.

I recently came upon the notebook in which I recorded my "cases" during my residency 1938–39 at the Toronto General Hospital. It may be of interest to you to see some pages from that record, as an example of the nature of anaesthetic practice in a major urban hospital at the time (Figure 1).

Certain features of this list are of interest. You will notice the frequency of ether anaesthesia with ethyl chloride induction. This notation indicates open drop ether with a gauze mask, excepting those cases specifically marked "endotracheal" and the mastoidectomies. Patients undergoing mastoidectomy and intra-nasal operations were anaesthetized by the endotracheal insufflation technique of Meltzer and Auer, in which ether vapour in air was blown by a compressor pump into the trachea through a small gum-elastic catheter. Spontaneous respiration occurred around the catheter.

Ether anaesthesia for neurosurgical operations was also maintained with ether vapourized in air delivered by a compressor and insufflated under a

R.A. Gordon CD MD FRCP(C) FFARCS Hon. FFARCS Hon. FWACS. Professor Emeritus, Department of Anaesthesia, University of Toronto.



No.	Date	Anaesthetic	Operation
627	16-XI-38	Cyclopropane	Sequestrectomy
628	16-XI-38	Ether (Endotracheal)	Block dissection neck
629	16-XI-38	N_2O-O_2	Thyroidectomy
630	16-XI-38	Pentothal Sodium	Implant. Radium Needle
631	17-XI-38	Ether (N_2O)	Lung from breast
632	17-XI-38	Ether (E.C.)	Reduction of colles
633	17-XI-38	Cyclopropane	Intervert. disc lumbar
634	17-XI-38	Ether (Endotracheal)	Fract. nose
635	18-XI-38	Ether (Endotracheal)	Exc. Mandible
636	18-XI-38	Cyclopropane	Transurethral
637	18-XI-38	Ether (C.C.E)	Rupture membranes
638	18-XI-38	Spinal procaine	Drainage of abscess
639	19-XI-38	Cyclopropane	Appendectomy
640	19-XI-38	Cyclopropane	Suture tendons
641	19-XI-38	Ether (E.C.)	Mastoidectomy
642	19-XI-38	Ether (C.E.)	Fixation hip joint
643	21-XI-38	Ether (Endotracheal)	Section Sensory N.
644	21-XI-38	Ether	Removal placenta
645	21-XI-38	Ether (Endotracheal)	Block dissection neck
646	21-XI-38	Ether (C.E.)	Reduction fracture
647	21-XI-38	N_2O-O_2-Ether	Rupture fetal membranes
648	22-XI-38	Procaine	Appendectomy
649	22-XI-38	Cyclopropane	Thyroidectomy
650	22-XI-38	Nupercaine	Cholecystectomy
651	22-XI-38	Ether (C.E.)	Caesarean Section
652	23-XI-38	Caudal Block	Haemorrhoidectomy
653	23-XI-38	Ether (E.C.)	Brain subpetrosal abscess
654	24-XI-38	Spinal procaine	Trans-urethral prostate
655	24-XI-38	Cyclopropane	Ventral Hernia
656	24-XI-38	N_2O-O_2	Drain finger
657	25-XI-38	Cyclopropane	Insertion radium
658	25-XI-38	Sp. nupercaine	Abdomino-perineal
659	26-XI-38	Ether (N_2O)	Rep. inguinal hernia
660	26-XI-38	Ether	Red. fract. tibia
661	28-XI-38	N_2O-O_2	Cystoscopy
662	28-XI-38	Ether	Removal placenta
663	28-XI-38	N_2O-O_2	Thyroidectomy
664	29-XI-38	Spinal procaine	Bone graft tibia
665	29-XI-38	N_2O-O_2 (Endotracheal)	Thyroidectomy
666	30-XI-38	Ether (E.C.)	Appendectomy
667	30-XI-38	Ether (Endotracheal)	Bone flap
668	30-XI-38	Ether (Endotracheal)	Plastic to nose

FIGURE 1 Typical list of anaesthetics in a teaching hospital in 1938.

gauze-covered ether mask strapped over the open end of a Magill's tracheal tube.

You will see that endotracheal anaesthesia is specially noted in these lists (Figure 1). Endotracheal anaesthesia was a very special technique. We had three Guedel laryngoscopes at the Toronto General Hospital. One was kept in the neurosurgical suite. The others were kept with a small selection of Magill's tubes in two "endotracheal boxes." If one planned to use a tracheal tube it was necessary to reserve the equipment in advance, on a first-come first-served basis.

The almost routine use of spinal anaesthesia for abdominal operations is evident. Most surgeons considered this mandatory for adequate relaxation in upper abdominal operations. The only alternative was deep ether anaesthesia.

Thyroidectomy was a common operation and the anaesthesia was local infiltration supplemented by nitrous oxide with a mask. Intubation of the trachea was frowned upon, because the surgeons feared that irritation of the larynx and trachea would lead to postoperative respiratory obstruction. I am sure, too, that they relied upon the timely occurrence of stridor to warn them that they were about to damage the recurrent laryngeal nerve. It required great perseverance and a strong hand to support the chin, the weight of the instruments and the surgical assistant's arm through one of these operations. I admit that I have been guilty of introducing a needle through the drapes to stimulate the assistant to move.

Intravenous anaesthesia was very new. Thiopentone was used rarely and almost experimentally, to provide anaesthesia for some short operations in situations where inhalational and regional methods were awkward. Avertin (tribomethanol) by rectum provided quiet and pleasant anaesthetic induction and basal anaesthesia for plastic and neurosurgical operations.

Cyclopropane was our newest inhalation agent in 1938 and was the favourite approach to general

anaesthesia when relaxation was not important. It had several disadvantages, of course, additional to the problem of relaxation. It was explosive; this had been dramatically demonstrated in several of the large American hospitals. It was expensive (in those depression days we were apparently more concerned about that than most of you are today) and it required expensive equipment for its administration. I doubt that any hospital at that time had equipped all its operating rooms with gas machines and certainly not with closed circuit machines with carbon dioxide absorbers! The single exception in the world may have been the Wisconsin University Hospital at Madison where cyclopropane was the usual anaesthetic.

Dr. Harry Shields told a delightful story of his attempt to get cyclopropane for use in the Toronto General Hospital in 1935. It had been on order for many months when he enquired about it from the Scottish nurse in charge of the central supply service. Her reply, as he reported it, was "Dr. Shields, we have only one very small cylinder; it cost $40.00, and I'm not about to give that out!"

The years of the war presented to anaesthetists problems associated with treatment of mass casualties for which no ready-made solutions existed and stimulated both improvisation and investigation. The exigencies of the time developed the banking of blood and introduced the clinical use of pooled plasma and serum and the dextrans as plasma volume expanders. Experience and investigation improved the understanding and the treatment of surgical shock. The introduction of the antibiotics produced a totally new orientation in the treatment of human disease, as the morbidity and mortality caused by bacterial infection became less and less important.

The introduction of muscle relaxants to the practice of anaesthesia by Harold Griffith in 1942 enlarged the scope of the anaesthetist and so changed the face of clinical surgery that it has been regarded as the most revolutionary happening in surgery since the introduction of antisepsis by Lister. The muscle relaxants made it possible to tailor anaesthesia to the requirements of the individual patient in a way that had never been possible before. Surgical treatment could now be offered to seriously ill patients who would not have survived the depression of vital functions which attended anaesthesia by the older inhalation or regional techniques and, as a corollary, surgical intervention could now be contemplated in circumstances which previously would not have been considered.

As the frontiers of surgery were expanded, anaesthetists faced a challenge to develop the means to control the vital cardio-respiratory and metabolic functions of the body. Responses to this challenge required more intimate knowledge of these vital functions than was available to us as we entered this new era. The development of the specialty of anaesthesia during the past 40 years is a direct result of the expansion of our basic knowledge of physiological processes and their alteration by disease and pharmacological manipulation. It has been said that, although technology changes, the basic facts remain the same. This is only superficially true, since the basic facts are constantly changing and expanding as we learn more about life processes. Today's dogma may be tomorrow's error. The story is told of a ten-year graduate returning to his medical school for a reunion. He called on the professor of physiology and, in the course of the conversation, asked what sort of questions the students of the day were asked on examination. On being shown a recent examination paper he exclaimed "These are the same questions you asked us ten years ago!" "Oh yes," said the professor, "but the answers are different."

Thirty-five years ago I wrote a paper on "Disasters in Anaesthesia." My thesis was that no matter what the initiating cause, the common pathway to disaster was anoxia! How naive that seems now. About 30 years ago the biochemists first demonstrated to clinicians the importance of the potassium ion and electrolyte balance in the maintenance of normal tissue function. The importance of acid–base balance and of carbon dioxide, the relationship of these to electrolyte distribution and tissue function and the volatile nature of the whole system were brought home to us a little later; but we were unable to make clinical use of this knowledge until it became possible to measure arterial blood gases and electrolytes quickly and precisely. The useful clinical measurement of electrolytes was made possible by the development of chromatography just over 25 years ago, but the useful measurement of blood gases only became possible with the introduction of the Clarke and the Severinghaus electrodes, about 1960. The electron microscope has shown us things undreamed 20 years ago; radio-

Anaesthetic	*Operation*
Innovar and Thiopentone	Radiofrequency Lesion of Mandibular Nerve
Thiopentone, N_2O, Succinylcholine	Cervical Polypectomy
Thiopentone, N_2O, Halothane	Biopsy Chest Wall
Thiopentone, Succinylcholine, N_2O, Enflurane	Removal Bladder Stone
Thiopentone, N_2O, Fentanyl	D & C
Thiopentone, Succinylcholine, Pancuronium, Pantopon, N_2O, Enflurane	Radical Mastectomy
Thiopentone, Succinylcholine, N_2O/Enflurane	Tonsillectomy
Droperidol, Fentanyl, O_2 (Orbital Block)	Cataract Extraction
Thiopentone, Fentanyl, N_2O	D & C. Cauterization.
Lidocaine Intravenous Block	Right Dupuytren's Contracture
Thiopentone, Succinylcholine, Pancuronium, Diazepam, N_2O/O_2	Gastro-oesophageal resection; Colonic Transplant
Thiopentone, N_2O, Enflurane	Myringotomy – Insertion of Tube
Thiopentone, Gallamine, N_2O/Enflurane	Ovarian Cystectomy
Thiopentone, Pancuronium, Pantopon, N_2O/O_2	Thoraco-abdominal Nephrectomy
Thiopentone, Pancuronium, Pantopon, N_2O/O_2	Vagotomy, Pyloroplasty, Repair Hiatus Hernia
Thiopentone, Pancuronium, Fentanyl, N_2O/O_2	Septorhinoplasty
Ketamine, Enflurane, N_2O/O_2	T & A
Thiopentone, Succinylcholine, D-tubocurarine, Droperidol, Fentanyl, N_2O/O_2	Cholecystectomy and Choledocotomy
Thiopentone, Pancuronium, Pantopon, N_2O/O_2 Cardiopulmonary bypass – Membrane Oxygenator	Aortocoronary Bypass

FIGURE 2 A typical contemporary operating list from the same institution.

active isotopes, the mass spectrograph, the computer and other electronic devices has made it possible for us to identify and measure things which were recently beyond our ken.

These and other new tools for monitoring the physiological status of our patients made it possible for anaesthetists, as for other physicians, to determine the effects of our technical and pharmacological manipulations and to recognize deviations from normal which demanded intervention. We were stimulated or driven to adopt new techniques and pharmacological agents appropriate to the new knowledge thus presented to use. By this process clinical practice has been gradually but dramatically changed.

Forty-five years ago we looked to a single anaesthetic drug to meet all our requirements for surgical anaesthesia. Investigators were intent on discovering the ideal anaesthetic agent. The concept of the single drug became obsolete with the introduction of the muscle relaxants. It became apparent that many of the toxic and unpleasant effects of anaesthetics could be avoided when the necessary doses of these were reduced by the use of specific muscle relaxants. The concept of "Balanced Anaesthesia" quickly followed, the hypothesis being that a combination of drugs might be used for individual control of each component of the triad of requirements for anaesthesia, these being hypnosis (or amnesia), analgesia and relaxation. Experience with this concept indicated the desirability of maintaining the normal homeostatic responses of the body and of specific intervention when these were altered. Research in anaesthesia through the past 25 years has been directed to the study of alterations in function produced by anaesthesia in general, by anaesthetic drugs, by surgical stress and disease and the means of treating or avoiding undesirable changes. As an example, our developing knowledge of cardio-respiratory physiology has

led to the modern emphasis on optimal pulmonary ventilation and the control of this function by the anaesthetist.

As an illustration of the impact of all these changes on the practice of surgical anaesthesia and of surgery it is interesting to compare two operating lists from the same hospital at the beginning and the end of my 45-year era. The first is from 1938, and the second is a list for a recent day in the same institution (Figures 1 and 2).

Extension of the anaesthetists' responsibilities

Because their experience in the operating room has developed unique expertise in the close monitoring of vital functions and prompt reaction to correct deviations from normal, anaesthetists have been recruited to manage the intensive care of acutely ill patients outside the operating room environment. In my personal experience this began when I found myself responsible for the intensive care of patients in a burn unit in the Canadian army, where the surgeons concerned themselves with the definitive treatment of burns, while I had the responsibility to keep the patients alive. The first area where anaesthetists generally found themselves recruited to such responsibilities was in the postoperative recovery room. Although the first postoperative recovery room of which we have a record was established at the Royal Jubilee Hospital in Victoria, B.C. in 1898, the idea lay dormant until Dr. John Lundy established such a unit at the Mayo Clinic in 1940 and subsequently advertized the benefits to the patients. Such units began to appear in our Canadian hospitals about 1950. It is interesting that the only opposition to their establishment came from surgeons, who were convinced that their patients would be better cared for on their own wards. Anaesthetists of my generation will remember from the era before recovery rooms the patients who died during the journey from operating room to ward, or on the ward while the road to disaster was carefully charted by a student nurse at the bedside; and they will remember the stress and awful sense of frustration and futility when they were informed during their next anaesthetic that their last patient was in trouble in a locus far removed from the operating room.

The next area of such responsibility was care for patients in respiratory failure. The collection of these patients into definitive units where they could receive intensive care and ventilation was, in retrospect, an obvious development which was too long delayed. It is a matter of great satisfaction to me that the first such unit was established in my own hospital – The Toronto General Hospital. In these units the anaesthetist again has a dominant role because of his daily experience in providing ventilation for paralysed patients in the operating room. Intensive care units now cater to the problems of a variety of other patients, and usually the "Intensivist" primarily involved is an anaesthetist.

Because of their expertise in regional anaesthesia many anaesthetists have become involved in the diagnosis and specific management of intractable pain.

All these changes have been made possible only by the development of a special discipline in medicine which we call anaesthesia. I have indicated that in my youth few physicians were fully committed to this specialty. Anaesthesia for surgical operations was provided almost universally by general medical practitioners, for many of whom anaesthesia was a minor interest and conducted by rule of thumb as a technical manoeuvre. It is interesting that the whole field of anaesthesia was so little understood by the profession as a whole that when the Royal College of Physicians and Surgeons of Canada first undertook the designation of specialists there was serious recorded objection from some senior internists to granting specialist status to anaesthetists. Fortunately sounder judgement prevailed.

Without exception the senior anaesthetists of my youth had come to the practice of anaesthesia directly from a junior interneship. The new era has made rigorous specialized training in the discipline a necessity. Although surgical anaesthesia and first-line resuscitation must still be provided by general physicians in many of our communities, it is no longer acceptable that they should undertake these responsibilities without a modicum of training in the discipline. This is now recognized by the licensing and regulating agencies. The modern anaesthetist must be a competent physician and a competent clinical pharmacologist with a nice appreciation of the effects of the potentially lethal drugs which are his armamentarium. He must have command of a variety of specialized techniques and

stand prepared on the instant to deal with unexpected effects of drugs and surgery. Unlike the situation 40 years ago the training of such specialists to a high level of competence is now the principal preoccupation of departments of anaesthesia in our medical schools. When we first developed a formal post-graduate training programme in anaesthesia at the University of Toronto, with a total of seven residents, the head of our department worried aloud about where all these people would find employment. That has never been a problem.

Despite 40 years of active post-graduate training programmes in the specialty we have a real shortage of anaesthetists throughout the world today. While the chief factor in this deficit is undoubtedly increased demand, other things have also mitigated against recruitment to the specialty. Many young physicians feel that the brief contact with patients which is characteristic of anaesthetic practice is professionally unrewarding. Others are unable to face the stress of constant monitoring of patients and the necessity to make life and death decisions in moments of sheer panic. Unfortunately economic factors have also been a major deterrent; the financial rewards of anaesthesia have historically been less than those in most other specialties of medicine and the anaesthetist is never master of his own time. The intrusion of bureaucracy into medical practice has also provided special problems for the anaesthetist.

I have tried in this brief communication to give you an overview of the changes in a special segment of our profession of medicine during a career spanning 45 years. Despite the vast increase in our knowledge and capabilities over the past four decades the unanswered questions are legion and each answer poses a new question.

Our whole society today seems to be engaged in omphaloscopy and a process which is euphemistically called planning. A recent editorial in our Canadian Anaesthetists' Society Journal was entitled "Whither Anaesthesia?" Without doubt the future will be as interesting as the past.