

EDITORIAL

## The future of anaesthesiology

Following its introduction in 1844, anaesthesia has crossed two turns of centuries and thus it can no longer be regarded as a young medical speciality. Anaesthesia has become mature and is now facing the problems of maturity. Its first period was characterized by the rapid development of inhalation anaesthetic techniques, the introduction of breathing systems and intubation equipment and the definition of the basic principles of anaesthesia. After World War II, modern anaesthesia administration technology, anaesthesia ventilators and monitoring equipment were rapidly introduced. This resulted in a marked increase in the safety of anaesthesia with a mortality and serious morbidity lower than in any other field of medicine. For example, the mortality decreased from 1 in 50 before World War II to 1 in 100 000 around 1980 and the present estimate is approximately 1 in 200 000. During the last two decades of the 20th century the quality of anaesthesia also improved owing to the introduction of various modern anaesthetic drugs. This has permitted a rapid growth of day care surgery under general anaesthesia, extension of the possibilities of surgery at the extremes of age and prolonged anaesthesia for complicated surgery in extremely ill patients. In my opinion, the time has now come for us to divert our attention away from *safety for patients* towards *comfort and quality for patients*.

In the past, anaesthesiology was limited to providing a general anaesthetic in the operating room. The present description of the medical discipline of Anaesthesiology is 'the clinical science related to the manipulation of vital organ functions'. Anaesthesiologists for example change consciousness, respiration and circulation, and influence pain and discomfort in patients undergoing surgery or diagnostic procedures (anaesthesia), in patients with illness and following trauma (resuscitation and critical care). The modern anaesthesiologist furthermore is involved in teaching and research and in health care management.

In the past one had to be fairly healthy in order to undergo an anaesthetic safely. At present, hardly any limitation exists for providing anaesthesia. Development of monitoring (e.g. capnography, pulse oximetry, agent analyzer), improved anaesthetic administration technology (e.g. target-controlled infusions, patient-controlled systems, the transdermal route, the spinal/epidural route), introduction of numerous disposable gadgets (e.g. multilumen catheters, spinal catheters, laryngeal mask, fiberoptic intubating scope) and the development of new pharmacological tools (e.g. propofol, rapacuronium, remifentanyl, ropivacaine) have extended the possibilities of anaesthesia. Now anaesthesia can be pharmacologically adjusted not only to the requirements of the patient (age, gender, concurrent diseases and comedication), but also to the surgical discipline. These widened boundaries of anaesthesia have themselves induced developments in surgery (minimally invasive surgery, outpatient surgery, transplantation, neonatal surgery). An interactive circle of developments is the ongoing result, where the demands of surgery have induced anaesthesia developments and developments in anaesthesia have induced changes in surgery. From simply providing anaesthesia, a number of other activities have developed over the years, including pain treatment, cardiopulmonary resuscitation, brain protection, intensive care medicine, trauma and emergency care, preoperative assessment, and preparation and postoperative care. Currently, office-based anaesthesia, sedation and contributions to palliative care are developing areas. The anaesthesiologists' duties have thus changed and will continue to change. One thing is certain, however, like in all fields of medicine, there are some individual personality characteristics that are still required for anaesthesiologists, namely Commitment, Continuing medical education, Consistency, Compassion, and a Caring spirit. One of the prime questions is whether or not we must

change the name Anaesthesiology. Many have proposed the introduction of the title 'perioperative medicine'. It is hardly imaginable that we will preoperatively treat patients with uncontrolled medical conditions or treat postoperative medical events when they do not occur in the intensive care unit or the recovery room [1]. In this respect I strongly believe that the term perioperative care is an improper one to describe our clinical practice. It is on the one hand too narrow and thus will prevent the real impact of anaesthesiology developing. On the other hand, it will demand duties that we will not be able to cover. It also excludes many areas such as parts of pain treatment, palliative care and treatment of 'spontaneous' respiratory failure. Therefore, we should maintain the name 'Anaesthesiology' and broaden the description of the content. Anaesthesiology is a broad speciality in which subspecialization as cardiac anaesthetist, obstetric anaesthetist, neuro-anaesthetist, paediatric anaesthetist and others are developing parallel to the surgical disciplines. I believe that we should no longer follow a surgical discipline related vertical development of our speciality and that we should follow a different track. What we really should begin to develop, rather than for cardiac anaesthesia, would be 'anaesthesia for patients with haemodynamic dysfunction', regardless of in what surgical discipline the patient is treated. Regional perfusion and bypass of parts of the body is now employed by many specialities including cardiac surgery, critical care (extracorporeal membrane oxygenation), organ transplantation, oncology, etc. Furthermore, patients with severe haemodynamic dysfunction are also operated on for otorhinolaryngology, ophthalmology, gynaecology and many other surgical specialities. We should therefore be developing anaesthesiology for patients with metabolic disorders, anaesthesiology for patients with disturbed pulmonary gas exchange, paediatric anaesthesiology, geriatric anaesthesiology, etc. Such fields should in my opinion include all traditional parts of anaesthesiology, i.e. anaesthesia, intensive care and pain treatment. If we continue to follow the surgical track, then we run the risk of developing into an artificial vertical medical discipline rather than remaining the broad horizontal speciality that we are at this moment.

Anaesthesiology is a dynamic medical speciality, continuously changing and improving and guided

by both intrinsic (e.g. scientific and technological development, manpower, image) and extrinsic (e.g. esteem, demand, developments in surgery) factors. The future of anaesthesiology depends on how its professionals go along with the inherent problems and opportunities. Two-thirds of patients require the involvement of anaesthesia in their treatment. A Canadian survey revealed that 40% of the anaesthesiologists' activities currently are outside the operating room [2]. This provides us with the opportunity to make ourselves known to the public. Although anaesthesia is now more than 150-year-old, our specialist colleagues, hospital administrators, patients, lay public, media, government bodies, politicians and many others still do not know who we are, what we do, or how we are trained [3]. It is not realized by many that anaesthesiologists on average are involved in 60% of the activities of a hospital. Only about half of the patients realize that anaesthesiologists are qualified physicians. In many institutions, anaesthesiologists run the operating rooms and, because they participate in the treatment of so many different patient groups, they become increasingly involved in other parts of hospital management. All of these activities on the one hand provide opportunities for us to improve our image and to acquire more professional esteem. However, on the other hand, these activities absorb substantial manpower, which at present in many places is not available. The need for manpower will increase even more because patients are tending to have more complex medical problems and require more extensive surgery. Many hospital beds are being transferred from low care to high care in their function. This also demands more intense participation by anaesthesiologists in postoperative care. In addition, the increasing average age of the population together with the post-war baby boom will demand growing medical care during the coming two decades with a knock-on effect on anaesthesia services. There are other developments that demand more anaesthesia manpower. The increase in out-patient care requires a different type of preanaesthetic assessment and the introduction of outpatient anaesthetic evaluation clinics. Social developments such as part-time employment and fewer working hours will further increase the need for anaesthetists. The number of females entering anaesthesia will rapidly grow as a result of the increase in the proportion of female intake (currently 55–60%)

into medical school. This will, if only for the reason that many women choose to balance a career and a family, will demand a different approach towards training and in later practice towards overtime and emergency care, which are commonly undertaken on top of a normal daily workload. This difference must be accepted and in my opinion is a reasonable request from these colleagues. At present, in my own department, 50% of the trainees are female. The issues arising from this are difficult, but not impossible to solve. The present shortage of anaesthetists in relation to the amount of work to be done has led to the situation that in a number of countries nurses are involved in providing anaesthesia. This situation is most prevalent in the USA where nurse anaesthetists are becoming more and more independent from anaesthesiologists. In some European countries, nurses are involved in anaesthesia delivery although there is a requirement that they be under the continuous supervision of an anaesthesiologist and are not allowed to practice independently.

There is a developing shortage of anaesthesiologists. This has been the case in Canada for over 10 years where between 1986 and 1996 the number of anaesthesiologists increased by 10%, whereas the total Canadian population grew by 18.6% [2]. This shortage will get worse in the years to come [4]. In France, the number of trainees in anaesthesiology has decreased dramatically owing to government regulations. This will bring the number of anaesthesiologists in France in 2010 back to the level that it was in 1980, despite the fact that the number of anaesthetics is rising (from 3.5 million in 1980 to 8 million in 1996) [5]. In 1997, 17% of anaesthesiologists in Australia and 18.5% in the USA were female. It can be expected that the figures will be similar in Europe.

Because a higher manpower demand is not limited to anaesthesia but also affects other specialities, a manpower problem affecting the whole of health care can be anticipated. For many medical students, anaesthesiology does not have a high priority when they make the choice for further education and thus anaesthesiology will be more likely to be affected by the manpower shortage than for example internal medicine, obstetrics and gynaecology and surgery. On the other hand, the increased safety of anaesthesia and its high-tech profile may give the impression that anaesthesia is easy and does not require highly trained

professionals. In many countries a shortage of physicians and at the same time an increasing health care demand is appearing. These two together have persuaded government bodies to recommend that anaesthesia is provided by nonphysicians. It cannot be expected that government bodies, surgeons or hospital administrators will allow surgical cases to be cancelled because of a shortage of anaesthetists. Already now a loud cry for nonphysician anaesthesia care providers is sounding through management and government offices. It seems likely that nurses will first become involved in providing sedation and later even providing anaesthesia, while the anaesthesiologist will be forced to give up new acquisitions like intensive care, pain treatment, preoperative assessment, postoperative care and graduate teaching in order to be available for providing anaesthesia care [6,7]. Such a development is wholly undesirable and will be detrimental to our patients and to the development of anaesthesiology, and will stop the currently observed growth in esteem for the profession of anaesthesiology. The position of nurse anaesthetists is already producing considerable discussion in many countries including the United States. A recent publication clearly demonstrated that a medically led anaesthesia team has better outcome than a nonphysician anaesthesia team [8].

Not only is the provision of anaesthesia under attack, but other areas are also under attack. For example, a recently published study from Denmark stated that general practitioners can replace anaesthesiologists in doctor staffed ambulance helicopters. In the same study, however, it was demonstrated that a decrease in quality occurs because 38% of the required procedures or drug administrations could not have been performed by any other than an anaesthesiologist. However, this was completely ignored [9]. Postoperative care, including critical care, is under continuous offence from internists. We can try and fight this situation, but it will necessitate an increase in anaesthesia manpower, which is a major and increasing problem. An investigation in Scotland demonstrated that 83% of medical students and 88% of physicians would support a module in anaesthesia [10].

The lack of esteem that is experienced in anaesthesia is an important factor. This together with the increased demand for candidates for surgical training

has already led to decreasing numbers of young physicians choosing anaesthesia. In the USA, a marked decrease in the number of applicants has made it impossible to fill the training programmes in most institutions. In Canada, around 4% of the training places are not filled. A Belgian study calculated that at present in Belgium there is a 13–14% shortage of anaesthetists, which will disappear within a few years. However, in 2010 again a shortage will reappear owing to reduced inflow and ageing of the existing group [11]. In a second study this group demonstrated that the average working hours are 60 per week; males 11% more than females. Fifty per cent of the time is devoted to providing anaesthesia in the operating room and 25% to the Intensive Care Unit [12]. In 1996, in Belgium, 0.48–1.25 anaesthesiologists were available per operating room, which rises to 0.52 when the trainees are included [13]. A European survey indicated that in 1995 in the European Union there was an average of 10.8 anaesthesiologists per 100 000 inhabitants. In the USA this number was 9.2 in 1992 and in Canada 7.7 in 1991 [14]. In Europe, for every four anaesthesiologists, there is approximately one trainee. One of our future tasks must be to attract young physicians into the speciality. At present, in many countries, anaesthesia is not a part of the undergraduate teaching programme in medical school, but merely a postgraduate clinical discipline. When anaesthesia is more involved in undergraduate teaching, this will markedly enhance the interest in the speciality and also demand the involvement of anaesthesiologists in such teaching. The rapid developments in anaesthesia increasingly demand permanent education of its providers.

In many countries, continuing medical education is still obligatory; however, an increasing number of countries have made permanent education mandatory. New developments in the form of the education have been introduced, including the use of the Internet and teleconferencing methods. Guidelines vary enormously between the various countries, however, European regulation is pending. In my opinion, in the near future, evaluation of continuous education will be introduced both for the quality and content of the courses as well as for the knowledge acquired by the individual anaesthesiologist. Introduction of national and international examinations to obtain and retain licenses to practice are being discussed in many countries. It is likely that anaesthesia simulators

will play an important role both in education and in evaluation of knowledge and practical capabilities. Virtual reality and artificial intelligence are on the horizon of educational activities and these will improve the abilities of anaesthesia simulator sessions to evaluate skills, while periodic testing of theoretical knowledge using telecommunication technology is likely to be introduced in the next half decade.

An increasing number of practice guidelines have been produced during the last decade. Because of European regulations and laws it must be expected that such so-called quality improvements will proceed further from standardization of practice. Whether the extensive introduction of protocols really increases the quality of care has never been proven. In anaesthesia, adjustment of care to the individual needs of the patient is an important issue that should not be limited by rigid protocols. In some countries and many institutions, so many guidelines for anaesthesia exist that they have produced a two-volume textbook on anaesthesia. The introduction of protocols is, of course, a positive development, but limitation is crucial. From experience, one must suspect that guidelines will more and more come to serve a legal goal – determination of whether a treatment has been according to the standard of present medical science. This is not, however, always related to the benefit of the patient, a problem that is not confined to the field of anaesthesiology.

During the past decades, enormous progress has been made in understanding the biological mechanisms of the human brain and its mental activity. Anaesthesia strongly influences the functioning of the human brain, and thus it can be expected that anaesthesiology will benefit from the developments in neurobiology. Most of this research involves molecular biology, an area for which hardly any expertise exists amongst anaesthesiologists. It is unlikely that in the next 5–10 years new anaesthetic drugs will be introduced into clinical practice. The market for such drugs is very small compared with the market for antihypertensives, antibiotics, analgesics or antidepressants. Therefore, most pharmaceutical companies have withdrawn from the anaesthesia market and research is only performed in the field of analgesics and local anaesthetics. We thus have to focus on other aspects of anaesthesiology. Major complications of

anaesthesia have a low incidence, however, the incidence of minor complications and effects of anaesthesia is unknown. How frequently are we confronted with the relatives telling us that 'grandmother after anaesthesia has never been the same as she was before'?

In the future, studies on the impact of anaesthesia on cognitive function are needed. In addition, awareness during anaesthesia seems to be an increasing problem. Major issues related to anaesthesia are drowsiness, nausea and vomiting. These and post-operative pain are important factors in patient satisfaction with anaesthesia [15]. Other important issues are immunological consequences and stress inhibition. These fields require a different type of researcher than those currently present in anaesthesiology. An expansion of departments with members of other basic specialities, e.g. molecular biologists is required. The financing of academic anaesthesia departments is a long-term problem, however. Not only is there a wide gap in income between academic and privately employed anaesthesiologists, but also academic anaesthesiology departments are not in general heavily supported by government organizations or university funds. The income gap frequently forces promising bright young anaesthesiologists to opt for private practise rather than for academia. Contributory to this is the change in individual general attitude toward egocentrism and growing financial awareness.

The computer has entered the anaesthesia work field, not only for computer-controlled drug administration, but also for monitoring, acquisition of physiological data and automatic reporting. Computers are also used as a tool in decision making and as a database for drug dosing, pharmacological information, and for easy access to protocols and guidelines. Evidence based medicine is increasingly important and guidelines are starting to dominate medical practise – including anaesthesia. Computers will play an even more important role not only in the actual administration of anaesthesia (target-controlled anaesthesia), but also in management, information and decision support. The anaesthesia record will be further automated and integrated with other patient data management systems and the recorded information used for management purposes. Connections with other databases, for example, with the central sterilization department and pharmacy, will make

ordering of disposables (needles, syringes, tracheal tubes, suction catheters, filters, infusion sets, etc.) and drugs automatic. Connections with the invoice department and administrative offices are other developments.

It is to be expected that computers will be used not only to control anaesthesia, but also in real closed loop anaesthesia with feedback from physiological patient parameters [16]. The development of more accurate infusion pumps in the seventies and the introduction of shorter acting more controllable drugs in the eighties were, in addition to the rapid development of computer technology, basic requirements for the realization of this dream. The change from bulky main-frame and voluminous desktop computers towards smaller laptop and tiny palmtop computers were other important stimuli. Nowadays, target-controlled anaesthesia, patient-controlled analgesia and sedation and the use of feedback control systems are more or less common practice. But the development will not stop there. A better understanding of the pharmacokinetic behaviour of drugs, especially the concept of context sensitive half-time, the development of more sensitive monitoring devices and the possibility to inter-relate the values coming from these devices make closing the loop feasible. Feedback systems based on brain activity (bispectral index, spectral edge, etc.) are already in clinical use and connections with haemodynamic changes are being studied. Within a decade, parameters from the central nervous system, the cardiovascular system and the respiratory system will be added together and serve to control computerized automatic anaesthesia. Target-controlled devices that maintain plasma concentrations of anaesthetic drugs based on population pharmacokinetics, are already in routine use. Such devices are also available for patient controlled sedation [17].

The computer is playing an increasing role in the monitoring of vital functions. The recent developments in computerized analysis of the electroencephalogram and other neurophysiological parameters are enormous. It must be expected that the so-called depth of anaesthesia monitor is likely to be introduced in the next decade. Anaesthesia will then be more adjustable to the requirements for the particular intervention. More accurate noninvasive and continuous monitoring of haemodynamic parameters will also become available, e.g. continuous cardiac output,

tissue (organ) perfusion, tissue oxygenation, cellular metabolism.

Anaesthesiology is a dynamic discipline, the future development of which is based on its history. The future is loaded with opportunities. The realization of these opportunities depends largely on the practising anaesthesiologists themselves.

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