THE ANNALS OF THE SCOTTISH SOCIETY OF ANAESTHETISTS

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SCOTTISH SOCIETY OF ANAESTHETISTS

COUNCIL FOR 1996- 1997

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Programme for 1997

Registrars Prize: Entries to be submitted to the Hon.Secretary by 28th February 1997.
Annual General Meeting: Peebles Hydro Hotel 25-27th April 1997
Trainee's Meeting: Stirling 12-13th June 1997
Scientific Meeting and Gillies Memorial Lecture: Dundee 21st November 1997
Golf Outing: Glenbervie 29th May 1997

PRESIDENT'S NEWSLETTER

PROFESSOR ALISTAIR A. SPENCE

With this particular opportunity previous Presidents have usually referred to the current crises affecting health care. Each year we appear to be at a watershed. I do not propose an exception. Our health care trusts and similar authorities include many who are operating in the red. The situation is worse in England than in Scotland. The solutions are to inject a larger proportion of the national product or further limit the scope of the service. In my Presidential Address I pointed to the need to influence and participate in change. An important problem now, in my view, is the excessive separation of clinicians from the implementation of health policy. I do not seek a return to the "cog wheel" (for those who remember the 1970's) but we should ask ourselves what is the status of our "divisions" and how effective they are. Are hospital staff medical committees still meeting, and do they do anything? Are departments proactive and reactive? Or are they buffeted by influences which they can't control, living from hand to mouth.

Although we are not yet out of the wood, they anaesthetic manpower crisis is abating slowly as we believed it would. Now concern moves to the work pattern of trainees and whether or not they will be ready to be consultants at the end of their defined training. In considering this we should remember:

- The organisation of Schools of Anaesthesia should give a better chance than ever before for optimising learning and training opportunities.
- The quality of recruitment in anaesthesia is higher than ever before.
- Specialisation within anaesthesia is developing at an increasing rate. "Generalist" anaesthesia will itself become a specialty. All this is anticipated in training plans for anaesthesia and needs good stewardship.
- In most other advanced societies the defined training period is shorter or the same length as ours. With good organisation this does not involve loss of quality although, as in the UK now, continuing education and development is integral and the new consultant may be free-standing but not isolated. Maturity through experience is part of the expectation.

Recently I had the pleasure of visiting the United States, in company with others including our Vice President, where on 10th October 1996 W.T.G. Morton's pioneering demonstration of ether was marked at Boston with visits to graves, lectures and banqueting. Through the hard work of Dr Jonathan Wedgwood we have made available photographs of some anaesthetic sites of interest in Scotland (Dumfries, Bathgate and Edinburgh) and hope these will eventually be displayed at the ASA Wood Library at Chicago. In 1997 we will commemorate, 4th to 7th September, Sir James Young Simpson and chloroform. I have been in discussion with the minister of St Giles Cathedral because there is a view, which is shared by the minister, that Simpson and the anaesthetic discovery should be commemorated by a plaque. As it happens there is a handsome bust in Westminster Abbey (fig). The Council of our Society has agreed that they wish to be associated with this event which we hope will occur during the September celebrations and during the visit to Scotland of the European Academy of Anaesthesiology.

For some time an informal group drawn from the four Scottish academic departments has been discussing the possibility of an anaesthetic training simulator. At the moment this has valued support from an increasing number of clinicians, postgraduate deans and the Scottish Council for Postgraduate Medical and Dental Education. It is an expensive project and is by no means fully funded so far. Simulator systems are already established in more than a dozen US centres, in Canada, Copenhagen, Leiden, Brussels and Basel. Others are developing and, in November 1996, the first in Britain was installed at Bristol. We hope the Scottish project might work in partnership with Bristol. Simulators are of value for training in the "protocol" of rare complications such as malignant hyperpyrexia, anaphylaxis etc. They also provide basic familiarisation with the technical skills and sequelae of the anaesthetised state for a variety of practitioners beginning anaesthesia and outside anaesthesia (paramedics, nurses etc). They may also be of value to the pharmaceutical industry in their training programmes. The special role of simulators, however, is in allowing anaesthetists to develop crisis management skills in a manner analogous to the ATLS programmes. If the simulator venture is to succeed it needs not only money but enthusiastic support in implementation and development.

Others will do this more fully elsewhere but I send good wishes to four of our members who have given us special cause for pride in 1996. Leslie Baird is President of the Association of Anaesthetists, Gavin Kenny has been appointed to the vacant Chair of Anaesthesia at Glasgow, Kenneth Mackenzie is Chairman of the Scottish Committee for Hospital Medical Services and Peter Wallace is President of the Intensive Care Society. This is a distinguished but not exclusive list, for many of our members are prominent in the medical profession. Our predecessors would be proud, as we are proud.

I feel greatly privileged to have been your President in this sesquicentenary year and to follow and precede two distinguished colleagues, Alan Macdonald and Iain Davidson who have so many talents from which the Society has benefited and will continue to do so. They with the other Officers and Council, all of whom I thank, give me justification in assuring you that the Society is in good hands.

PRESIDENT'S ADDRESS

ALISTAIR SPENCE

FROM JOHN SNOW TO SPECIALIST REGISTRAR

Every year has its anniversaries but this year, at least to me, is particularly important. At a personal level I become eligible for cheaper rail fares. It is the 35th anniversary of the start of my career in anaesthesia, the fifth anniversary of the NHS Reforms and the third birthday of the Calman Report. On a grander scale it is, of course, the 150th anniversary of the first successful public demonstration of ether anaesthesia.

The story of the introduction of ether is as familiar to some as is the Christmas story to others. As with most developments it was not a matter of one individual on his own but of many. Crawford Long had used ether successfully, at least as early as 1842. Charles Jackson introduced ether to Morton. We remember the sad story of Horace Wells; none of us nowadays has any difficulty in understanding how he succeeded and then failed with nitrous oxide. We note also his close professional association with Morton and recognise that he was cheated of his justified place in the momentous attempts to demonstrate anaesthesia. Nevertheless it is to William Thomas Green Morton that true credit for the first public demonstration must go.

The story on this side of the Atlantic is equally well known, although it is only in the last ten years or so that it has more fully clarified. Professor Jacob Bigelow of Boston, a senior and influential member of the faculty there and whose son, Henry, was present at the first public demonstration, wrote to a fellow American in London. Francis Boott who disseminated the news of ether with commendable speed. Morton, described by Jacob Bigelow as "not a man of much cultivation or science" was principally interested in taking out a patent on ether anaesthesia for his own gain, and time and energy was spent on how the spoils would be divided. As a result ether anaesthesia did not develop rapidly in the United States, a story very different from that in the United Kingdom. Boott communicated, as requested, with Robert Liston so that the demonstration in London, upon Frederick Churchill, took place remarkably quickly. Boott also knew James Robinson, a high class dentist of Gower Street, London. On Saturday 19th December 1846, Miss Lonsdale, a patient of Robinson, was anaesthetised in Boott's study for the extraction of a "firmly fixed molar tooth" using apparatus made by Hooper of Pall Mall to the specification of Boott and Robinson. On Monday 21st December in the same area of London, at University College Hospital, Liston operated on Churchill when he was anaesthetised with ether.

The Dumfries claim is something we, in Scotland, like to remember. Dr Tom Baillie was my mentor in obstetric anaesthesia. His little book "From Boston to Dumfries" is a valued part of my library. It is not his fault that the long delay before any publication of the Dumfries claim, and the lack of any contemporary record of the patient or the outcome, removes that episode from any role in advancing anaesthesia.

The bust of James Young Simpson in Westminster Abbey

James Young Simpson was quick to take an interest in ether. He went to London before the end of December 1846 to find out at first hand, so that early in 1847 ether reached Edinburgh and Simpson was soon pursuing his novel interest of pain relief in obstetrics. In the view of most, however, the skill and intellect which John Snow brought to ether anaesthesia marks him as the true leader.

Induction of examiners at the Faculty of Anaesthetists by the Dean, Professor Donald Campbell. Dr Aileen Adams was Vice Dean and Professor Gordon Robson, a former Dean, was a senior member of the Board of Faculty. Dr Dick Ellis is third from the left Others in the photograph are Dr Joe Stoddart and Dr Margaret Branthwaite.

Figure 1 shows the admission or re-admission of three examiners for the Final FFARCS. In passing, I might be allowed to note that there are three Presidents of this Society in the photograph. My main purpose, however, is to mention Dr Dick Ellis, a good friend who sadly died last summer. He was a major contributor to the history of anaesthesia, completing Volume 3 of Sykes "Essays on the first 100 years of Anaesthesia". His principal interest was the period whose sesquicentenary we have started to celebrate. He pulled the record of James Robinson from relative obscurity, persuading English Heritage that Robinson's house in Gower Street, very near to the headquarters of the Association of Anaesthetists, should be marked with a blue plaque

which I was privileged to unveil on 19th December 1991. Dick Ellis produced annotated reproductions of Robinson's work, and also of Snow's serialised account of inhalation anaesthesia. For many years he campaigned for the printing of Snow's professional diaries. The work is fascinating to read, and I am embarrassed now at having expressed an early view that there might be little interest. Had he survived, Dick Ellis would - this year especially - have been a glittering performer on both sides of the Atlantic.

John Snow, born in York. Intellectually brilliant, capable of very hard work, a non conformist, vegetarian, consumptive, highly respected but not gregarious, he was the individual who made the greatest contributions to the safe use of ether and a wider knowledge of anaesthesia by the inhalation of vapours. He died in his mid forties in 1858 having secured pride of place not just in anaesthesia but in epidemiology through his pertinacity regarding the association between cholera and the public water supply. His association with the Broad Street pump has been over romanticised. He persuaded the authorities to remove the handle but did not vandalise the pump himself. Snow's other celebrated contribution, this time contributing to Simpson's dream of pain relief in labour, was his administration of chloroform to Queen Victoria at the birth of Prince Leopold. Leopold was not the first child born to the queen after the discovery of anaesthesia, so she was not impetuous. Prince Albert, very advanced in so much, regularly consulted Robinson as his dentist. One wonders if this association contributed to the Queen's education in the use of chloroform.

THEN AND NOW

Snow's time and ours, in some respects his era and ours are within the same story in the history of medicine. The 1850s growth of anaesthetic practice was the springboard for surgery, which can be crudely described as cutting for palliation or cure. Today cutting surgery remains a major component of the repertoire of therapies, but we are already witnessing developments which minimise and will finally avoid the crudeness of the traditional scalpel.

The 1850s, like today, was a time when there was much confusion as to what constituted a suitably qualified practitioner. It was the period of various attempts to regulate medicine through the Medical Acts, culminating in the creation of the General Medical Council as we know it.

Snow, and Simpson, and others, were seriously interested in the study and control of fever, particularly surgical fever, and the effects of contagion, although it would be almost 20 years before recognition of the role of microbes. The invasion of the body by pathogens, and the prevention and treatment of their effect, where possible, is a partly solved but continuing problem of our time. But at the end of this century we sense that the further development of the new medical sciences could change all that and bring to medicine totally different challenges, even within the next ten years.

The ethical issues facing us (in genetic manipulation, transplantation, apotosis etc), or just around the corner, are of an order that would amaze most practitioners of the last 150 years. As always, the impact on doctors will depend on their ability to manage change - an expression which has become, itself, a new part of our vocabulary in the last decade. On reflection about two major revolutions to which I have been close I conclude that the medical profession, so far, are not particularly adroit at managing change. I refer to the reforms in the National Health Service and the revolution in vocational training. I would like to tell you how such major change can be managed; but I do not know. It might help, however, to say just a little about what I have experienced so far in these revolutions, neither of which is complete.

In the early spring of 1989, as Vice Dean of the Faculty and acting for the Dean who was out of the country, I attended my first meeting of the Conference of Colleges and Faculties. The preparatory reading for that day was "Working for Patients". It was the blueprint for Health Service reform. Our dean Professor Rosen and I were keen to meet with people who might instruct us in the change that was likely to come. I recall particularly meetings with Mr David Willatts, now MP for Havant, and who at that time was involved with the Conservative think tank. From these discussions I learned how serious was the concern in and around government about professions in general and medicine in particular. It was clear that the government, Parliament and many of the population, were looking for an effective system of accountability in the delivery of health care to our society. It was not just about finance it was also about service and treatment.

The Conference meeting was, as I believe it still is, a sensible, friendly and constructive forum which, like others, struggles to be better informed on all relevant issues. On that particular afternoon (in the Royal College of Pathologists, housed in the impressive former London home of the Duke of Roxburgh) there was a constructive and interesting discussion. The whole meeting lasted only two and a half hours. This gave time for the Secretary of Conference and one or two others to repair with me to the Caledonian Club for a refreshment before returning to the Pathologists for a very pleasant dinner. The next morning we met, as is the pattern, as the Joint Consultants Committee (The Colleges and the CCHMS). The CCHMS Chairman was Mr Paddy Ross, whom I later came to know as a good friend but had never met previously. He was their

leader, and ours was Sir Ian Todd PRCS. We had the benefit of our discussions the day before, but the BMA had position papers on everything and they dominated our thinking for the day, having told us that the BMA planned a hard hitting press conference for 4 o'clock that afternoon. They voiced major opposition to the reforms borne out of pique at quite inadequate consultation with the medical profession before "Working for Patients" had been published. Although some of the Conference team spoke effectively, and I remember particularly Dame Rosemary Rue, from the Faculty of Public Health Medicine, the Colleges lost to the BMA that day because we were not prepared as well as they. I came away feeling that what had started as a very pleasant social occasion had turned into a disaster. By 6 o'clock that evening the BBC reported that we had "fallen out with the government". That was true, and for all of the next year the level and quality of exchange between government and the profession was appalling, to the detriment of both and to the NHS reforms.

It is now clear that the medical profession simply did not recognise or accept the government's fundamental concern about professional lack of accountability. In fact, the blueprint document was a collection of very general statements, and although it set out such fundamental ideas as the internal market, there was no detail. We were looking for the small print and the itinerary, believing that there was a deep conspiracy to be unleashed. None of these existed. Politicians address issues of presentation on a broad canvas and with a political slant that is hoped to attracts the electorate. Civil servants deal with the detail, divided into pockets of responsibility which may take some time to reach a finished form. The obvious mistake on this occasion was that the medical profession failed to grasp that there was no plan other than a most general plan. Instead of standing outside the issue and complaining, we would have been much better to enter the fray helping to drive and develop the change. We learned to do that, but dangerously late.

Now, as we anticipate a change of government I prophesy that the reforms will not go away, because there is no better way of delivering health care that anyone can think of at the moment. There will be fine tuning, perhaps the disappearance of fund holding general practices etc but not very much more. The delivery of the reforms is still far from complete and, late though it may seem, the ball is still at the feet of the profession. My favourite example relates to clinical and practice guidelines. Guidelines and audit were an essential part of the language of change. The profession already had a track record in audit of a kind, but many in medicine decided, demonstrating unbelievable ignorance, that guidelines were not to be encouraged because they might limit "clinical freedom". Of course guidelines had nothing to do with that at all. They are to provide the means by which we can bring together the best practice from evidence based medicine (based on good outcome measures). Any statement or guideline must command so-called ownership which means, simply, that most reasonable people accept the guideline as being correct and comfortable to follow.

Of course, the guidelines or specification are an essential component of contracting. If we buy a car we have some idea of what we are looking for (and can afford) and we have some idea of the quality that we seek. Five years on, the contracting for services is still at a rudimentary or "unsophisticated" stage. Society has failed to receive a complete solution to Mrs Thatcher's anxiety about the need to bring the deliverers of health care to a frame of accountability and some effective control. At the moment purchasers purchase and we deliver within their contracts without there being any guarantee about the quality. The sooner that is addressed effectively the safer will be the Health Service, health professions, and most of all patients. If you don't believe me try to find your purchasing team and ask if they use guidelines in the contracting.

"CALMAN"

On a beautiful June afternoon Conference was back at the Duke of Roxburgh's London home. By now lessons had been learned and it was an all day meeting. Some of us were beginning to wilt but were consoled by the beautiful music which was coming from Horseguards where they were practising for Trooping the Colour. At four o'clock Kenneth Calman, now the Chief Medical Officer, joined us with some of his colleagues and to convey, albeit indirectly, that the government was in a tight corner having been charged with infraction of European agreements because of the inability to define a United Kingdom medical specialist in such a way that would allow the legal requirement of exchange of professionals between countries of the community. Within the three previous years there had grown a list of European trained doctors who complained that their specialist designation was not easily accepted within the ill defined path to the appointment of consultants in the National Health Service. There was no doubt that they had a valid argument, but what was the solution? In a frenetic period that followed both the CCHMS and the Royal Colleges and Faculties worked in relative harmony with the Department of Health and with the GMC to redefine the whole basis of training for specialist practice. The effect of this in anaesthesia is becoming increasingly well known and I do not wish to deal with that this afternoon, other than to say that there were three major processes underway simultaneously and highly likely to conflict. There was the exercise of "Achieving a balance" driven by government in response to junior doctors pressure. There were the NHS reforms and there was a new plan for "Training for specialist practice" which is seen in its original form in Annex C of the Report from the Chief Medical Officer's Working Group to Advise on Specialist Training in the United Kingdom. There were desired outcomes and inevitable outcomes. Everyone agreed that an emphasis on training-led service rather than service-led training was sensible. More civilised working hours could hardly be complained about by anyone. The less articulated outcome was that the balance of clinical service as between consultants or specialists and trainees was bound to alter. This was not simply a matter of arithmetic. It was bringing us to face something that British specialist medicine preferred not to reveal, never mind discuss. There was an obvious

need for a strategy to manage this last important aspect but many in leadership positions in medicine refused to face that and the profession became increasingly apprehensive. It is too early to say whether we have emerged from the crisis completely or not. I believe we have, and I consider that substantial credit should go to the new trusts and health authorities. They were allowed a flexibility in manpower that previously did not exist and I think that has brought the substantial proportion of the adjustment that was necessary. But that should not obscure the fact that consultants and trainees themselves have adjusted commendably in both their work practices and their attitudes.

For anaesthesia, all of these were a rigorous test of the new Royal College of Anaesthetists, founded in 1992. Over the years there was evidence that most members of the medical profession had lost any clear understanding of the purpose in creating royal colleges, the responsibilities of colleges, and to whom (Ref. Spence AA 1991. Collegiate developments. British Journal of Anaesthesia 68: 457-458). As these recent revolutions came about the colleges had a responsibility to maintain the highest standards of specialist practice in the public interest. They were and are charged with doing that while answerable to society through the Queen from whom the Charter comes. There is of course a need for accountability to fellows and members but not to pursue their interests to the detriment of patients and society. Anaesthetists in their new Royal College were on a very rapid learning curve but I believe that to have been true of all the colleges who were faced for the first time with crises which were threatening the very foundations of medicine. If I argue that the outcome, which continues to evolve, is highly satisfactory compared with what might have been, I hope I have conveyed enough to indicate that there were also a number of breakdowns along the route.

To return to Snow. He, like us, lived in a time when evidence based practice hardly existed and there were no guidelines. In his way and in his time he made a massive contribution to the evidence base for medicine in general and anaesthesia and epidemiology in particular. In his time, also, there was much confusion about what constituted fitness to practice. The conditions that determined who would and who would not be acceptable to the General Medical Council, which had not yet been properly formed, the influence of the power bases of the time, the emerging university schools, the powerful colleges such as the Physicians of London led to much confusion. There was misunderstanding, fear, and a good deal of litigation centred on all of that. Snow did the right thing and is a model for today. From his early introduction to medical practice as an apprentice he saw the need to be not only competent in the craft but to have academic qualifications which were above reproach. Thus in London he proceeded MRCS and finally MD (a complex and difficult examination now no longer exists in the format of the time which included papers on philosophy etc as well as medical science).
Medicine as a profession has, I believe, an inbuilt drive towards aspects of perceived quality although it is notoriously reactionary and is, every now and then, in need of substantial interference in its affairs. If you think I exaggerate I quote a conversation that I overheard amongst senior consultants in the medical staff room of a Glasgow hospital after the publication of the Wright Report which, as some will remember, was to do with vocational training in the 1960s. "Have you seen what they say?" said one of them, "Senior registrars are to be regarded as trainees. Whatever nonsense will they think of next?".

Finally, and I hope relevant, I would like to share with you one or two images which to me are unforgettable and which I believe bring together a surprising number of the strands of what I have been trying to convey. They relate to the splendid July day in 1993 when Her Majesty the Queen came to open the new Royal College of Anaesthetists at Russell Square. She met many of the Fellows, including several from countries of the European community, trainees who were new Fellows and who were embarking on a career in the "revolutionised" Health Service. She met many who over the years had helped in the creation of an independent collegiate institution for anaesthesia and who had developed the specialty to a level that conveyed the highest standard in the public interest. Such recognition from the Head of State occurs only once in a lifetime, but signalled that our specialty had fully matured.

Visit by Her Majesty the Queen for the opening of the headquarters of the Royal College of Anaesthetists at Russell Square, London

Pavement scene at Russell Square

Visit to the gardens showing the bust of John Snow, donated by the Obstetric Anaesthetists Association, the lady in the white jacket is the sculptress.

Her Majesty the Queen meets Dr John Mackenzie, who was then Honorary Secretary of the Scottish Society of Anaesthetists.

COUNCIL TRAINEE REPRESENTATIVE

DR. PAM CUPPLES GLASGOW

In March of this year I was elected to council as the first trainee representative. The Scottish Society has always been very interested in trainee matters and issues relating to training, never more so than over the past year, following the implementation of the recommendations made by the Calman report and the ongoing efforts to reduce the trainees' hours of work.

Certainly to date, the Scottish Society has attempted to keep abreadth of issues affecting trainees. Inevitably, this was from a consultant viewpoint, usually by consultant council members representing the opinions of trainees in their region and more generally by those members of council who had a college tutor commitment. Regardless of whether the true views of trainees were being represented, the Society was always up to date with the latest college rulings.

Dr. Alan MacDonald, during his term in office as President of the Society, was very enthusiastic about getting a trainee elected onto council. The main reason for this was so that trainee issues could be represented by a trainee. This way the Scottish Society would be more in touch with trainee matters and as a result could give its support on a more informed basis. The trainee co-opted onto council was chosen from names put forward from the four regions. Following the council meeting in October of last year my name was chosen and I was elected onto council at the Annual General Meeting in April 1996.

My commitment as the trainee council member will be for three years. The exact mechanism of choosing my successor has yet to be decided upon but may be on a regional rotational basis. Hopefully, with an expanding trainee membership, we will be able in the future to hold a postal election or have a linkperson in each region who will be able to nominate a trainee for election to council. These are just two possibilities.

My primary role is to represent the current views of trainees to council, in order to keep them informed of matters directly relating to trainees. The Society is well established amongst consultants but unfortunately is not so familiar to trainees of all levels. I am keen, as is council, to expand the trainee membership and raise the profile of the Scottish Society amongst trainees in Scotland. I hope to accomplish this during the next three years.

In the near future, I plan to have regular communications with one trainee from each of the main hospitals in each of the four regions. With their help, the Scottish Society will gain more exposure amongst trainees and with this will hopefully come a significant increase in trainee members. The benefit of having a trainee who is interested in the Society and who is willing to act as a linkperson, will be that I am better equipped to voice the opinions of trainees to council. As a result consultant members of council will be more realistically informed.

Another of my duties will be to help organise the trainees' meeting held in the summer. The old format was a one day scientific meeting whose venue rotated around Glasgow, Edinburgh, Aberdeen and Dundee. Normally each region took it in turn to host the meeting and organise the educational content, choosing speakers who could lecture on topics of current scientific and clinical interest. The topics were usually of great interest, especially to those exam candidates in the audience.

The attendance at this meeting has been disappointing in the past, whether due to problems obtaining study leave or poor publicity. It was proposed and agreed at the Annual General Meeting last year to change the format on a trail basis. Amongst the reasons for this were an attempt to elevate the status of the meeting and try to emulate the popularity of the Peebles meeting. The changes to the meeting are firstly to centralise the venue in Stirling. The idea behind this is the central location within Scotland and therefore easier traveling for all. Secondly, the meeting has been extended to a day and a half starting on Thursday lunchtime and ending on Friday afternoon. On Thursday evening an informal dinner followed by a ceilidh has been arranged. This is to take place in the atmospheric surroundings of Stirling Castle. We hope that both the scientific content and social component will be well attended and that most trainees will take advantage of the reduced rates for accommodation which we have arranged and stay overnight. The evening's entertainment is one of the biggest changes to the meeting and we hope we can emulate the well enjoyed social aspects of Peebles.

At last summer's trainees' meeting in Edinburgh, I circulated a questionnaire aiming to assess the views of trainees about the proposed changes. Thankfully the changes were endorsed by the majority of those who took the trouble to answer and were happy to give the new format a trial run. Obviously, council and myself are especially keen to see the trainees' meeting in June 1997 as a huge success. With this in mind, Stirling Castle will certainly prove to be an appropriate entertainment venue for those frustrated bravehearts attending.

I hope the Stirling meeting will be well supported and that in future it will become a regular date in everyone's diary just as Peebles is already.

JOHN GILLIES MEMORIAL LECTURE 1996

PHARMACOLOGICAL MANIPULATION OF NEUROMUSCULAR TRANSMISSION

PROFESSOR W.C. BOWMAN UNIVERSITY OF STRATHCLYDE

The 19th John Gillies Memorial Lecture was delivered by Professor Bill Bowman with the clarity and simplicity of a true expert, at the joint meeting of the Scottish and South Western Region Societies on the 29th November 1996.

The process of neuromuscular transmission is conceptually simple, the main basic events having been established and widely accepted for more than 40 years. The neurotransmitter acetylcholine is synthesized within the nerve endings and stored in small (50 nm diameter) translucent vesicles. A small, ineffective amount is continuously released spontaneously, mainly from the axoplasm but also from the vesicles. Vesicular release (but not axoplasmic release) is abruptly and greatly accelerated, through a Ca^{2+}-dependent mechanism, by the arrival of a nerve impulse at the nerve endings. The released acetylcholine diffuses across the narrow junctional cleft and combines fleetingly with the nicotinic acetylcholine receptors on the postjunctional membrane of the motor endplate. The consequence is a localized depolarization, the endplate potential, which initiates a propagating action potential that passes around the muscle fibre membrane to trigger the contractile mechanism. Although these basic tenets of the transmission process have been accepted for many years, important advances in detailed knowledge continue to be made through the accelerating developments of new skills and techniques, especially in the fields of molecular biology and electrophysiology. The nicotinic acetylcholine receptors of the neuromuscular junction were the first to be isolated, biochemically and biophysically characterized, reconstituted into artificial bilayers, and cloned and sequenced.

About half of the acetylcholine synthesized in the axoplasm of the nerve terminals is loaded into small translucent vesicles, each vesicle containing around 12000 molecules. A frog nerve terminal contains about a million vesicles. However, acetylcholine is present not only in the nerve endings but also in the terminal Schwann cells (less than 10% of the total) and in the sarcoplasm of the muscle fibres (*ca* 25% of the total). Its functions, if any, at these sites are unknown.

The loading of acetylcholine into the synaptic vesicles may be inhibited by the compound called vesamicol, a mechanism first proposed by my colleague I G Marshall, and subsequently confirmed by him and others. Studies of the effects of this compound have taught us much about the loading mechanism itself. A trans-vesicular membrane proton gradient is established by the activity of a V-type proton pumping ATPase. Acetylcholine is then transported from the cytoplasm to the interior of the vesicle in exchange for protons. Vesamicol binds to the acetylcholine transporter. Currently, vesamicol has no clinical uses, but in the future, compounds of this type might be developed for the production of prolonged paralysis in the intensive care unit, or for local application in certain types of muscle dystonia.

Certain proteins of the vesicular membrane (synaptotagmins, synaptobrevins, synaptophysins, synaptogyrins, rab3A) and of the axoplasmic face of the terminal axon membrane (syntaxin, SNAP-25) play essential roles in the docking, priming, fusion, exocytosis of the contents and reforming of the vesicles, and much research is being devoted to further elucidation of this process which, in its essentials, resembles that of membrane fusions elsewhere. Botulinum toxin (from *Clostridium botulinum*), as well as being an occasional serious food contaminant, is used clinically to alleviate certain muscle dystonias (blepharospasm, torticollis). The toxin consists of 7 proteins (denoted by the letters A to G) which are actually enzymes, zinc endopeptidases. They prevent acetylcholine release by inactivating synaptobrevin (toxins B,D,F and G), syntaxin (toxin C) and SNAP-25 (toxins A,C and E).

α-Latrotoxin, from the venom of the black widow spider, has a specific binding site in the release sites of the terminal axonal membrane. It is the same site to which synaptotagmin binds. The toxin causes initial excessive vesicular release of acetylcholine and prevents the vesicles from reforming so that the end effect is abolition of acetylcholine release and absence of acetylcholine-containing vesicles. The synaptotagmin site also appears to be a component of the site that acts as an antigen giving rise to the circulating autoantibody responsible for the Lambert-Eaton myasthenic syndrome.

Other vesicular proteins, notably the synapsins, are involved in the anchoring and mobilisation of reserve vesicles. Both processes, mobilization and exocytosis, are Ca^{2+}-dependent, the Ca^{2+} entering the axoplasm from the extracellular fluid through voltage-operated channels that are opened by the nerve action potential. The main Ca^{2+} -channels of the nerve terminals are blocked by ω-agatoxin from the American funnel web spider, indicating that they are so-called P-type calcium channels. Other types of Ca^{2+} channels are, however, also present and may come into play under certain circumstances. Drugs such as aminopyridines that enhance Ca^{2+} influx by blocking the opposing potassium efflux thereby prolonging the nerve terminal action potential, produce an increase in acetylcholine release and have found occasional clinical use in situations in which facilitated neuromuscular

transmission is desirable. Neostigmine has an effect of this type, which, though weak, may be sufficient to contribute to its effects on neuromuscular transmission in conjunction with its anticholinesterase acitivity.

In addition to acetylcholine-containing vesicles, motor nerve terminals also contain relatively large dense-cored vesicles which are loaded with the polypeptide, calcitonin gene-related peptide (CGRP). About one hundredth of the vesicles are of the large dense-cored type, which still amounts to a substantial number. The contents of these vesicles are also released by nerve impulses and release is Ca^{2+}-dependent. However, the finer details of the release of CGRP are different from that of acetylcholine, since exocytosis from the larger vesicles requires a higher frequency of nerve impulses and the release is not affected by black widow spider venom. CGRP produces a number of acute effects at the neuromuscular junction including an increase in acetylcholine synthesis, enhancement of post-tetanic potentiation, and postjunctional acetylcholine receptor desensitisation, all of which may be a consequence of its ability to increase cyclic AMP formation. Changeux and his co-workers have shown that its chronic effect is to stimulate the synthesis of new acetylcholine receptors. It may be therefore that its physiological role is concerned with the up-regulation of endplate acetylcholine receptors.

Receptors present on motor nerve endings include both muscarinic (M_1 and M_2) and nicotinic acetylcholine receptors, both α- and β-adrenoceptors, and both adenosine A_1 and A_{2A} receptors. Both the acetylcholine and the adenosine receptors may be regarded as autoreceptors, since both agonists are released from the motor nerves. This might not be the only source however, for muscle and Schwann cells also release acetylcholine, and adenosine may be derived from ATP released from contracting muscle. Japanese workers have elegantly demonstrated the presence in motor nerves and their terminals of nicotinic receptors of the type that contain $\alpha 3$ subunits. The adrenoceptors are clearly heteroreceptors, since there is no evidence of an adrenergic innervation of skeletal muscle. When activated, the α-adrenoceptors enhance acetylcholine release in response to nerve impulses, whereas the β-adrenoceptors enhance acetylcholine synthesis in circumstances in which it is impaired. It is not yet clear whether the nerve terminal adrenoceptors play any physiological or pathological roles in transmission. If they do, they are presumably activated by catecholamines released from the adrenal medullae, or by noradrenaline that spills over from the sympathetic innervation of neighbouring blood vessels.

Prejunctional nicotinic receptors

The familiar tetanic fade and "train-of-four" (2 Hz for 2 sec) fade are commonly produced by drugs of the tubocurarine-type. Not only is the amplitude of contractions reduced by the drug, but in a tetanus the tension rapidly wanes to zero despite continued stimulation. With "train of four" the last twitch of the group is a great deal more depressed than the first. α-Bungarotoxin, which irreversibly blocks postjunctional nicotinic receptors, does not produce these fade phenomena, but merely produces a uniform depression of amplitude showing that fade is not simply a consequence of postjunctional receptor block. The conclusion has been reached that whereas the depression of amplitude is essentially post-junctional in origin, the fade is the result of the tubocurarine-like drug blocking prejunctional nicotinic receptors that normally act to facilitate mobilization of acetylcholine into the releasable situation, so that output can keep up with the demands of the high frequency stimulation. The inadequate mobilization consequent upon blockade of this process causes the fading tension. This explanation is compatible with the presence of α-type nicotinic receptors in the nerve, since such receptors are known to be resistant to α–bungarotoxin. The main type of evidence for the prejunctional nature of the fade response is illustrated in Fig 1.

Fig 1. *Isolated phrenic nerve-hemidiaphragm preparations of rats. All responses are to train-of-four stimulation (2Hz for 1.9 seconds) before (left) and in the presence of 5 μM vecuronium (right).* ***a:*** *Twitches evoked by nerve stimulation* ***b:*** *Endplate currents (epcs) recorded from a cut muscle fibre clamped at -60mV, evoked by stimulation of the motor nerve* ***c:*** *End plate current responses, recorded from a cut muscle fibre clamped at -80 mV, evoked by jets of acetylcholine applied ionophoretically. Rundown, as distinct from depression of overall amplitude, was present only when the nerve was stimulated.*

In the experiment illustrated in Fig 1, the neuromuscular blocking drug vecuronium produced depression and fade of the mechanical twitches and of the endplate currents evoked by stimulating the nerve, but caused only a uniform depression, with no fade, of endplate currents evoked by ionophoretic release of jets of acetylcholine. It might be of course that the ability of neuromuscular blocking drugs to impair transmitter mobilisation in this way is a consequence of some unknown action that is independent of the prejunctional nicotinic receptors. However, the fact that the drugs that produce the effect are all nicotinic receptor antagonists, even though of different chemical classes (bisbenzylisoquinoliniums, aminosteroids, gallamine, etc.,) coupled with the absence of any other known common mechanism suggests that blockade of a presynaptic nicotinic receptor is the most likely explanation.

My colleagues I G Marshall and his co-workers have shown that whatever the presynaptic action of the tubocurarine-like drug is, it is not a consequence of it preventing the entry of Ca^{2+} from the extracellular fluid. Likewise, the ability of tubocurarine to reduce the release of radio-labelled acetylcholine is also independent of extracellular Ca^{2+}. This does not of course mean that *intracellular* Ca^{2+} is not involved. It might be that acetylcholine normally acts

presynaptically to release a second messenger that then acts to cause Ca^{2+} release from internal stores, and that this internal Ca^{2+} then enhances mobilisation. The nicotinic antagonist, by blocking this action of acetylcholine, would then prevent the necessary enhanced mobilisation. Although it is rare for a nicotinic receptor to function other than entirely by opening a ligand-gated ion channel, alternate actions are known. For example, in cultured myotubes stimulation of nicotinic receptors leads to phosphatidyl inositol breakdown, and inositol trisphosphate is known to evoke Ca^{2+} release from internal stores. If such an effect were to occur at nerve endings, perhaps triggered by acetylcholine-induced Na^{+} influx, it might account for mobilisation of the transmitter.

There is evidence for a second population of nicotinic receptors near motor nerve endings which may be described as preterminal. Many nicotinic agonists including acetylcholine itself, nicotine, carbachol, dimethylphenylpiperazinium, suxamethonium and, in some species, decamethonium, have been shown, by Wessler and Vizi and their coworkers, to increase the release of acetylcholine measured as tritiated choline. Large concentrations of the same agonists, or even small concentrations left in contact with the preparation, produce a decrease in transmitter release. The effects of some of these nicotinic agonists are exhibited in the histogram of Fig 2.

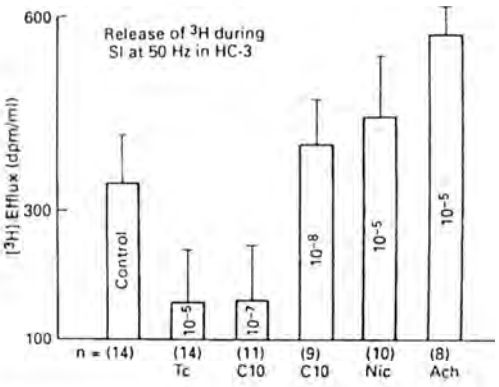

Fig 2. Rat phrenic nerve-diaphragm preparations. Release of radiolabelled choline in the presence of hemicholinium (0.4 x 10^{-3}M) to prevent re-uptake, during the first nerve stimulation period (S), 7.5 min, 50 HZ), in the absence of other drugs (Control) and in the presence of tubocurarine (TC), decamethonium (C10, nicotine (Nic) or acetylcholine (Ach) in the molar concentration indicated The number of preparations (n) is given in brackets below each column. Note that the smaller concentration of decamethonium (10^{-8}M) enhanced release, whereas the larger concentration (10^{-5}M) depressed release. (Unpublished results provided by Dr D Joseph).

These effects are entirely dependent upon extracellular Ca^{2+}. They are prevented by application of reversible nicotinic antagonists such as tubocurarine and pancuronium, and high concentrations of hexamethonium, but not by α-bungarotoxin. This is again compatible with the possibility that these receptors too are of the α3-subunit-containing type, although they are not necessarily the same in their remaining subunit composition as those thought to be responsible for enhanced mobilisation.

The fact that the released transmitter acetylcholine does not itself appear to activate this second population of nerve ending receptors except after cholinesterase inhibition, suggests that they are normally protected from the transmitter by acetylcholinesterase. They therefore have pharmacological relevance, but apparently no physiological role in neuromuscular transmission. They may represent a vestigial remnant of receptors that are present at many nerve endings, including some that are non-cholinergic; for example, those at certain locust nerve endings, at synapses in *Aplysia californica,* and at sensory nerve endings. Another possible explanation of their presence is that nicotinic receptors synthesized in the nerve cell body for insertion into the dendritic or soma membranes, are aberrently transported along the microtubules to the terminals and are inserted into the membrane there. Since they are protected from transmitter acetylcholine by acetylcholinesterase, they can do no harm and they therefore persist.

In summary, the following hypothesis is proposed. Nicotinic receptors of the α3 subunit-containing type are synthesized in the cell bodies, perhaps mainly for insertion into the dendritic membranes. However, some pass along the axons via the microtubules and are inserted into the non-myelinated endings where they form two separate populations. A more distal group close to the terminals has acquired a physiological function. When activated by the released transmitter acetylcholine, they serve to mobilise reserve acetylcholine into the readily-releasable or immediately available store, so that the availability of transmitter matches the demands of the heavy traffic of nerve impulses that is characteristic of the neuromuscular junction. Blockade of these receptors by tubocurarine and related drugs produces the well-known fade phenomena (tetanic fade, train-of-four fade, run-down in a series of endplate potentials or endplate currents). The mechanism that couples receptor activation to facilitated mobilization is not known except to say that it does not depend upon entry of extracellular Ca^{2+}, and it is inactivated at low temperatures.

A second population of nicotinic receptors is supposed to be located more centrally, perhaps just peripherally to the end of the myelin. These may correspond to what others have termed preterminal receptors. They are not accessible to the transmitter because they are protected from it by the junctional cholinesterase. When activated by stable nicotinic agonists, or by the transmitter itself after cholinesterase is inhibited, they produce a localized depolarization which initially gives rise to repetitive firing in the motor nerves and to Ca^{2+}-dependent enhanced release of transmitter. Subsequently, the depolarization may be sufficient to produce conduction block in the nerve terminals. At this stage the release evoked by nerve impulses is actually decreased. These aberrant receptors appear not to play a physiological role in transmission, but they

have pharmacological importance. It is possible that nicotinic receptors found at other sites, for example on sensory nerve endings and dopaminergic terminals, have a similar type of origin. This could be so even where there is no evidence that acetylcholine could ever impinge upon them in normal physiology. Fig 3 represents the postulated sites and functions of nicotinic receptors at the neuromuscular junction.

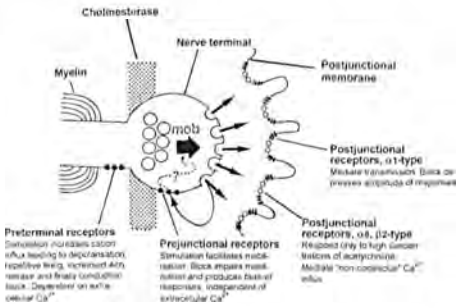

Fig 3. The postulated sites and roles of nicotinic receptors at the neuromuscular junction. The preterminal receptors are protected from the neurotransmitter acetylcholine by the junctional acetylcholinesterase which is present, associated with the basement membrane, throughout the junctional gap. The column of cholinesterase depicted in the diagram is not meant to be anatomically accurate but is merely to suggest that it acts as a protective barrier. The question mark indicates that the link between activation of the prejunctional receptors and the process of transmitter mobilisation is not known. Nicotinic receptors containing α3 protomers have been detected in the axonal and terminal membranes of motor nerves.

Prejunctional adenosine receptors

ATP is released from motor nerves along with acetylcholine, and is also released from contracting muscle. ATP is rapidly broken down to adenosine, and adenosine (P_1) receptors of both the inhibitory A_1 and excitatory A_{2A} subtypes have been detected on motor nerve endings. Under normal circumstances, activation of the inhibitory A_1 subtype is dominant. Ginsborg and Hirst in Edinburgh first showed that adenosine inhibits acetylcholine release in the isolated phrenic nerve-diaphragm preparation of the rat and this has been confirmed repeatedly in isolated nerve-muscle preparations of rodents and amphibia. The effect is prevented by pre-treatment with pertussis toxin, indicating the involvement of a G-protein.

In mammals, although apparently not in amphibia, the inhibitory effect of adenosine release is a consequence of inhibition of the nerve terminal Ca^{2+} influx that occurs in response to the nerve action potential. Drugs that modify adenosine mechanisms are increasingly being developed for therapeutic use in several fields, for example, cardiovascular and analgesic drugs. Anaesthetists should be aware of the potential for interaction with neuromuscular blocking drugs.

Postjunctional nicotinic receptors

It is well known that the adult postjunctional receptors concerned with neuromuscular transmission consist of a ring of five protomers with the stoichiometry $\alpha 1_2$, $\beta 1$, ε, δ. They are located at a density of about 10 000/μm^2 on the shoulders of the junctional folds, and much is being learned about the various proteins (agrin, rapsyn, laminin, α-dystroglycan, adhalin, utrophin, syntrophin, spectrin, and others) that serve to aggregate and anchor the receptors appropriately. When two molecules of acetylcholine interact with their recognition sites located on the two α-subunits of the receptor, a conformation change in the protein occurs which is transmitted throughout the receptor complex, resulting in the opening of a cation channel and allowing the influx of a current carried mainly by Na^+ ions. Unwin, in Oxford, has recently been able to visualize the activated channel in the open state. The walls of the junctional folds extending into the valleys are studded with special voltage-gated Na^+ channels that amplify the effects of the acetylcholine-induced current in initiating the muscle action potential.

The receptors involved in transmission are not the only nicotinic receptors present in the postjunctional membrane. Kimura and colleagues in Japan have recently shown that there is also a population of receptors containing $\alpha 8$ and $\beta 2$ subunits which are responsible for Ca^{2+} influx that is unconnected with the contractile mechanism. The role of these receptors appears to involve desensitization of the receptors involved in transmission by activation of protein kinase C. The $\alpha 8$ / $\beta 2$-type receptors are activated only by relatively high concentrations of acetylcholine. Excessive Ca^{2+} entry through them and consequent activation of proteinase enzymes might be a factor in the prolonged muscle fibre damage that may follow poisoning by organophosphorous anticholinesterases.

We (I G Marshall, C Prior and I) have been interested in the design and development of new neuromuscular blocking drugs, in conjunction with chemists and pharmacologists of Organon Laboratories (T Sleigh, R J Marshall, A Muir, I McIndewar and the late D Savage). Vecuronium and rocuronium are results of such studies. Through such industrial contact we have been able to study some hundreds of potential neuromuscular blocking drugs of the aminosteroid class. One aim has been to find a nondepolarizing equivalent of succinylcholine as free as possible from unwanted effects.

Throughout a very large series of compounds, we have consistently found that rapid onset of action, and usually, although not invariably, rapid offset of action also, is associated with lack of potency. The original observation was with only 20 or so compounds, but numerous subsequent experiments have illustrated the generality of the rule that rapid onset and offset demand low potency, or, more accurately, a high extracellular fluid drug concentration of an impotent compound. The aminosteroidal compound ANQ 9040 also fits this rule and it has also been demonstrated with different chemical series, including the bisbenzyliso-quinoliniums. The concept is illustrated for 4 compounds in Fig 4.

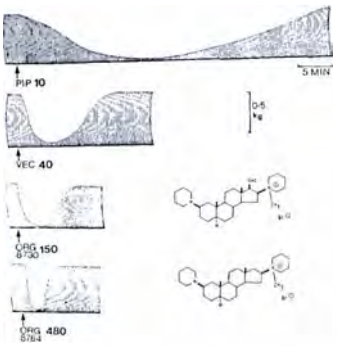

Fig 4. Cats, chloralose anaesthesia. Four different experiments. Typical blocks (approx 90%) are shown to pipecuronium (PIP), vecuronium (VEC), ORG 8730, and ORG 8764. The numbers denote the doses in μg per kg i.v. Generally, highly potent drugs have slower onset and longer duration of action than less potent drugs.

These observations indicate that it is probably possible to produce a nondepolarizing drug with the time-course of action of suxamethonium. However, the dose would be prohibitively high. Some degree of compromise is therefore required if a fast onset drug for easy intubation is to be developed, since the less potent the compound, the more expensive it is to produce and the more likely it is to give rise to unwanted effects. Rocuronium is such a compromise. It is said to be rapid enough in onset to permit intubation but, exceptionally, its duration of action is not much different from that of vecuronium. Its cardiovascular effects are weak, although the margin of safety between its neuromuscular blocking dose and the dose to produce tachycardia is considerably smaller than that of vecuronium. Rocuronium has the advantage that it is stable in solution.

Such is the slowness of the bureaucracy associated with drug development that we must already know the chemicals that will be used as muscle relaxants well into the next century. Advances in surgical techniques coupled with the increased propensity to use regional instead of general anaesthesia, and the reluctance of government health agencies to spend excessively, may mean that we already possess all of the neuromuscular blocking drugs that can reasonably be required in the future. There is little doubt that marginal improvements on existing drugs could be made, but we have to ask whether the work involved would justify the cost. It is only anaesthetists who can instruct pharmacologists in this matter.

Professor Bowman receiving Rose Bowl from the President.

VISITING FELLOW DR. PAVEL POLONINKINE

Dr. Pavel Polovinkine was invited by the Society to spend 4 weeks in Scotland during April and May 1996 and included attendance at the College Meeting of that year. Pavel is from the Clinical Hospital in Saint Petersburg, Russia. His letter to the Society speaks for itself and is published in an unedited form.

Dear Colleagues of Scottish Society of Anaesthetists,

I was kindly invited by the Scottish Society of Anaesthetists as an Overseas Fellow in April - May 1996. I had this honour to visit your country with its well known achievements and strong traditions in anaesthesia, to see your hospitals, to learn real work of your anaesthetists, to explore your country with its rich ancient culture.

It became possible thanks to the fact of new changes in the life of our countries. Soviet Anaesthesiology unfortunately developed without any contacts with Western one. We have been cut off because of political separation. New times bring possibilities of contacts with Western colleagues. Owing to your hospitality I had the chance to visit a number of hospitals in Edinburgh and in Glasgow and to learn anaesthetic management in different fields.

I have started my visit in Royal Infirmary of Edinburgh with cardiac anaesthesia where Dr.Colin Sinclair and his colleagues kindly showed me anaesthesia and intensive therapy in cardiac surgery. I was greatly impressed by professionalism of your anaesthetists and the whole operating team, by the organisation of work in ICU. Next day I was in Western General Hospital of Edinburgh, where Dr. Michael Souter enthusiastically and with excellent competence showed me perioperative management in neurosurgery paying special attention to the possibilities of monitoring in intensive therapy in neurosurgical patients. Then again in Royal Infirmary with Prof. Spence and Dr. Michael Souter I had the chance of first hand acquaintance with anaesthesia using laryngeal mask in combination with regional anaesthesia. Extremely useful and interesting were two days with Dr. Gordon Pugh and Dr. Chris Thorpe in Thoracic Theatre, City Hospital of Edinburgh. I was impressed by their proficiency and highly skilled anaesthesia in thoracic surgery.

During my week in Glasgow I had a very rich programme arranged by Dr. Alan Macdonald. I admired the organisation and management of anaesthesia in obstetrics that was showed me by Dr. Brian Stuart and Dr. Susan Smith in Rutherglen Maternity Hospital. It was an example of true humanism of your health care system. Very interesting was my visit to Victoria Infirmary with Dr. Gavin Gordon and then to ICU with Dr. Lorraine Murphy and Dr. Alan Davidson where I saw an impressive system of computer analysis of intensive therapy. My visit to Glasgow Royal Infirmary with Dr. Brain Maule and his colleagues to Cardiac and Vascular Operating Theatres and then to ICU with Dr. Mansfield was very useful and interesting. Another delightful school of humanism and professionalism was the visit to Yorkhill, the Royal Hospital for Sick Children with Dr. Donald Miller and his colleagues. Anaesthesia for children, intensive care and Pain Relief Services, run by Dr. Neil Morton and Susan Fisher not only worth notice, it is excellent. My last visit in Glasgow was to the Institute of Neurological Sciences, Southern General Hospital where I saw together with Dr. Douglas Walker modern anaesthesia in neurosurgery, and Dr. Jim Borthwick kindly showed me ICU, anaesthetic facilities in MRI, high dependency unit, neurosurgical ward. It was the whole overview of perioperative management in neurosurgery.

My last week in Scotland was again in Edinburgh, Royal Infirmary with Dr. John McClure where I observed excellent professional and skillful anaesthesia in vascular surgery and gynaecology and then Dr. Iain Davidson in cardiac surgery.

I finished my programme in London where I visited Royal College of Anaesthetists with Prof. Alastair Spence and attended the scientific meeting on Resuscitation.

Everywhere, in each hospital I was impressed by the proficiency of your anaesthetists, by high level of

anaesthetic management and intensive therapy, by your approaches, effective and safe methods of treatment, efficiency and economy of your system of health care.

But not only professional programme has been retained in my memory. Russians know Scotland as the country of ancient and powerful culture, the country of proud and high spirited Highlanders, adventurous and romantic, as the country that gave the world great writers and poets. Undisputed genius Robert Burns, Robert Louis Stevenson whose books and verses every Russian remembers from his school years. I have seen with my own eyes the country of Sir Walter Scott, country of my child dreams. Here I have discovered for myself this delightful country with beautiful and romantic Edinburgh, impressive and unforgettable Glasgow and fascinating Pebbles.

Thanks to warm hospitality of Dr. Alan Macdonald, Prof. Alastair Spence and Dr. Iain Davidson I saw beautiful countryside and historical places. Loch Lomond, Loch Fyne, Firth of Clyde with their marvellous scenery, legendary Inverary Castle where I had the honour to meet the Duke of Argyll, beautiful Culzean Castle, Alloway with Burns Cottage and Modern Art Gallery in Glasgow, Auld Brig o'Doon and Forth Bridges - all these things with their aura of the times past give rise to deep sentiments - the continuity of your rich, quite distinct and original history.

But the most exciting impression was to meet real people who were amazingly friendly and always ready to help. I had the chance to take part in your Annual Meeting in Peebles where I enjoyed staying very much and was happy to meet many of your colleagues. It was indeed a very pleasant surprise to see the way you keep up traditions of your nation.

I am most grateful to your Society and everyone who helped me during my visit. My extreme gratitude to Prof. Spence who inspired this visit and took care of me during my stay in Scotland and then in London. I am obliged so much to Dr. Colin Sinclair, Dr. Alan Macdonald, Dr Iain Davidson for all the arrangements connected with my visit, for the warm hospitality of their families offered to me. I am very thankful to Dr. David Scott. My special thanks to Mrs Cindy Middleton for her attention and care.

I believe that my visit will further to closer relationships between Scottish Society of Anaesthetists and Russian Society of Anaesthesiologists and will encourage personal contacts between our people.

With my best wishes to your Society,

Yours sincerely,

Dr. Pavel Polovinkine

Dept. of Anaesthesiology, Dept. of Reanimatology

Clinical Regional Hospital

Saint Petersburgh

Russia.

SYSTEMATIC REVIEWS

HENRY MCQUAY **ANDREW MOORE**

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HENRY MCQUAY, Clinical Reader in Pain Relief **ANDREW MOORE,** Consultant Biochemist

EFFICACY AND SAFETY

There are both professional and political reasons for determining whether the interventions we use are effective and safe. The professional agenda is that we want to use those interventions for our patients. The political agenda is that with finite resources it makes sense to pay for the effective and not pay for the ineffective.

The problem is working out what is effective and what is safe. The tool used here is the systematic review. The term systematic review is used generically to encompass both qualitative reviews, no data-pooling possible or none done, and quantitative reviews, where data-pooling (meta-analysis) was done. Systematic reviews are different from classical narrative reviews because they have explicit methods, describing the systematic way in which all the relevant studies have been identified and considered. Systematic reviews should be less open to bias than narrative reviews, and you should be able to repeat the review using the authors' methods - you might not come to the same conclusions, but at least you would be working from the same data.

EFFICACY

The rules for guiding us to the 'best' evidence about efficacy are relatively clear.

Figure 1: Grading evidence by study architecture

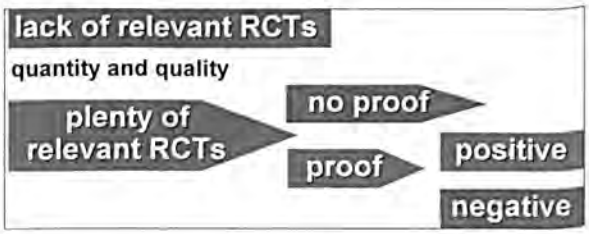
TYPE & STRENGTH OF EVIDENCE

I	Strong evidence from at least 1 systematic review of multiple well-designed randomised controlled trials.
II	Strong evidence from at least 1 properly designed randomised controlled trial of appropriate size.
III	Evidence from well designed trials without randomisation, single group pre-post, cohort, time series or matched case-controlled studies
IV	Evidence from well designed nonexperimental studies from more than 1 centre or research group
V	Opinions of respected studies or reports of expert committees

Opinions of experts (grade V) are less likely to give us the correct answer about efficacy than randomised trials or systematic reviews (grade I).

The arguments for restricting reviews to randomised trials (when these are available) are powerful [1]. It is important to realise that even if there are many RCTs relevant to the question you want to pose it may not be possible for a systematic review to deliver an answer (Figure 2).

Figure 2: Possible outcomes when posing a question for systematic review



If all the trials use different outcome measures, or if each trial is invalid for some bizarre methodological reason, then there may be no proof either way on the question you want to answer. With plenty of relevant trials which do pass muster on quality and validity standards there may be proof, either that the intervention is effective or that it is ineffective.

SAFETY

The rules for the quality of evidence about safety are not as well developed as those for efficacy. Whereas a case-report about efficacy should carry very little weight, because of the strong possibility of bias, a case-report of a serious adverse event occurring in a 'benign' setting - death after tonsillectomy for instance - may be extremely important. Rare events are unlikely to be identified in the relatively small numbers of patients involved in randomised trials. Rare and serious adverse events are therefore much more likely to be reported from observations.

APPLYING ALL THIS TO ANAESTHESIA

In anaesthesia, just as in other therapeutic areas, there are often many ways to tackle a particular problem. There may be evidence of benefit for each of the alternatives. The task which faces us is to have a way of ranking the relative efficacy and safety of these interventions. Then we can make informed decisions about which should be selected, purchased and offered to patients.

Perhaps in the ideal world there would be large randomised trials comparing the various interventions. In practice what we have is a number of small studies. How do we rank the relative performance of the

interventions? The ranking often has to be indirect, how well does each intervention compare with placebo, rather than derived from direct 'head-to-head' comparisons of the treatments (Table 1).

Table 1: Ranking relative efficacy

	Data Source	
Trial Comparator	individual patient data	published group data
comparisons with placebo	indirect ranking	
comparison with other 'active'	direct ranking	

Combining Data and Interpreting the Results

As professionals we want to use the best treatments and, as patients, to be given them. Knowing that an intervention works (or does not work) is fundamental to clinical decision-making.

When is the evidence strong enough to justify changing practice? Some of the decisions we make are based on individual studies, often on small numbers of patients, which, given the random play of chance, may lead to incorrect decisions. Systematic reviews identify and review all the relevant studies, and are more likely to give a reliable answer. They use explicit methods and quality standards to reduce bias. Their results are the closest we are likely to get to the truth in the current state of knowledge.

The questions a systematic review should answer for us are:

- how well does an intervention work (compared with placebo, no treatment or other interventions in current use) - or can I forget about it?
- is it safe?
- will it work and be safe for the patients in my practice?

Clinicians live in the real world and are busy people, and need to synthesise their knowledge of a particular patient in their practice, their experience and expertise, and the best external evidence from systematic review. They can then be pretty sure that they are doing their best. But the product of systematic review and particularly meta-analysis - often some sort of statistical output - is not usually readily interpretable or usable in day-to-day clinical practice. A common currency to help make the best treatment decision for a particular patient is what is needed. We think that common currency is the number-needed-to-treat (NNT).

Quality Control

Systematic reviews of inadequate quality may be worse than none, because faulty decisions may be made with unjustified confidence. Quality control in the systematic review process, from literature searching onwards, is vital. How to judge the quality of a systematic review is encapsulated in the questions [2]:

- Were the question(s) and methods stated clearly?
- Were the search methods used to locate relevant studies comprehensive?
- Were explicit methods used to determine which articles o include in the review?
- Was the methodological quality of the primary studies assessed?
- Were the selection and assessment of the primary studies reproducible and free from bias?
- Were differences in individual study results explained adequately?
- Were the results of the primary studies combined appropriately?
- Were the reviewers' conclusions supported by the data cited?

When systematic reviews use data from different numbers of papers (see [3] for an excellent discussion of eligibility criteria for trials of head lice infection), reasons should be sought. Reviews can use criteria which exclude information important to individual clinicians, or may be too lax by including studies with inadequate trial design. The defence against either mistake is to read the inclusion and exclusion criteria critically to see if they make sense in your clinical circumstance.

Outcome measures chosen for data extraction should also be sensible. Usually this is not a problem, but again it is a part of the methods that needs to be read carefully to see if you agree with the outcome measure extracted. The reviewer may have used all that is available, and any problems were due to the original trials, but it is a determinant of the clinical utility of the review. Examples in antibiotic treatment of Helicobacter pylori infection and peptic ulcer would be outcome measures of short-term bacterial kill rates and long-term remission.

Therapeutic Interventions: Which Study Architectures are Admissible?

For a systematic review of therapeutic efficacy the gold standard is that eligible studies should be randomised controlled trials (RCTs). If trials are not randomised estimates of treatment effect may be exaggerated by up to 40% [4]. In a systematic review of transcutaneous electrical nerve stimulation (TENS) in postoperative pain, 17 reports on 786 patients could be regarded unequivocally as RCTs in acute postoperative pain. Fifteen of these 17 RCTs demonstrated no benefit of TENS over placebo. Nineteen reports had pain outcomes but were not RCTs; in 17 of these 19, TENS was considered by their authors to have had a positive analgesic effect [1]. When appropriate, and particularly with subjective outcomes, the gold standard for an efficacy systematic review is studies which are both randomised and double-blind. The therapeutic effect may be exaggerated by up to 20% in trials with deficient blinding [4].

Not All Data Can Be Combined in a Meta-Analysis: Qualitative Systematic Reviews

It is often not possible or sensible to combine (pool) data, resulting in a qualitative rather than a quantitative

systematic review. Combining data is not possible if there is no quantitative information in the component trials of the review. Combining data may not be sensible if trials used different clinical outcomes or followed the patients for different lengths of time. Combining continuous rather than dichotomous data may be difficult. Even if trials measure and present dichotomous data, if the trials are otherwise of poor quality [5] it may not be sensible to combine the data.

Making decisions from qualitative systematic reviews

Making decisions about whether or not a therapy works from such a qualitative systematic review may look easy. In the example above, 15 of the 17 RCTs of TENS in acute pain showed no benefit compared with control. The thinking clinician will catch the Bayesian drift, that TENS in acute pain is not effective. The problem with this simple vote-counting is that it may mislead. It ignores the sample size of the constituent studies, the magnitude of the effect in the studies and the validity of their design even though they were randomised.

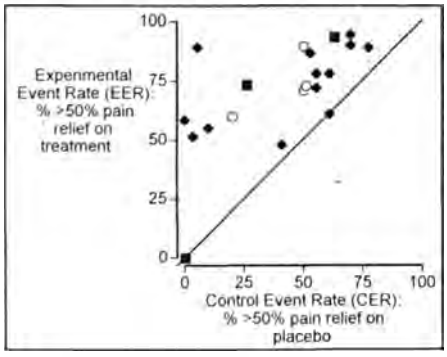
Combining data: quantitative systematic reviews

There are also two parts to the "Does it work?" question: how does it compare with placebo and how does it compare with other therapies. Whichever comparison is being considered, the three stages of examining a review are a L'Abbé plot, statistical testing (odds ratio or relative risk), and a clinical significance measure such as NNT.

L'Abbé plots [6]

For therapies a first stage is to look at a simple scatter plot, which can yield a surprisingly comprehensive qualitative view of the data. Even if the review does not show the data in this way you can do it from information on individual trials presented in the review tables. Figure 3 contains data extracted from three different systematic reviews of treatments for painful diabetic neuropathy [7, 8, 9]. Each point on the graph is the result of a single trial, and what happens with the intervention in question (experimental event rate [EER]) is plotted against the event rate in the controls (control event rate [CER]).

Figure 3: L'Abbé plot of Experimental Event Rate (EER; %> 50% relief on treatment) against Control Event Rate (CER; %> 50% relief on placebo) for RCTs of anticonvulsants, ■ antidepressants ◆, and topical capsaicin ○ in diabetic neuropathy [7, 8, 9].



Trials in which the experimental treatment proves better than the control (EER > CER) will be in the upper left of the plot, between the y axis and the line of equality. All three interventions in the Figure were effective; the Figure does not say how effective. If experimental is no better than control then the point will fall on the line of equality (EER = CER), and if control is better than experimental then the point will be in the lower right of the plot, between the x axis and the line of equality (EER < CER).

Visual inspection gives a quick and easy indication of the level of agreement among trials. Heterogeneity is often assumed to be due to variation in the experimental event rate, the effect of the intervention. Figure 3 shows that variation in the control event rate can also be a source of heterogeneity, and in this case the controls were all matched placebo in a relatively homogenous chronic condition with treatments over several weeks to several months.

L'Abbé plots are not yet widely used. They do have several benefits: the simple visual presentation is easy to assimilate. They make us think about the reasons why there can be such wide variation in (especially) placebo responses, and about other factors in the overall package of care that can contribute to effectiveness. They explain the need for placebo controls if ethical issues about future trials arise. They keep us sceptical about overly good or bad results for an intervention in a single trial where the major influence may be how good or bad was the response with placebo.

Variation in control (placebo) response rates

The large variation in CER (from 0 to 80%) is not unusual. Similar variation was seen in trials of anti emetics in postoperative vomiting [10], and in six trials of prophylactic natural surfactant for preterm infants the CER for bronchopulmonary dysplasia was 24 - 69% [11]. Such variation would not be expected in other circumstances, like use of antimicrobials. Rates of eradication of H pylori with short term use of ulcer healing drugs were 0 - 17% in eleven RCTs (with 10 of 11 below 10%) [12].

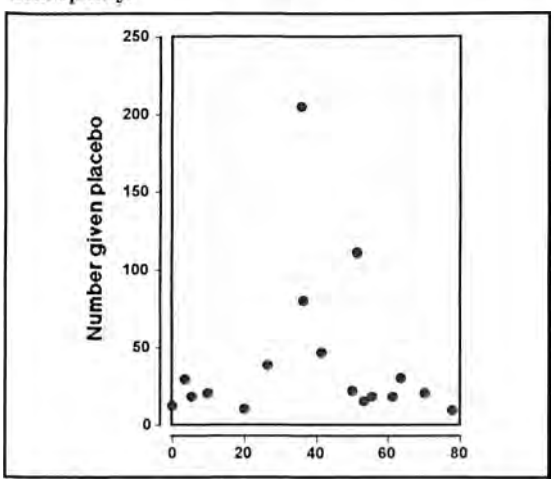
The reason for large variations in event rates with placebo may have something to do with trial design and population. The overwhelming reason for large variations in variation in placebo rates in pain studies (and probably studies in other clinical conditions) is the relatively small group sizes in trials. Group sizes are chosen to produce statistical significance through power calculations - for pain studies the usual size is 30-40 patients for a 30% difference between placebo and active.

An individual patient can have no pain relief or 100% pain relief. Random selection of patients can therefore produce groups with low placebo response rate or high placebo response rate, or somewhere in between. Ongoing mathematical modelling based on individual patient data is showing that while group sizes of up to 50 patients are likely to show a statistical difference 80-

90% of the time, to generate a close approximation to the "true" clinical impact of a therapy requires as many as 500 patients per group (or more than 1,000 patients in a trial). This is part of the rationale of systematic review.

Examples of the way group size can be a source of variation are important in understanding how pooling of information in pain trials can be of help. One example is given in Figure 4, of trials in diabetic neuropathy where the proportion of patients given placebo is plotted against the number given placebo.

Figure 4
Relationship between placebo response and trial size for pharmacological interventions in diabetic neuropathy.



Proportion of patients with more than 50% pain relief with placebo

A similar pattern of an inverted 'V' can also be seen for topical NSAID trials, and indicates that almost all of the variability in placebo responses occurs in trials of small size. In rheumatoid arthritis, Gøtzsche [13] found a similar variability in estimates of change in ESR and joint size by sample size.

The lessons are that information from individual trials of small size should be treated with circumspection in pain and probably other therapeutic areas, and that variation in outcomes seen in trials of small size is probably artefactual, especially in the absence of any Bayesian drift.

Indirect comparisons

Indirect comparisons of efficacy of different interventions, for example by trying to compare treatments which have each been compared with placebo rather than with each other, may not be viable if the control event rates are dissimilar. Post-hoc approaches, taking all the trials, then using only those which have a low or a high CER, are frowned on, though using particular clinical settings and anticipating less control event rate spread may be more acceptable [14]. In some circumstances, for instance in prophylaxis for nausea and vomiting, particular control event rate spreads may be determinants of trial validity [15].

In most pain studies neither of these apply.

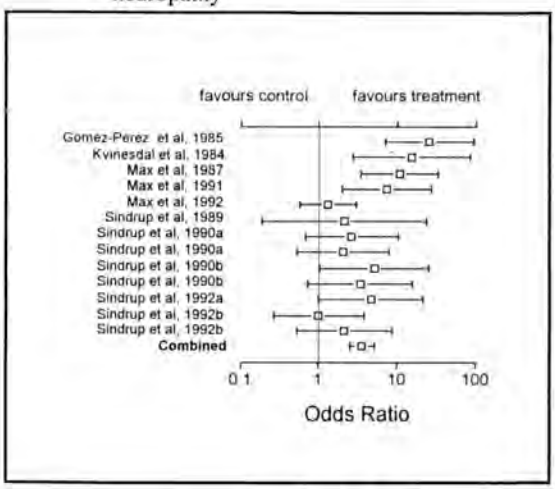
Statistical Significance

Odds Ratios

When it is legitimate and feasible to combine data the odds ratio and relative risk are the accepted statistical tests to show that the intervention works significantly better than the comparator. As systematic reviews are used more to compare therapies clinicians need to grip these clinical epidemiological tools, which present the results in an unfamiliar way.

Figure 5 shows the odds ratios for the trials of antidepressants in diabetic neuropathy mentioned above. Some of the component trials did not show statistical significance; the lower 95% confidence interval of the odds ratio was less than 1. Conversely other trials, and the combined analysis, did show statistical significance, with the lower 95% confidence interval being greater than 1, which means that 19 times out of 20 the 'true' value will be greater than 1.

Figure 5: Odds ratios for antidepressants in diabetic neuropathy



Odds Ratio

The odds ratio can give a distorted impression when analyses are conducted on subgroups which differ substantially in baseline risk [14]. Where control event rates are high (certainly when they are above 50%), odds ratios should be interpreted with caution.

Relative risk

The fact that it is the odds ratio rather than relative risk reduction which is used as the test of statistical significance for systematic reviews seems to be due to custom and practice rather than any inherent intellectual advantage [14]. Relative risk may be better than odds ratios because it is more robust in situations where control event rate is high [16]. With event rates above 10% relative risk produces more conservative figures [17].

In following chapters both odds ratios and relative risks are used, reflecting a degree of uncertainty and disagreement amongst statisticians and reviewers. In all cases the actual numbers are given so that when the dust has settled calculations can be re-done according to the prevailing opinion.

Heterogeneity

Clinicians making decisions on the basis of systematic reviews need to be confident that apples are not being compared with oranges. The L'Abb_ plot is a qualitative defence against this spectre. Statistical testing provides a quantitative rampart, and is available in standard software [18]. Unfortunately all these tests lack power, so that, while a test positive for heterogeneity suggests mixed fruits are being compared, a negative test does not provide complete reassurance that there is no heterogeneity.

Heterogeneity will also appear to occur because of variations in control and experimental event rates due to the random play of chance in trials of small size. Generally trials of fewer than 10 patients per group have been omitted in reviews in this report, but considerable variability will occur in group sizes below 50 patients.

How well does the intervention work?

While odds ratios and relative risks can show that an intervention works compared with control they are of limited help in saying how well the intervention works - the size of the effect or its clinical significance.

Effect size

The classic method of estimating effect size was to use the standardised mean difference [19]. The advantages of this approach are that it can be used to compare the efficacy of different interventions measured on continuous rather than dichotomous scales, and even using different outcome measures. The z score output is in standard deviation units, and therefore is scale-free.

The disadvantage of effect size is that it is not intuitive for clinicians.

Number-needed-to-treat

The number-needed-to-treat (NNT) concept is proving to be a very effective alternative as the measure of clinical significance from quantitative systematic reviews. It has the crucial advantage of applicability to clinical practice, and shows the effort required to achieve a particular therapeutic target. The NNT is given by the equation

$$NNT = \frac{1}{(IMP_{act}/TOT_{act}) - (IMP_{con}/TOT_{con})}$$

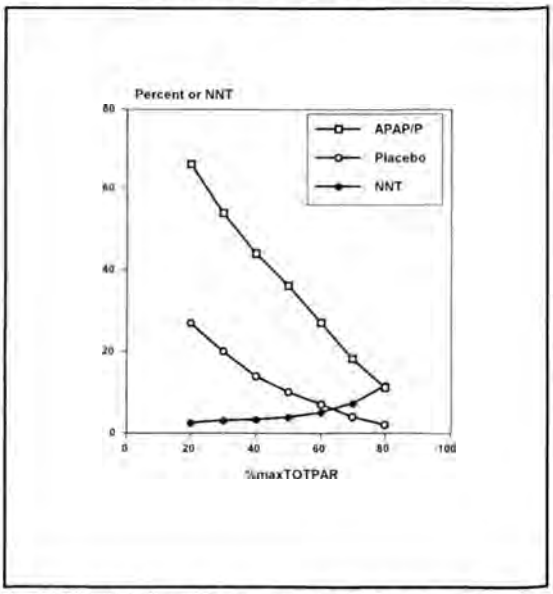
where:
IMPact = number of patients given active treatment achieving the target
TOTact = total number of patients given the active treatment
IMPcon = number of patients given a control treatment achieving the target
TOTcon = total number of patients given the control treatment

Treatment-specific

NNT is treatment specific. It describes the difference between active treatment and control. The threshold used to calculate NNT can vary, but NNT is likely to be relatively unchanged because changing threshold changes results for both active and control.

In the example below from an individual patient data meta-analysis of postoperative pain relief, NNTs compared with placebo were calculated for paracetamol 650 mg plus propoxyphene 100 mg (APAP/P) between 20 and 80% relief of pain. With placebo the proportion of patients achieving a particular level of pain relief fell quickly as the target was raised. For an effective analgesic, this proportion fell slowly until high relief targets were reached. The difference remained largely unaltered over a wide range of targets - generating stable NNTs.

Fig. 6: Effect of different thresholds of pain relief on NNT



An NNT of 1 describes an event which occurs in every patient given the treatment but in no patient in a comparator group. This could be described as the "perfect" result in, say, a therapeutic trial of an antibiotic compared with placebo. For therapeutic benefit the NNT should be as close as possible to 1; there are few circumstances in which a treatment is close to 100% effective and the control or placebo completely ineffective, so NNTs of 2 or 3 often indicate an effective intervention. For unwanted effects, NNT becomes the NNH (number-needed-to-harm), which should be as large as possible.

It is important to remember that the NNT is always relative to the comparator and applies to a particular clinical outcome. The duration of treatment necessary to achieve the target should be specified. The NNT for

cure of head-lice at two weeks with permethrin 1% compared with control vehicle was 1.1 (95%CI 1.0 - 1.2) [3, 20].

Confidence Intervals

The confidence intervals of the NNT are an indication that 19 times out of 20 the 'true' value will be in the specified range. If the odds ratio is not statistically significant then the NNT is infinite. An NNT with an infinite confidence interval is then but a point estimate. It may still have clinical importance as a benchmark until further data permits finite confidence intervals, but decisions must take account of this parlous state.

Disadvantages

The disadvantage of the NNT approach, apparent from the formula, is that it needs dichotomous data. Continuous data can be converted to dichotomous for acute pain studies so that NNTs may be calculated, by deriving a relationship between the two from individual patient data [21]. Because of the way it is calculated, NNT will also be sensitive to trials with high control event rates. As CER rises the potential for treatment specific improvement decreases: higher (and apparently less effective) NNTs result. So, as with any summary measure from a quantitative systematic review, NNT needs to be treated with caution, and comparisons can only be made confidently if CERs are in the same range.

Is it safe?

Estimating the risk of harm is a critical part of clinical decisions. Systematic reviews should report adverse events as well as efficacy, and consider the issue of rare but important adverse events. Large RCTs apart, most trials study limited patient numbers. New medicines may be launched after trials on 1,500 patients [22], missing these rare but important adverse events. The rule of three is important here. If a particular serious event does not occur in 1,500 patients given the treatment, we can be 95% confident that the chance of it occurring is at most 3/1,500 [23].

Much the same rules apply to harm as to efficacy, but with some important differences, the rules of admissible evidence and the Number-Needed-to-Harm (NNH) rather than to-treat (NNT). Number-Needed-to-Harm (NNH). For minor adverse effects reported in RCTs, NNH may be calculated in the same way as NNT. When there is low incidence it is likely that point estimates alone will emerge (infinite confidence intervals). Major harm may be defined in a set of RCTs as intervention-related study withdrawal, and be calculated from those numbers. Precise estimates of major harm will require much wider literature search to trawl for case reports or series. The absence of information on adverse effects in systematic reviews reduces their usefulness.

Rules of evidence

The gold standard of evidence for harm, as for efficacy, is the RCT. The problem is that in the relatively small number of patients studied in RCTs rare serious harm may not be spotted. For an adverse effect systematic review, study architectures of lower intrinsic quality may therefore be admissible. An extreme example is that observer blinding is superfluous if the outcome is death. Such rare and serious harm cannot and should not be dismissed just because it is reported in a case report rather than in an RCT. The 'process rules' in this area have yet to be determined.

Using NNTs

In the ideal world you will have three numbers for each intervention, an NNT for benefit and NNHs for minor and major harm. This three numbers become the yardstick against which alternative interventions should be judged, and is the pivot for the clinical decision on whether or not to use the intervention for an individual patient.

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REGISTRAR'S PRIZE

TIM WALSH

OXYGEN CONSUMPTION DURING ORTHOTOPIC LIVER TRANSPLANTATION

Introduction

The aim of this essay is to describe studies in which the Deltatrac metabolic monitor has been used to study oxygen consumption (VO_2) during orthotopic liver transplantation. The measurement of VO_2 is not straightforward. I have therefore reviewed the techniques available, and potential sources of error associated with each, as background to the work which has been carried out. A detailed description of the mode of action of the Deltatrac metabolic monitor has been included because it clarifies the limitations of the technique and the rationale for some of the studies which we have performed.

Background

The measurement of oxygen consumption

The measurement of VO_2 by the body is desireable during anaesthesia and critical illness. With accurate and reproducible techniques, the total oxygen requirements of the body can be estimated and, more importantly, the effect of interventions which alter oxygen delivery to the tissues (DO_2) can be assessed. Many studies in critically ill patients have suggested that VO_2 increases if DO_2 is increased with fluids, inotropes, vasodilators, or red blood cells. This apparent "supply-dependency" of oxygen consumption has been thought to reflect tissue hypoxia and it has been considered logical to maximise DO_2. Many intensive care practitioners utilise specific numerical targets for oxygen delivery, extraction, or consumption to guide resuscitation. With this "goal directed therapy" several studies have demonstrated improved outcome.

The majority of these studies have measured VO_2 using the reverse Fick method. With this technique the arteriovenous oxygen content difference is calculated and multiplied by the cardiac output. A pulmonary artery catheter is required for the measurement of cardiac output by thermodilution, and for sampling mixed venous blood. The technique is relatively straightforward, cheap, and simple. It may, however, be fundamentally flawed. Oxygen consumption by the lungs is ignored which, while a small fraction of total VO_2 during health, may be considerable during critical illness. This may explain why Fick derived VO_2 calculations are consistently lower than those made with techniques which include pulmonary oxygen consumption. The technique is also potentially subject to multiple measurement errors. The arteriovenous oxygen content difference is often small, particulary in patients with sepsis or fulminant hepatic failure. Small inaccuracies in the measurement of haemoglobin or haemoglobin saturation therefore potentially introduce significant error. In addition, the measurement of cardiac output by thermodilution is known to be subject to multiple measurement errors. A measured change of at least 10% has been suggested before a true physiological change can be assumed.

When VO_2 is calculated from cardiac output mathematical coupling of data can occur. If 2 pairs of data are separated by an intervention which increases one of the variables, the second variable has a high chance of increasing if it is derived from the first irrespective of a true physiological change. These effects are purely mathematical and can be illustrated with randomly generated numbers. When cardiac output is both manipulated and used in the calculation of VO_2, mathematical coupling becomes a common source of error which has been neglected in the critical care literature until recent years. It is now accepted that VO_2 should be measured independently from cardiac output in future studies.

Oxygen consumption can be measured by analysis of respiratory gases using the formula:

$$VO_2 = (V_I.F_I0_2) - (V_E.F_E0_2)$$

V_I	Inspired volume
V_E	Expired volume
F_IO_2	Inspired O_2 fraction
F_EO_2	Mixed expired O_2 fraction

Inspired and expired oxygen fractions can be accurately measured using a paramagnetic oxygen analyser, oxygen electrode or mass spectrometer. The accurate measurement of inspiratory and expiratory volumes is, however, technically difficult. Traditionally the Douglas bag method has been used to collect expired gases. The technique is cumbersome and impractical in routine clinical practice.

In recent years, a number of metabolic monitors have become commercially available. These were originally developed in response to the demand for a method of assessing energy expenditure and metabolic rate and are based on the "indirect calorimetry" principal. This assumes that all oxygen consumed by the body is utilised for the generation of energy through the oxidation of substrates, and that eliminated carbon dioxide (VCO_2) is exclusively the product of those reactions. Energy expenditure can then be estimated from VO_2 and VCO_2. From the ratio of VCO_2 to VO_2 the respiratory quotient (RQ) can be calculated: RQ =

VCO_2/VO_2. This gives information about the nature of the substrates being oxidised. It is immediately clear that for indirect calorimetry to accurately reflect metabolic rate the subject being studied must be at a "steady state", ie gas exchange across the lungs must reflect what is occurring in the tissues. In particular, changes in ventilation will invalidate the assumption that VCO_2 reflects the products of substrate oxidation until a new steady state is reached. The concept of steady state is central to the use of indirect calorimetry. The most widely used commercially available metabolic monitor is the Deltatrac (Datex, Helsinki). This device has been designed to avoid the technical problems of measuring gas volumes with sufficient accuracy for metabolic measurements. VCO_2 is measured directly and the RQ calculated from inspired and expired oxygen and carbon dioxide fractions. The methods of measurement are described in detail below. VO_2 is then calculated each minute by a simple rearrangement of the above formula: $VO_2 = VCO_2/RQ$.

The Deltatrac has been used for measuring VO_2 in critically ill patients. The potential problems of the reverse Fick method have led several groups to compare measurements made simultaneously with the two techniques. In stable patients following cardiac surgery the reverse Fick method consistently underestimated VO_2 measured by indirect calorimetry although the reproducibility of the two techniques was comparable. A number of studies have examined the effect of increasing DO_2 on VO_2 measured with each method. Under these circumstances the results differ significantly. Calculated VO_2 (reverse Fick) increases in response to increased DO_2 whilst measured VO_2 (indirect calorimetry) does not change or increases minimally. This discrepancy can be explained by mathematical coupling and suggests that the results of many earlier studies in which the reverse Fick method was used may have been misleading. Other work using indirect calorimetry has suggested that the whole concept of supply dependency may result from artefact due to mathematical coupling of data except at very low levels of DO_2. It is clear that the method of measuring VO_2 is important and future studies should use methods which are independent of cardiac output.

Liver Transplantation

Surgery for orthotopic liver transplantation is divided into preanhepatic, anhepatic, and post anhepatic phases. During the anhepatic phase the clamping of major vascular structures may result in tissue ischaemia. In particular, post operative renal failure has been attributed to hypoperfusion during the anhepatic phase. Gut ischaemia may increase translocation of bacteria and the incidence of postoperative sepsis. In the earliest surgical techniques, the inferior vena cava (IVC) was cross clamped above and below the liver resulting in a decrease in cardiac output and venous congestion of infrahepatic organs. Congestion of the gut resulted from clamping of the portal vein. The use of extracorporeal venovenous bypass from portal and femoral to axillary or subclavian veins reduces venous congestion and improves cardiac output. Despite these measures, a recent study using gastric tonometry indicates that gastric ischaemia occurs during the anhepatic phase even when venovenous bypass is used. A further surgical technique, the "piggyback", has been employed in a number of centres. With this approach the hepatic veins are selectively ligated to produce a single recipient hepatic venous lumen. A side clamp is then applied to the IVC around the hepatic vein such that bloodflow through the IVC is preserved. The donor IVC is fashioned into a single lumen for anastomosis. During the anhepatic phase, the portal vein is clamped or a temporary portocaval anastomosis fashioned to optimise venous drainage from the gut. This technique appears to improve haemodynamic stability and does not require an extracorporeal bypass circuit.

Several studies have measured VO_2 during liver transplantation. These have demonstrated a decrease in VO_2 during the anhepatic stage. At reperfusion a rapid increase in VO_2 occurs. Several authors have noted that the change in VO_2 between the anhepatic and post reperfusion stages is usually approximately 25%. The normal liver is thought to account for 25% of basal oxygen requirements and it has been suggested that the magnitude of the increase in VO_2 may relate to the function of the new liver. This could potentially provide an early indication of graft function. Several large retrospective studies have used the reverse Fick method to examine this hypothesis and concluded that patients in whom primary graft non-function occurs exhibit a smaller increase in VO_2 at reperfusion. This has been suggested as a valuable "in theatre" test. Three small studies have used indirect calorimetry to assess the same phenomenon. In two studies the change in VO_2 appeared to have some predictive value for graft function but the third observed an increase in VO_2 in a case of primary liver non function and concluded it had no value. As numbers were small the conclusions were largely based on anecdotal cases.

At reperfusion rapid changes occur in blood temperature, cardiac output, and systemic vascular resistance. The use of thermodilution cardiac output to calculate VO_2 may therefore be subject to considerable error. In addition, when the reverse Fick method is used to calculate a change in VO_2 at reperfusion, the increase in cardiac output will account for most of the calculated increase in VO_2 as the change in arteriovenous oxygen content difference is small. This is the typical situation in which mathematical coupling will introduce significant error. Oxygen kinetics during liver transplantation should therefore be evaluated using analysis of respiratory gases to measure VO_2.

The Deltatrac metabolic monitor

The Deltatrac metabolic monitor is an open circuit indirect calorimeter which has been validated in the laboratory and intensive care setting. Its mode of action and an evaluation of accuracy have also been described. Inspiratory gases are sampled and the F_IO_2 measured. Exhaled gas is collected from the ventilator and enters a mixing chamber from which it is drawn into a 45 $l.min^{-1}$ fixed flow generator which mixes all the expired gas

with entrained air. The CO_2 concentration in the effluent, multiplied by 45 l.min^{-1} gives the CO_2 output (VCO_2) assuming a negligible CO_2 concentration in air. The F_EO_2 and F_ECO_2 are measured in the mixing chamber. Gas analysis is by an infrared CO_2 analyser and a differential paramagnetic oxygen analyser. The respiratory quotient (RQ) is then calculated according to the equation:

$$RQ = \frac{1 - F_I0_2}{\frac{[F_I0_2 - F_E0_2]}{F_E0_2} - F_I0_2}$$

This equation is derived by substitution from basic equations describing pulmonary physiology. The VO_2 is then derived as VCO_2/RQ. As previously described this system avoids the problems of measuring inspired and expired volumes with the precision required for metabolic measurements but assumes that VCO_2 represents only the volume of carbon dioxide produced by substrate oxidation in the body. It is assumed that the RQ measured (the different volumes of oxygen and carbon dioxide exchanged across the lungs) is the same as the "metabolic" RQ, ie. what is occurring in the tissues. These assumptions can only be made if the patient is at a "steady state".

Prior to use the machine is allowed to warm up according to manufacturers guidelines and then a gas calibration performed with an oxygen/carbon dioxide mixture, and pressure calibrated to ambient atmospheric pressure measured with a barometer. Thereafter, automatic calibration of both O_2 and CO_2 analysers is carried out every 10 minutes. Data is presented as one minute averages and is collected continuously and recorded onto computer using software provided by the manufacturers. The machine incorporates an algorithm which detects and rejects artefactual data. Gas volumes are corrected to standard temperature and pressure.

Our intention has been to use the Deltatrac metabolic monitor to measure VO_2 during liver transplantation. It was hoped that this technique could be used to further study the changes in global VO_2 which occur at the different phases of surgery. In particular we were keen to examine the increase which occurred at reperfusion. Both venovenous bypass and the piggyback technique are used in the unit and it was our intention to evaluate whether oxygen kinetics differed with the two techniques. A pilot study was undertaken to gain experience with the apparatus.

Pilot study

The derivation of the equation for RQ which is used in the Deltatrac makes the assumption that all gases other than oxygen and carbon dioxide are in equilibrium. The presence of nitrous oxide or volatile anaesthetics would also interfere with the accuracy of the infrared carbon dioxide analyser which is not designed to measure other agents. It was therefore necessary to employ a total intravenous anaesthetic technique during the studies. Patients were anaesthetised with a midazolam, propofol, alfentanil regime and muscle relaxation maintained with atracurium. All patients also received a renal dose of dopamine and a standard infusion regime of aprotinin which is the usual practice in our centre. Patients were ventilated with an air/oxygen mixture using a Servo 900C ventilator. This ventilator was chosen because it produces minimal fluctuation in F_IO_2 during the inspiratory phase. This improves the accuracy of Deltatrac calculations. The Deltatrac monitor available to us could be used up to a maximum F_IO_2 of 0.6. The accuracy of the machine is greatest at low F_IO_2 values. Wherever possible a low F_IO_2 was used.

Arterial, central venous, and pulmonary artery pressures were monitored continuously using arterial and pulmonary artery catheters. Cardiac output was measured continuously using a thermodilution technique (Baxter Vigilance).

It became clear at an early stage that a reliable and powerful data collection system was a prerequisite for future studies. Deltatrac data was collected onto laptop computer on a minute by minute basis. A system was devised for collecting all haemodynamic data including continuous cardiac output using the analogue output of the monitors. This was collected via a Critikon Cerebral Redox monitor, which was being used for other studies, onto computer using software designed by Critikon. The data collected could be processed to give a haemodynamic profile each minute. Events could also be marked using this setup. All data was subsequently processed and manipulated in Excel for Windows (Microsoft).

Results

Both VO_2 and VCO_2 clearly decreased when the diseased liver was removed and remained low during the anhepatic phase. At reperfusion a rapid increase occurred which was maintained. This appeared to confirm the findings of others.

Discussion

The increase in VO_2 calculated from immediately before to 10 minutes after reperfusion was approximately 25% of anhepatic levels and it was tempting to conclude that this represented oxygen consumption by the new liver. However, at reperfusion a number of metabolic and physiological changes occur. Despite flushing the graft prior to reperfusion an acid load is released from the new liver into the circulation. Acid may also be flushed from the splanchnic and other tissue beds which were relatively ischaemic during the anhepatic phase. This acid load will be buffered by plasma bicarbonate generating carbon dioxide. Furthermore, venous return and cardiac output increase following reperfusion. These changes may be accompanied by acute alterations in pulmonary artery pressure and pulmonary vascular resistance. Sudden changes in cardiac output are known to alter VCO_2. Some authors have found that changes in VCO_2 and end tidal CO_2 correlate well with changes in cardiac output. The Deltatrac calculates VO_2 from VCO_2 and RQ assuming them to represent tissue metabolism and a

steady state. This is clearly not the case immediately following reperfusion as a number of factors may alter measured VCO_2 and RQ which are unrelated to altered metabolic production (table 1).

Table 1
Factors which may influence VCO_2 following graft reperfusion

Metabolic	Increased liver metabolism
	Increased CO2 production by previously ischaemic organs eg gut
	Hypothermia
	Acute acid load (from graft and other tissues)
Pulmonary	Increased pulmonary perfusion
	Altered pulmonary deadspace

It was also clear that a change in ventilation would alter VCO_2. Carbon dioxide stores in the body are large (approximately 12 litres) and exist in muliple forms. Following a change in ventilation VCO_2 is altered from baseline levels until a new steady state is achieved. Carbon dioxide stores exist in multiple tissue compartments which equilibrate at different rates following a change. The time taken for a new steady state to be established is difficult to predict on an individual patient basis but probably depends on factors such as cardiac output. It may take several hours. During this period the measurement of VO_2 by the Deltatrac will be subject to error.

We therefore undertook two studies to answer the following questions:
(1) If the ventilation is not changed when is it reasonable to assume a steady state is present following reperfusion (ie when is the VO2 measurement valid with the Deltatrac)?
(2) During a period when metabolic rate is assumed not to change and no major haemodynamic or acid-base changes are occurring, how long does it take to reestablish a steady state in this group of patients following a step change in ventilation?

When is the measurement of VO_2 using the Deltatrac metabolic monitor valid following reperfusion during liver transplantation?

Study design
20 patients undergoing liver transplantation with a variety of diagnoses were studied (table 2).

Table 2

Diagnosis	Number of patients
Primary Biliary Cirrhosis	8
Primary Sclerosing cholangitis	3
Alcoholic Liver Disease	4
Chronic Rejection	2
Fulminant Hepatic Failure	3
TOTAL	20

Haemodynamic and gas exchange data were collected continuously as previously described. Three time points were chosen for analysis (1) 30 minutes before reperfusion (2) 30 minutes after reperfusion and (3) 90 minutes after reperfusion. At each time point an arterial blood sample was drawn and analysed within 5 minutes for $PaCO_2$, H+, and standard bicarbonate. Ten minute averages were calculated at each time point for cardiac index, mean pulmonary artery pressure (MPAP), oxygen consumption index (VO_2I), carbon dioxide elimination index (VCO_2I), RQ, and mixed expired carbon dioxide fraction (F_ECO_2, from Deltatrac data). Pulmonary artery wedge pressure (PAWP) was also recorded.

Over the study period ventilation and FIO2 were not changed unless clinically indicated. When this was necessary, subsequent data points were not included in the analysis.

At each time point the following were calculated:
Total functional deadspace ratio (ie pulmonary deadspace plus apparatus deadspace) from the Bohr equation:

V_D/V_T Total functional deadspace
P_ACO_2 Alveolar partial pressure of CO_2

$$\frac{V_D}{V_D} = \frac{P_ACO_2 - P_ECO_2}{P_ACO_2}$$

P_ECO_2 Mixed expired CO_2 pressure
P_ACO_2 was assumed to equal $PaCO_2$.

P_ECO_2 was calculated as:

$$P_ECO_2 = F_ECO_2\,(PB - SVP_{H20}).$$

P_B Atmospheric pressure (kPa)
SVP_{H20} Saturated vapour pressure of water at 37°C

Pulmonary vascular resistance index from the equation:
Statistical analysis was with the Student's t test.

$$PVRI = \left[\frac{MPAP - PAWP}{CI}\right].80$$

Results
Acid base balance and $PaCO_2$:
At 30 minutes following reperfusion a significant increase in $PaCO_2$ occurred. This was accompanied by an acute metabolic acidosis (increased H+ and decreased standard bicarbonate) consistent with the release of an acid load from the graft and ischaemic tissues. At this point VCO_2 may in part be made up of excreted buffered acid. VO_2 may therefore be overestimated by the Deltatrac. Between 30 and 90 minutes following reperfusion no further significant changes occurred in $PaCO_2$ or H+. Standard bicarbonate increased significantly compared to 30 minutes post reperfusion to a level which did not differ from pre reperfusion values. At 90 minutes after reperfusion it therefore seems likely that the majority of the acute acid load released at reperfuson has been eliminated. $PaCO_2$ remains elevated because metabolic production has increased as the new liver warms and

starts to utilise oxygen. A new steady state has been established at a higher $PaCO_2$ because ventilation was held constant.

Pulmonary perfusion and deadspace:
A significant increase occurred in cardiac output and mean pulmonary artery pressure immediately following reperfusion. This was accompanied by a small but significant decrease in pulmonary deadspace. Pulmonary vascular resistance did not change. None of the patients studied suffered from a severe "post reperfusion syndrome" in which pulmonary hypertension is associated with systemic hypotension and vasodilatation. At 90 minutes after reperfusion no further significant change in cardiac output or pulmonary deadspace occurred.

At reperfusion a sudden increase in venous return and cardiac output occur. Although pulmonary artery pressures increase, pulmonary vascular resistance is unchanged when the group is considered as a whole. Perfusion of alveoli increases with an overall decrease in ventilation/perfusion ratios. This is reflected by a small but significant decrease in pulmonary deadspace. The effect of these changes will be to increase VCO2 irrespective of altered metabolic production resulting in further error in the measurement of VO2 by the Deltatrac. No further significant changes occurred between 30 and 90 minutes; it is therefore a reasonable assumption that a steady state is reestablished over this period.

RQ decreased immediately following reperfusion but did not change between 30 and 90 minutes after reperfusion. Assuming the VO_2 measurement at 90 minutes is not subject to error from unsteady state a highly significant increase in both VO_2 and VCO_2 is seen at this time when compared to anhepatic measurements.

Discussion

This study demonstrates that VO_2 measured with the Deltatrac metabolic monitor is subject to inaccuracy immediately following reperfusion because a physiological steady state cannot be assumed. At 90 minutes following reperfusion, one hour has elapsed during which time no significant changes occurred in the physiological variables measured. It is therefore a reasonable assumption that in the stable patient inaccuracies in VO_2 due to unsteady state are likely to be small at this time.

The Effect of Step Changes In Ventilation on VCO_2 following Liver Transplantation

In order to study the time course over which a steady state is reestablished after a step change in ventilation we have studied patients immediately following liver transplantation on the intensive care unit. This study is ongoing and preliminary results are presented here.

Methods

Our aim has been to study patients during a period of haemodynamic stability during which time metabolic rate is assumed to remain relatively constant over several hours. Following admission to the intensive care unit patients were sedated with alfentanil and propofol, and muscle relaxation maintained with atracurium. Patients in whom body temperature was unstable or in whom inotropic agents were required have been excluded. Recordings were made with the Deltatrac metabolic monitor during a period of unaltered ventilation. After a 30 minute period of stable VCO_2, VO_2, and RQ measurement a 20% step increase was made to the minute ventilation. This was calculated to keep a constant tidal volume and therefore minimise changes in pulmonary deadspace. Arterial blood was sampled and blood gas analysis performed at 30 minute intervals over the study period. Patients were studied for 90-120 minutes or until VCO_2 had clearly returned to baseline values and $PaCO_2$ stabilised at a new plasma partial pressure.

Results

To date 5 patients have been studied; the changes follow a similar time course in each case. As numbers are small no statistical or kinetic analysis is presented here but it is clear that approximately 60 minutes are required following a step increase in ventilation to return to baseline values of VCO_2.

Discussion

Previous studies which have examined carbon dioxide kinetics following step changes in ventilation have described the process of recquilibration in terms of multiple kinetic compartments. The rate of equilibration will depend on perfusion of these compartments and is in part a function of cardiac output. A study of critically ill patients has indicated that 2 hours may be required before complete reequilibration has occurred. Our provisional results suggest that following liver transplantation reequilibration occurs over approximately 60 minutes. The time course may be shorter in our patients because cardiac output is generally high at this time. During this period a steady state is not present and measurement by the Deltatrac will be subject to inaccuracy. Inaccuracy will be greatest immediately following a change because reequilibration is an exponential function. Further study is required to define the expected error in VO_2 measurement at different times following alterations to the ventilation. Accuracy will be greatest if ventilation changes are avoided.

Oxygen consumption during liver transplantation: a comparison of venovenous bypass with the piggyback technique.

It has been our clinical impression that cardiac output is better maintained during the anhepatic phase when the piggyback technique, with preservation of vena caval flow, is used in preference to venovenous bypass. We hypothesised that if this were true, tissue oxygenation might also be better. If this were the case a smaller decrease in global oxygen consumption might be anticipated during the anhepatic period. We have therefore carried out a study to compare the two techniques.

Methods

Using the standard anaesthetic technique, monitoring, and data collection system previously described 16 patients undergoing orthotopic liver transplantation were studied. In 8 cases venovenous bypass (VVB) was used from portal and femoral veins to axillary vein during the anhepatic phase. In 8 cases the piggyback technique (PB) was used. In 6 of these a temporary portocaval shunt was fashioned; in the remaining 2 cases the portal vein was clamped during the anhepatic phase. Surgical preference dictated the choice of technique. The mean values of cardiac index, VO_2I, and VCO_2I were calculated for the following time periods: (1) the 10 minutes prior to ligation of the hepatic artery (the first major vascular event in the procedure), (2) the entire anhepatic phase (defined as caval crossclamp or sideclamp time to reperfusion), (3) 90 to 110 minutes post reperfusion (chosen on the basis of the earlier studies). As numbers of patients were small, data was not assumed to be normally distributed. Non parametric statistical tests (Mann Whitney U test and Wilcoxon Rank Sum tests) were therefore used.

Results

Prior to hepatic artery ligation no significant differences existed between the VVB and PB groups for VO_2I, VCO_2I, or CI. These baseline measurements suggest the groups were comparable. At 90 to 110 minutes post reperfusion there were also no significant differences between the groups. All patients survived with normally functioning grafts. During the anhepatic phase CI and VCO_2I were significantly lower in the VVB group ($p<0.02$ and $p<0.05$ respectively) VO_2I decreased significantly during the anhepatic phase with both techniques ($p<0.001$). The decrease in VO_2I during the anhepatic phase was significantly greater in the VVB group ($p<0.01$). Cardiac index decreased during the anhepatic phase in the VVB group ($p<0.05$) but did not change significantly in the piggyback group.

Discussion

This study has shown that cardiac output is higher during the anhepatic phase of liver transplantation when the piggyback technique is used in comparison with venovenous bypass. Anhepatic oxygen consumption decreased less with the piggyback technique. This may indicate that less tissue ischaemia occurs with this surgical technique, possibly because DO_2 is higher. Carbon dioxide elimination was higher during the anhepatic phase with the piggyback technique. This will in part reflect the larger VO_2 but may also have implications for acid-base status. Further controlled studies are required to determine whether acidosis is less severe during the anhepatic phase using the piggyback technique.

This study also has important implications regarding the use of the increase in VO_2 at reperfusion to predict graft function. Previous workers have assumed that the decrease in VO_2 which occurs during the anhepatic phase results principally from the decrease in metabolic rate which results from hepatectomy. The results of this study suggest that the surgical technique employed, and in particular the cardiac output, are a major influence on anhepatic VO_2. The "baseline" from which changes are measured cannot, therefore, be assumed to be predictable or constant.

Conclusions

In this essay I have attempted to examine the problems involved in measuring oxygen consumption, in particular under circumstances of rapid physiological change as occur during liver transplantation. There are clear theoretical arguments, and examples from the literature, which support the view that the reverse Fick method is subject to significant error which can generate inaccurate data from which incorrect conclusions may be drawn. Analysis of respiratory gases is not subject to many of these errors but also has practical and theoretical limitations. The development of commercially available metabolic monitors, such as the Deltatrac, which measure VO_2 in this way has stimulated renewed interest in oxygen kinetics. However, it is clear from our studies that a full understanding of the mode of action of these devices and the assumptions made during measurement is essential if the use of inaccurate data is to be avoided.

The work presented has attempted to define the practical limitations of the Deltatrac during liver transplantation. Following graft reperfusion the measurement of VO_2 is subject to inaccuracy because multiple factors act to disrupt the physiological steady state. The data suggests that at 90 minutes after reperfusion it is a reasonable assumption that error attributable to these factors is relatively small. Post reperfusion data will therefore be analysed at this time point in future studies. We have also shown that the surgical technique employed influences VO_2 during surgery. The piggyback technique is associated with a higher VO_2 during the anhepatic phase than venovenous bypass. This may be a result of improved oxygen delivery to tissues which are at risk from ischaemia. Further studies are required to determine whether this observation is associated with reduced post operative morbidity. It is also clear from this data that the decrease in VO_2 following hepatectomy is not only related to liver oxygen consumption. It therefore seems unlikely that the increase in VO_2 following reperfusion will prove a specific and sensitive marker of graft function. Further studies are required to clarify this.

THE SCOTTISH SOCIETY OF ANAESTHETISTS

Joint meeting with

THE SOCIETY OF ANAESTHETISTS OF THE SOUTH WESTERN REGION

The Presidents: Professor Alistair Spence and Dr. Trevor Thomas

The return match with The Society of Anaesthetists of the South Western Region was held in the Moat House Hotel in Glasgow on Friday the 29th and Saturday 30th November 1996. Despite some early confusion on the part of some of our guests as to whether they were in Syndey when viewing the conference facilities under construction next door, the sight of the River Clyde on a wonderful sunny November morning and their inability to understand their hosts, reassured them that they were indeed in Scotland. Supporters from both Societies were well in evidence.

Both teams fielded some of their best players and strong refereeing from The Presidents of each Society, Professor Alistair Spence and Dr.Trevor Thomas, aided by Dr.Iain Davidson, the Vice President of the SSA, ensured a highly informative and enjoyable first and second half in the conference hall. There was a minor degree of crowd trouble off the field, especially at half time but nothing local council members couldn't control with timely refilling of glasses!

The first half kicked off with overviews of Pulmonary Thromboembolism from Professor G.D.O.Lowe, Peri-operative Assessment of Myocardial Function from Dr.John Booth and Asthma from Dr.Andrew Peacock. Dr.John Booth had even flown in especially for the occasion from his current secondment to the Massachusetts General Hospital in the States. After lunch Dr.Brian McLelland of the Scottish Blood Transfusion Service, addressed the Current Issues in Blood Transfusion explaining the problems of obtaining and using blood donations with the ever expanding number of screening tests. This reassured the audience that the difficulty in getting anything out of Blood Transfusion was not cussidness on their part but reflected the increasing safety of blood and its products! Dr.John Kinsella then went on to discuss Current Trends in Opioid Therapy. To some of us present the realisation that there were opioids other than morphine, some with names we had never heard of, was an eye opener! John's difficult task was to convince us of their use. This was followed by a timely reminder to all of us that the child is not a small adult, but presents its own unique problems, as Dr.Pamela Cullen explained the problems of ' Resuscitation and Transport of the Critically Ill Child'.

The afternoon was rounded off in style by Professor Bill Bowman giving the 1996 Gillies Memorial Lecture, ***'The Pharmacological Manipulation of Neuromuscular Transmission'*** presented with the skill and simplicity of a true expert in his field. This lecture is reproduced elsewhere in this issue.

Wonderful things glasses, Alistair!

Saturday morning was devoted to the subject of Quality in Anaesthetic Practice and Intensive Care with different aspects of this important issue being addressed by Dr. Sheila Willatts, Dr. Camie Howie, Professor Jim Petrie and Dr. Harry Burns.

ASSESSMENT OF QUALITY ANAESTHESIA

Sheila M. Willatts, Bristol

INTRODUCTION

Issues relating to quality of care were not on the blackboards when most of us qualified in anaesthesia and many physicians have reacted unenthusiastically but our privileges are provided by a public which expects that we are knowledgeable and will manage our patients in their best interests. If physicians cannot lead the current debate about quality in healthcare their claim to mastery of the field will be challenged by both politicians and economists - even worse the public may loose confidence. Age-old concepts of medicine and current theory about quality both hold that improving quality requires active participation and leadership by the people who do the day-to-day work.

A major anxiety at this time is that doctors and patients will see quality jeopardised by efforts to reduce the costs of healthcare. Quality experts have argued that improvement in quality and cost reduction are compatible goals. However it may be that the quality of

healthcare is now seriously threatened in the USA by the shift to managed care as the way to contain costs. Managed care plans involve an inherent conflict of interest. On the one hand they promise to take care of their subscribers but on the other hand their financial success depends upon doing as little for them as possible.

In 1990 the US Institute of Medicine said that 'quality consists of the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge'. Improvement in quality implies that we have achieved a standard which is superior to currently accepted quality.

Health care professionals tend to define quality in terms of attributes and results of care provided by practitioners and received by patients. There is emphasis on technical excellence and the characteristics of interactions between provider and patient. The technical quality of care has two dimensions - the appropriateness of the services provided and the skill with which the care is performed. High technical quality infers doing the right thing right i.e. high quality decision making and high quality performance.

MEASUREMENT OF QUALITY

This field is complex, rapidly evolving ,expensive and full of uncertainties. but there are new techniques and sciences for measurement of quality and thereby its improvement. - One of these methods is clinical epidemiology which has already identified the wide variation in practice and outcome of patients who received the same routine treatment for the same heath problem in different areas and in different healthcare settings. The challenge has now become to identify those factors associated with a good outcome. The second tool is outcomes research which has created new measures of quality that will change clinical practice. There has also been a strong effect of advances in computer technology and communications. Use of psychometric techniques enables us to evaluate the patient's view of the results of care. Meta-analysis is an evolving method for efforts to measure quality and is a tool for summarising research data on efficacy and effectiveness. Attempts to achieve high quality care may lead to development of guidelines or measurement tools for calculating risk adjusted outcomes.

There is every reason to seek improvements in quality. In 1991 the Harvard Medical Practice Study showed that adverse events occurred in 4% of hospital admissions and that 14% of these events were fatal. Guidelines have since been produced.

Until recently we relied on professional judgement to ensure that patients received high quality medical care. Improvement in quality of care was largely left to individual clinicians. Now we believe that there is far more variation in medical care than we had realised. There is greater interest in having objective information on clinicians practice and patients and purchasers want to know more about what is on offer for them. Quality can be assesses at several levels:, care by individuals, care delivered by departments and care provided by a healthcare plan. Quality can be evaluated on the basis of structure, process and outcome

High quality anaesthesia should be free of risk and the management of risk is an important part of medical audit. Total Quality Management (TQM) is the process of continued striving on the part of all staff to attain zero defects in all aspects of the organisations activities. Objective are:

- Reduction in morbidity and mortality due to anaesthesia
- Assurance of the availability and proper management of resources
- Well-being and safety of the patient

Most QA programmes are of some use as a method of examining one's own practice but there is little objective evidence that supports the idea of measuring individual anaesthetist competence. although systems have been developed to attempt objective evaluation of competence within an anaesthetic department.

Deaths due at least in part to anaesthetic factors are about 1 in 2000 but due solely to anaesthesia are between 1 in 100 000 and 200 000 cases. Most anaesthetic accidents are caused at least in part by human error. Training (and its testing) and continuing education are crucial to quality and safety. The Royal College of Anaesthetists plays a vital role in this process.

Data from the Australian study of over 2000 anaesthetic incidents identified commonly occurring contributory factors : misjudgement, failure to check equipment, fault of technique, other human factor problems, other equipment problem are the commonest. 48% of anaesthetists use new equipment without reading the manual and 60% do not follow the manufacture's check procedure.[1]

Risk management has been defined as the cost effective reduction in risk to levels perceived to be acceptable to society. There are four stages of assessment and management - identify what can go wrong, measure how often it does, put controls in place to be sure it doesn't happen again and to find money to pay for losses if it does go wrong. So all hospitals need a risk manager to deal with claims and to prevent injury in the first place and an educational update programme to support the initiative. Early communication to patients of adverse event may reduce the likelihood of subsequent litigation. Patients appear to accept that there is risk involved in surgical procedures but have difficulty relating risk to anaesthesia which they believe should be 100% safe.

Quality assurance measures in anaesthesia must be judged by their cost effectiveness. There is little information about costs or benefits of departmentally based QA programmes but consider what could happen if departments of anaesthesia stopped conducting their own QA programmes - given the public interest in medical services and the administrative activities required to control their cost there would have to be an

external regulatory body assigned responsibility for our practice - we would be given defined protocols and guidelines for treatment (to ensure uniformity of standards). Medical decisions would be based on probability analysis of certain practices producing certain outcomes rather than professional's interpretation of individuals needs and wants.

I'm not sure about this Trevor

ASSESSMENT OF THE QUALITY OF INTENSIVE CARE

Cameron Howie, Glasgow

The assessment of quality of intensive care is dependent on identifying qualities which are unequivocally associated with good intensive care practice. This involves appropriate admission of patients with recoverable conditions who require techniques exclusively available within an intensive care unit. The primary function in caring for such patients is to expedite recovery, not only to achieve ICU discharge but also subsequent hospital discharge with an acceptable quality of recovery. While recovery is the primary objective, recognition of the futility of treatment is important both in sparing the patient pointless discomfort and loss of dignity and in relieving the distress which relatives experience in such situations. In general good intensive care involves care both for the patient and the family. Optimal care implies that these objectives should be met at the lowest cost.

For this discussion I will limit myself to our ability to expedite recovery as the measurement of quality. Where survival to hospital discharge is used as an outcome measure, we must identify a mechanism to adjust for the variation in the pathological processes, disease severity and co-morbidity in different ICU populations. A variety of scoring systems have been developed to provide this case mix adjustment for general ICU populations. A primary objective of the current National Audit of Intensive Care in Scotland is identification of the methodology which performs best in the Scottish ICU population. Interim analysis suggests that on the basis of tests of discrimination and calibration, the APACHE 2 (Acute Physiology and Chronic Health Evaluation) and SAPS 2 (Simplified Acute Physiology Score) predictions perform best.

Standardised Mortality Ratio (SMR) is the ratio of actual to predicted deaths for a given population and is the indicator of performance derived from severity of illness scores such as APACHE. No intensive care unit in Scotland has an SMR significantly different from the Scottish population. Furthermore the spread of SMR's is similar to that seen in more selective audits in the U.K. and the United States. There is no evidence to suggest a better performance in particular types of unit e.g. district hospital versus teaching hospital.

The ability of severity of illness scores to adjust for variations in case mix and to be independent of variations in pre-ICU treatment, initial ICU interventions and physiological data collection is imperfect. As such, differences in SMR between ICU's should not automatically be inferred to be due entirely to variations in quality of care. For this reason publication of Scottish ICU league tables would serve no good purpose and might induce systematic errors in data entry. Currently a random sample of each unit's data is validated externally. This has demonstrated that some of the variation in SMR is accounted for by data entry errors but that overall there is no evidence of gaming i.e. inflation of scores to generate a lower SMR.

A major problem with outcome measures in intensive care is the lack of markers of good process of care. This absence of a clear link between process and outcome confounds our ability to close the audit loop. Randomised controlled studies which demonstrate the benefits of discreet ICU interventions, in either the general ICU population or in diagnostic subgroups, are required to determine which indicators of process we should audit to improve the quality of patient care.

Professor Andy Macmillan, Emeritus Professor of Architecture, Glasgow University

The meeting was brought to a close with a total change in subject as Professor Andy Macmillan, Emeritus Professor of Architecture at the University of Glasgow enthralled the audience with aspects of Glasgow architecture most us have passed at some point but never noticed, in his talk entitled 'Glasgow City of Architecture and Design 1999 '.

Combined meetings of any Societies, albeit with common interests, can be difficult to organise. The huge success of this meeting was a tribute to the hard work of the local organising committee, in particular Alan Macdonald, Liz O'Grady, Barbara Scorgie and Bill Kerr, to the excellence of the presentations and most particularly to the members of both the Society of Anaesthetists of the South Western Region and the Scottish Society of Anaesthetists to take a full and active part in this meeting.

ZAMBIAN REFRESHER COURSE 1996

GRANT HUTCHISON **DUNDEE**

My trip to Zambia was cosponsored by the Association of Anaesthetists of Great Britain and Ireland and the Scottish Society of Anaesthetists. I traveled with Dr. Ray Sinclair, Consultant in Anaesthesia and Intensive Care at Truro (who was sponsored by the World Federation of Societies of Anaesthetists), and John Hillier, a medical engineer from Gloucester.

Dr. Sinclair and I travelled with the purpose of participating in the two day Anaesthesia and Intensive Care Refresher Course, organised by the Zambian Society of Anaesthetists at Kitwe. We then planned to spend the rest of the week in Lusaka, giving tutorials to anaesthetic clinical officers at the University Teaching Hospital. Mr. Hillier's intention was to spend a fortnight at Kitwe, assisting with the servicing of anaesthetic and other medical equipment.

We carried with us gifts of textbooks contributed by the WFSA, AAGBI and by the Departments of Anaesthesia and Medicine at Ninewells Hospital, Dundee. I had also received some resuscitation posters from Laerdal Medical and Evans IMS.

Saturday 1st June: We flew overnight from London to Lusaka. There we were met by representatives from the two centres we planned to visit. A hospital administrator from Kitwe had kindly driven 280 miles to meet us at 8am and then drove us back to our accommodation in Kitwe. This journey was enlivened by a puncture at the midway point, coupled with the discovery that the car jack was non-functional: two anaesthetists and a hospital administrator lifted the car, while a medical engineer changed the wheel with salutary speed.

Sunday 2nd June: Accommodation in Kitwe was at the Zambia Consolidated Copper Mines conference centre. There we rendezvoused with the refresher course organisers to discuss their needs.

The course was organised by Dr. William Daka (president of the ZSA, and a consultant at the mine hospital in Mufulira) and Dr.Dixon Tembo (secretary of the ZSA, and a consultant at Nkana Mine Hospital in Kitwe). The course was aimed at doctors and clinical officers from all over Zambia and the expected attendance was between 30 and 40. Dr.Sinclair and I had both been previously advised of seven lecture topics, and now picked up an eighth topic each due to the absence of one of the planned lecturers. Topics were varied, but all aimed at detailing safe practice in areas of local concern. My own topics were; adult resuscitation, general anaesthesia for caesarian section, eclampsia, anaesthesia and head injury, anaesthesia and diabetes, valvular heart disease and caesarian section, anaesthesia for inhaled foreign body and epiglotitis, renal support following major surgery and trauma.

Monday 3rd and Tuesday 4th June: Each day started at 08.30, and ran through to 18.00 with breaks for lunch and coffee. Blocks of lectures were interspersed with panel discussion sessions on topics raised. All lectures were given by either Dr.Daka, Dr.Tembo, Dr. Sinclair or myself. On the first morning, attendance had increased to 45, and continued to rise until 70 delegates were present by mid-morning. In addition to doctors and clinical officers, we now found our audience included nurses and student clinical officers, making it difficult to find a suitable level of discussion for the topics presented. Several doctors requested an update on recent advances in anaesthesia, and rather than impose this on the other delegates, to whom it would be of less relevance, we hived off a small workshop for interested doctors on the second afternoon. I hosted the workshop, which covered the topics of new muscle relaxants and inhalational agents, nitric oxide, total intravenous anaesthesia and new monitoring modalities. Several

doctors attending had experience in these areas, and were able to contribute information of interest to their colleagues. In the main lecture area, clinical officers meanwhile presented topics they had prepared themselves.

At the suggestion of Dr. Sinclair, both days concluded with a thirty question quiz, based on the topics of the day, and with prizes from the gift books we had brought with us. In each quiz, three prizes were presented: for the best score by a doctor, by a nurse / clinical officer, and by a student clinical officer. The quizzes were popular and hotly contested.

Overall, the refresher course was deemed a success by those attending it.

Wednesday 5th June: Our transport for a return to Lusaka remained uncertain until late Tuesday. We had initially hoped to be driven south again, and had also been offered transport on ZCCM's own airline. Both these options failed to materialise and we finally obtained seats on a commercial flight from Ndola. Dr.Tembo very kindly collected us from our lodgings at the unsociable hour of 04.45 to drive us to Ndola airport.

On arrival in Lusaka, we had no clear programme of activities arranged for UTH, but by mid-morning Dr.Sinclair had arranged to meet Professor Munkongue (Dean of the Medical School). This meeting took place at midday and established a programme for the remainder of the week. Meanwhile, I arranged hotel accommodation for myself in Lusaka as Dr.Sinclair had arranged to stay with friends.

Thursday 6th June: The whole day was spent with final year medical students at UTH. Due to staffing difficulties, the students had received no formal lectures on anaesthesia. We filled the day with lectures on intensive care, pharmacology of local anaesthetics, spinal and epidural anaesthesia, and monitoring. We also created twenty multiple choice questions based upon the lecture content, suitable for inclusion in the final exams. At lunch time we toured the UTH operating theatres and ITU.

Friday 7th June: This whole day was to be set aside for teaching and assessment of student clinical officers.

Both Dr. Sinclair and I had intended to complete a week of teaching and then to take a weekend off plus two days holiday before returning to the UK. Unfortunately, I arrived in Zambia to find that the arrangements for my own holiday trip had been altered, meaning I would leave Lusaka on the Friday and return on the Sunday. Rather than cancel the trip or reduce my level of input, I arranged to be available on the Monday, after Dr. Sinclair had left on his own holiday.

Dr. Sinclair therefore spent Friday with the twelve student clinical officers at UTH, conducting 'mock vivas', and then setting five essay questions, five 'linked pair' questions and ten multiple choice questions for the students. This mixture simulated the examinations they would sit at the end of their training period.

Monday 10th June: I returned from holiday and spent the day at UTH marking the exam questions Dr. Sinclair had set! I annotated the essay papers with comments on style, content and any errors of fact, with the intention of providing as much constructive feedback as possible.

The Copperbelt hospitals seem in general to be well financed by the mining company. Equipment is modern, but therefore difficult to service and repair. The University Teaching Hospital in Lusaka, in contrast, suffers from chronic under-funding with little available equipment - the single ECG monitor is kept in the maternity theatre and borrowed as required.

Problems in UTH are exacerbated by the absence of a permanent head of the Anaesthetic Department. The Department, at present, consists of clinical officers and three expatriate Uzbek anaesthetists who seem to take little part in administration or teaching. Funding seems to by-pass anaesthesia in the absence of a strong medically qualified director to put the anaesthetic case. Student teaching does not occur. Teaching of clinical officers falls on Naomi Banda, a clinical officer who has a degree in Medical Education from Dundee University. While she is capable and willing, she has little authority and less control over her own workload. She therefore finds herself in an extremely difficult situation.

In the past, UTH has benefited from the attachment of visiting anaesthetists from the UK, who stimulated teaching and research as well as providing clinical support for the clinical officers. However, I think the present situation would be a very difficult one for a visiting registrar to alter.

My perception is that any solutions to the problems of UTH must involve the appointment of a strongly motivated, medically qualified, Zambian head of Department. Both Dr. Daka and Dr. Tembo have expressed a willingness to become involved at UTH in teaching and administration but there are difficulties here because of rivalry between government and mine hospitals, the distance separating the two centres and the reduction in salary which would be involved if either were to leave his present post.

TRAINEES MEETING

14TH JUNE 1996, EDINBURGH

Dr Alistair Lee

The Lister Postgraduate Institute

The 1996 Trainees Meeting was held in the Lister Postgraduate Institute in Edinburgh and was organised, highly successfully, by Dr.Alistair Lee.

It may be of interest to members to note that the Institute is named after Joseph Lister (1827-1912) who amongst his other achievements, is famed for his work on sepsis. It is ironic to note that it was James Young Simpson, whose achievements we celebrate this year, who recognised that patients on the operating table "faced danger equal to that on the battlefield", yet attacked Lister's system of antisepsis, preferring a design of hospital of small pavilions to tackle the problem.Both men had however a passionate concern for patient safety and outcome.

In keeping with this, the meeting took as its general theme anaesthetic safety and addressed the issues of monitoring, anaesthetic risk and teaching. Presenters included Dr Patrick Hopton on Near Infrared Spectroscopy, Dr.Alistair Lee on Tissue Oxygenation, Dr.Simon Mackenzie on Measuring Cardiac Output, Dr.Jonathen Wedgewood on Reducing Myocardial Risk and Dr.Ellis Simon on Simulators in Practice. Reproduced here are a series of abstaracts which reflect the theme and excellent quality of the meeting.

MONITORING IN SHOCK - SHOULD WE SHIFT THE GOALPOSTS?

Dr. David Ray, Edinburgh

The application of monitoring in shock is an area of controversy and debate. Controversy extends even to the most appropriate definition of shock. Many people use a working definition of "inadequate organ perfusion and tissue oxygenation", but this does not encompass all forms of shock and "a profound systemic energy crisis due to inadequacy of cellular energy production to meet cellular energy demands" may be more complete. Different types of shock exist and these can broadly be described as haemorrhagic, cardiogenic, septic, neurogenic, anaphylactic and obstructive (such as tension pneumothorax).

The evolution of haemodynamic monitoring has generally paralleled the history of our understanding of the shock state and resuscitation. In the 1960's arterial and central venous pressure were considered of primary importance in shock and direct measurement of these pressures developed. During the following decade perfusion was felt to be crucial and pulmonary artery catheters and measurement of cardiac output arrived. In the 1980's emphasis on global oxygen delivery and consumption led to continuous measurement of mixed venous oxygen saturation, and the current decade has seen the focus switch to monitoring of tissue oxygenation with the development of non-invasive monitors such a gastric tonometry (pHi) and near infrared spectroscopy (NIRS). There are some early indications that the next decade may see a return to the view that arterial pressure is all important.

We can monitor shock in four main ways;
Clinical observation such as heart rate, blood pressure, capillary return, conscious level and urine output.
Invasive haemodynamic monitoring such as direct measurement of arterial, central venous and pulmonary arterial pressures, cardiac output, mixed venous oxygen saturation and oxygen transport parameters.
Non-invasive monitoring using for example pHi, NIRS, oesophageal Doppler, Licox tissue oxygenation monitoring and Deltatrac metabolic monitoring.
Laboratory analysis of arterial lactate concentrations and arterial and mixed venous oxygen saturations.

The fundamental goals of monitoring can be considered as; ensuring the adequacy of perfusion in stable patients; allowing early detection of inadequacy of perfusion; allowing titration of therapy to specific haemodynamic endpoints; and to differentiate between various organ system dysfunctions. These have changed very little over the past several years.

For monitoring to be effective it must be reliable, readily available, preferably continuous, safe and ideally improve patient outcome. It is equally important to appreciate the potential pitfalls of monitoring. For example, does the monitor provide the information we really want or does it simply generate a number which may not be clinically useful? Is the information directly measured, or is it calculated from a mathematical formula or derived from assumed variables? Monitors are subject to technical problems especially as the degree of complexity increases and some continuous monitors may be slow to react to acute changes. Several of the non-invasive monitors are very dependent on operator experience to provide reliable data.

Effective monitoring should improve outcome though this is not proven. Better monitoring certainly leads to more interventions but unless the intervention is prompt, appropriate and adequate, outcome may not be improved. For example, pulmonary artery catheterisation has become commonplace in ITU but has not had a major impact on outcome despite its widespread usage: this may be related to how it is used and may reflect reactive rather than proactive management. The effect of manipulating oxygen transport variables on outcome is also not proven. Perhaps the disappointing effect on outcome reflects the view that global measurements of oxygen delivery, consumption and extraction do not provide reliable information on the adequacy of tissue oxygenation even in patients who are by all conventional clinical criteria, adequately resuscitated. For this reason, interest is turning to monitors of tissue oxygenation. Gastric tonometry appears promising but problems with the technique currently limit its potential and does not at present contribute greatly to the monitoring of shock. Other non-invasive monitors such as NIRS and Licox are available but require further evaluation to assess their clinical use.

As there is debate about the most appropriate definition of shock, so there is debate about what monitoring is required in shock. Optimal monitoring will depend to some degree on the type of shock present and where in the hospital the patient is being managed; requirements will be quite different in the Accident and Emergency Department, the operating theatre and the Intensive Therapy Unit. Irrespective of this, monitoring should be physiologically based and goal orientated for individual patients. The goal posts are continually shifting with the advent of more and more sophisticated monitoring tools; in these changing times it is important not to lose sight of the ball.

Anaesthetic Risk: Monitors and Alarms

Dr. Jeremy Thomas, Edinburgh

Human error has been shown to be the commonest cause of anaesthetic critical incidents and avoidable deaths. Sykes suggested that morbidity and mortality might be reduced and safety increased by the adoption of better standards of monitoring in anaesthesia. Eichhorn using a reduction in morbidity and mortality and a decrease in insurance claims as evidence, suggests that monitoring has been of benefit. However Orkin and Keats in separate papers both suggest that the fall in anaesthetic mortality could be due to many other changes that have occurred since the introduction of standards for monitoring such as new technology, new drugs and better anaesthetic training.

The organising committee at work

However, a significant proportion of critical incidents are due to the anaesthetist being distracted by some other activity. In these circumstances the alarm may act as the last line of defence.

A recent questionnaire survey showed a wide acceptance of the Association of Anaesthetists of Great Britain and Ireland (AAGBI) "Recommendations for Standards of Monitoring during Anaesthesia and Recovery" by anaesthetists of all grades. We undertook an audit to look at the local use of monitors and alarms in a clinical setting. Four hospitals were visited. We ensured that all patients had been in theatre for at least 10 minutes before approaching the anaesthetist to ask permission to carry out the audit. The anaesthetist was then asked a series of questions relating to AAGBI recommendations, current monitor and alarm use and alarm settings. The grade of anaesthetist and type of monitors being used were documented. A total of 45 anaesthetists were audited (20 consultants, 5 staff grades, 5 senior registrars, 6 registrars and 9 senior house officers).

Of those anaesthetists audited, 98% were familiar with recommendations relating to the use of monitors. 84% knew that guidelines had been published by the AAGBI and 77% thought that they were following these guidelines. However, only 49% were actually following them at the time of the audit and failure in each case was due to the fact that the inspired oxygen concentration alarm was switched off. All but one of those audited (98%) were monitoring the patient with at least pulse oximetry, capnography, an electrocardiogram, non-invasive blood pressure and

inspired oxygen concentration.

The use of alarms contrasted with this significantly. 71% of anaesthetists audited claimed that they usually either set the alarms limits on their monitors or checked the settings. However only 28% of these knew the alarm settings at the time of questioning.

Eleven anaesthetists (24%) had every available alarm switched off. Of these, three (7%) said that they had turned the alarms off on purpose because of the unwanted distractions of false alarms. The other eight were under the impression that the alarms were on.

Current monitors and alarms use what are called "limit alarms". They look only at set variables and are excellent at detecting life threatening situations. They have a sensitivity which is usually 100% if switched on! However their specificity is low with 40-75% of alarms being artefactual. This leads to them being misused or switched off by many anaesthetists.

Improvements are being made to increase the specificity of anaesthetic alarms and to make them more "user friendly". Most monitors and alarms are now integrated into one machine. Sensor design and artefact reducing measures, such as filters, are also improving. The setting and re-setting of alarm limits is now easier and personalised pre set and automatically set limits are available. An integrated monitor can prioritise alarms and can distinguish between the minor deviation of a variable and a life-threatening situation. The subsequent alarm will reflect the urgency of the situation. The monitor may also direct the anaesthetist to which variable has deviated rather than, or as well as, giving a general alarm.

"Smart" or "intelligent" monitors and alarms which involve a degree of artificial intelligence are currently being developed to try and increase further the specificity of anaesthetic alarms. The alarms themselves will identify specific problems and direct the anaesthetist to that problem. Some may even suggest appropriate action to correct the problem.

A survey of 32 projects involving the development of smart monitors by Urkun shows that most are related to intensive care rather than the operating room environment. Most systems are currently being developed purely as "proof of principle" rather than for clinical use. At present there are no randomised controlled clinical trials which compare smart and traditional monitors.

Although this technology is currently available there is a reluctance on the part of manufacturers to develop systems for clinical use because of concerns about possible medicolegal liability for adverse outcomes which are not prevented by the systems.

There is good evidence that the use of monitors and alarms increases patient safety. We have seen that there is excellent knowledge of the AAGBI recommendations and there is good use of the monitors available. However the findings with regard to alarm use appears to be less than satisfactory.

It is hoped that with improvements in limit alarms, to reduce artefactual alarms and increase user friendliness, their use will increase.
Smart or intelligent monitors are under development but it is unlikely that these will be widely available in the near future.

HUMAN ERROR
Dr. 'Arnie' F.E.Arnstein, Edinburgh

Most errors recognised in anaesthetic practice are discussed locally. Wider debate may be provoked by the publication of case reports and articles and in the courts. These processes are retrospective and inherently prone to misinterpretation. I wish to outline human error terminology and examine some of the factors which influence the prevalence of error. We all make errors and are susceptible to misinterpreting information. There are many comparisons with the aviation industry.

Errors may be divided into two major categories; active and latent. Active errors are events which occur immediately before an incident or accident. Latent errors are systems containing unrecognised faults which become evident under specific circumstances.

Active errors can be subdivided into contextual, modal or psychological. Psychological definitions aim to define cognitive mechanisms that lead to error. Theory suggests that using these definitions should make error causation predictable and comparable. Usefully, errors may be classed as knowledge, skill or rule based.

Knowledge based errors have their origins in a background of inadequate knowledge or experience. Rule based errors occur when there is a failure to apply a rule or an inappropriate rule is used. Anaesthetic seniority may confer an increased risk of making errors of this type as more short cuts are employed. Such deviations are also termed violations or intentional errors.

Skill based errors which incorporate slips and lapses relate to errors in conscious and subconscious (automatic) cognition. Subconscious or motor programs enable humans to perform multiple tasks simultaneously and rapidly, freeing up cognitive power for conscious effort. However, motor programs are rigid and occur by definition without awareness. Therefore, it is possible to select the wrong motor programs for the task.

Within these broad categories, subclassifications have evolved. Three further forms of error are described as fixation errors: despite evidence to the contrary, continuing with an inappropriate plan, dealing with everything except the real problem and believing the evidence is falsely positive. In essence these may be seen as 'cognitive tunnel vision'.

Human information processing may be unable to detect errors of recognition (illusions), imagine external stimuli (hallucinations) or may make false cognitive hypotheses (delusions). Each may lead to the whole system failing to complete a task correctly.

Failing to maintain accurate contact with the external reality may lead to disorientation. In aviation two forms of disorientation incidents are recognised. Type I is defined as when the pilot fails to recognise that his perception is incorrect, whereas during a type II, he senses that the cues presented to him may be inducing a false perception. The former represents a greater hazard in that an erroneous situation exists but the pilot remains unaware. It would seem reasonable to extrapolate these modes of disorientation to other human activities including the practice of anaesthesia.

Latent errors may be considered as inadequacies or failures of ergonomics, training, incorrect policies or protocols, inadequate assistance or supervision, social and cultural factors including language, physiological state of the patient (and staff). The risk factors associated with an individual latent error must be viewed with caution because the occurrence of errors may require shaping or enabling factors. Latent errors often cannot be identified prior to an activity and only vigilance prevents more incidents becoming accidents.

The psycho-physiological state of the anaesthetist may influence considerably the incidence of error and his or her performance. Factors to consider include the effects of immediate and underlying stress and personality trait. Good pilots and perhaps good anaesthetists, tend to be stable extroverts. Optimal performance of a task has been shown to occur at a particular stress level. Too little leads to drowsiness, reduced vigilance, errors of omission and slowed reactions. Too much stress results in increased response to false alarms, narrowing of attention, disruption of organised thought, increased speed but reduced accuracy of motor activity and finally panic.

Stressors appear in many forms. They may be immediate such as noise, heat, excess or too little light. they may also be more remote such as family and financial worries, career uncertainty, effects of unusual or excessive workschedules, poor team co-operation and the memory of prior incidents or accidents. Surprisingly, studies have failed to show that fatigue is associated with a significant degradation in performance. Life stressors have been scored in terms of life change units and correlate well with the prevalence of physical and psychiatric illness. Life stress has been demonstrated to be present in those blamed for aviation accidents but absent from those considered blameless.

Excess or adverse stress may induce a failure to cope resulting in social withdrawal and depression or general behavioural and life style changes. The aviation world accepts that failing to cope is not a medical disorder. Most stress reactions are now viewed as a normal response with the emphasis placed on the transitory nature of the stressor. Education in human factors is taking a more prominent position in the aviator's curriculum and perhaps should be considered formally in anaesthetic training.

It is recognised that the anaesthetist represents just one part of a complex team system. The work requires coordinated effort. Sharing work has the benefit of enabling the workload for any one person to be kept to an acceptable level. The successful division of labour requires good leadership, communication and co-ordination. The need for formal training in team management is recognised in the civil aviation industry by the introduction of crew resource management (CRM) courses. CRM includes the use of high fidelity simulators and the development of anaesthetic simulators should enable anaesthesia to evolve a similar approach.

It is important to remember that error does not equate to negligence. However error is often deemed culpable in retrospect. Retrospective analysis is fraught with difficulties. The need to examine all the circumstances

surrounding an error as they existed at the time is to be emphasised. Memory may be influenced by many factors.

Current systems to identify error in anaesthetic practice are limited particularly in that they rarely aim to, or succeed in, providing a complete answer as to why an error occurs. To justify expending resources to reduce the incidence of human error, it is important to assess the size of the problem. Mortality directly contributable to anaethesia is quoted at 1 in 10,000 to 3 in 500,000. Morbidity is harder to estimate and is probably under-reported.

The estimates of the contribution of human error to critical incidents and accidents in anaesthesia and aviation during the past 15 years support the notion that fundamental mechanisms cause error. The prevalence has appeared to increase in both areas which may reflect growing task complexity or increased recognition.

Human error remains and will probably always be the primary cause of accidents. This error may be focused on the performance of the individual, the team or the system. Its origin is usually multifactorial and complex to resolve. There is a need for anaesthetists to be formally trained in human factors including team management.

Anaesthetic Internet Resources

Dr. J. Rushmer, Edinburgh

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"We stand on the threshold of a revolution as profound as that brought about by the invention of the printing press. New technologies, which enable rapid communication to take place in a myriad of different ways across the globe, and permit information to be provided, sought, and received on a scale hitherto unimaginable, will bring fundamental change to all our lives" - Labour Party press release.

There is currently considerable interest in the internet as its various ingredients mix explosively. Interested commercial organisations are fueling its development now that the hardware of appropriate sophistication is widely available. There is now a large quantity of serious academic material available on the internet including many sites dedicated to anaesthesia.

The internet is basically a communications system allowing this to happen in a number of ways. These include E-mail, file transfer (FTP), the ability to log onto a distant computer, the ability to read documents and connect to computers transparently. Transparency is used to mean that you cannot 'see' or 'feel' the computer you are connected to: it still looks and feels like your own machine. Nowadays most communications media are available in digital form. This opens up a huge potential and live video conferencing is coming within reach of even modest budgets.

All these features are united in the 'world wide web' which is the recent medium making the internet so popular. The 'world wide web' is a series of multimedia documents containing labels or icons which the user can easily understand and will lead them to the information they are looking for. Whilst it is possible to search for information on the basis of keywords, this can be time consuming. An alternative is to consider 'newsgroups'. Where there is a group of like-minded individuals, they can be linked by dedicated computer servers into 'newsgroups'. This allows the rapid dissemination of information of specific interest to this group and a quick way for the individual of finding information of specific interest.

Much of the current development on the internet is into security related issues. Low running costs and 'hype' has produced a disorganised mix of sites. The prediction for the future is for the development of an 'onion skin' system with reduced areas of access. To most individuals this would mean the ability to window shop the 'outer most skin' but to enter the deeper layers you would need authorisation. The academic community will welcome this as it will reduce the number of unwanted guests (or lurkers as they are known) and isolate sites with disorganised information. It is likely commercial organisatons will use this facility to offer a pay per view service. At present the choice of access to internet is through commercial service providers or academic institutions. In the past it has been the academic institutions which have shaped the development of the net but the increasing commercial interest may mean that this could change.

In comparison to paper, the internet suffers from a lack of organisation. Paper does, however, have nearly a 600 year advantage. This is a comparison of 14th century technology with that of the 20th century. Availability of information on the internet is near immediate, into your own home if you wish and truly multimedia. Despite this, I would be the first to admit it may be some time before the gift of a CD-ROM has the same feel as a signed copy of a book!

More ways of measuring cardiac output

Dr. Simon Mackenzie, Edinburgh

The standard ways of measuring cardiac output include the 'physiological classics', namely the Fick technique and dye dilution using ICG, and the commonly used techniques of clinical judgement and thermodilution using a pulmonary artery catheter. The Fick and dye dilution techniques are impractical for routine clinical use, clinical estimation of cardiac output has been shown to be unreliable whilst thermodilution is invasive, expensive and intermittent. The ideal technique would be non-invasive, continuous, reliable under all conditions, easy to use, cheap and also able to indicate preload. Such a technique would make recent calls to measure cardiac output in more patients a practical proposition. There are many potential techniques, and there is only time to consider those which are, for one reason or another, topical. These are bioimpedance, oesophageal Doppler, the COLD machine and the Vigilance pulmonary artery catheter.

The impedance across the thorax is known to change with ventilation and with changes in blood volume related to cardiac contraction. Kubicek developed the first machine to measure cardiac output based on this in 1966. Stroke volume was calculated using an empirically derived equation which included blood resistivity and thoracic length as variables. Both were difficult to measure in practice, and this method was found to be unreliable. Berstein and Sramek developed a different equation which attempted to overcome these problems. Again it was empirically derived, and it is this equation which is the basis of the best known machine, the Biomed. Subsequently other machines have also been developed. Some studies have shown cardiac output values similar to thermodilution, but most have not. Bioimpedance is least satisfactory in patients with a low basal impedance, and this includes those with pleural effusions and pulmonary oedema. These are, of course, just the sort of patients in whom we want to measure cardiac output. Despite the enthusiasm of some proponents, bioimpedance is not sufficiently reliable for clinical use.

The Doppler technique for measuring the velocity of blood is well known, and may be used at a variety of sites, including the descending aorta. The commercially available ODM monitor is easy to insert into the oesophagus in ventilated patients but is poorly tolerated by the unsedated patient. Integration of the area under the velocity time curve gives the stroke distance, but to calculate stroke volume requires that this is multiplied by the cross sectional area of the aorta. This is very difficult to measure accurately in practice and in fact the ODM does not attempt to do so. It uses a nomogram based on the patient's age, height and weight to give what is termed the estimated stroke volume and the validity of this is uncertain. A further limitation is that only 75% of the cardiac output passes through the descending aorta, and it must be assumed that this percentage is constant at all cardiac outputs. This is probably true in most circumstances, but there is some, such as aortic cross clamping, where it is clearly not. The ODM may reasonably be used to measure trends in cardiac output but not absolute values. One potential advantage of the ODM is the ability to use the shape of the velocity time waveform to guide therapy, particularly in optimising preload.

The COLD machine is named from a somewhat forced acronym for Circulation, Oxygenation, Lung and Diagnosis. Using this machine it is possible to perform thermodilution cardiac outputs without a pulmonary artery catheter by making the injection into a central vein and detecting the temperature change in the femoral artery. It can be argued that this is less invasive, but the advantage is marginal. The real reason for interest in this machine is that it is possible, when combined with a pulmonary artery catheter, to use a double indicator technique to measure the intrathoracic blood volume and the extra-vascular lug water. The basis for this is that if both cold fluid and ICG are injected, the ICG will distribute only intravascularly but the cold fluid will also distribute extra-vascularly. The volumes of distribution are calculated from the cardiac output and the mean transit times. Intrathoracic blood volume is certainly a better measure of preload than the pulmonary artery occlusion pressure, but the value of extra-vascular lung water measurements in the management of, for example, ARDS, is unproven.

A modified pulmonary artery catheter, the Vigilance catheter, allows 'continuous' measurement of cardiac output. A coil on the catheter produces pulses of heat energy and the changes in blood temperature are cross correlated with this energy input to give a 'thermodilution curve'. The energy input varies with blood flow and there is a maximum temperature of 44 degrees Celsius to prevent damage to blood cells ore the vessel wall. The bias of these measurements compared to conventional thermodilution by bolus injection is very small and the limits of agreement are acceptable. Although this technique clearly has most of the limitations of pulmonary artery catheterisation in general, the continuous display of what is actually repeated updated series of individual measurements, is a major advance.

In conclusion, it seems likely that thermodilution measurements of cardiac output will be the mainstay for some time to come, and continuous measurement using the Vigilance system is the present technique of choice. Oesophageal Doppler may be used to follow trends and for assessment of preload but cannot give absolute values. The COLD machine offers little advantage for cardiac output measurement, but may prove to be of

real value for assessment of other parameters. It is certain that the development of other techniques will continue, but these must be rigorously assessed.

Predicting cardiac risk in patients with ischaemic heart disease presenting for non-cardiac surgery.

Dr. Jonathen Wedgewood, Edinburgh

Perioperative cardiac morbidity accounts for 50% of all morbidity associated with non-cardiac surgery and is the most common cause of death if one excludes surgical pathology. Clearly there would be significant benefits in reducing this level of perioperative cardiac morbidity - the ability to accurately and precisely identify those at risk is the first step in this process.

The fundamental requirement is an ability to identify preoperatively those characteristics which correlate with a poor outcome and to quantify the degree to which they predispose to that outcome. This is confounded by the fact that not only are there numerous patient specific factors to consider but there are also patient independent factors, notably the type and extent of the surgical procedure which determines the degree of physiological trespass involved and the perioperative management - although anaesthetic technique per se has not been clearly shown to influence the outcome, the conduct of the anaesthetic and the postoperative management may have a direct bearing on the probability of myocardial injury. In addition, the pathophysiological mechanisms leading to myocardial injury are complex. It is becoming increasingly clear that the traditional explanation for the occurrence of angina - that is the presence of a fixed coronary artery stenosis producing a limitation of blood flow thereby limiting oxygen supply and producing ischaemia at a fixed and reproducible level of demand - fails to explain the clinically observed phenomena of angina at markedly different levels of demand and the lack of a consistent relationship between angiographic findings and severity of symptoms. The concept of coronary atheroma inducing endothelial dysfunction and hence fluctuating coronary vessel spasm is only now beginning to be appreciated. The factors which influence this activity in the perioperative period have yet to be elucidated.

Is it possible to predict risk? In 1977 Leo Goldman recognised that numerous factors contribute to outcome and that they do so to varying degrees. He constructed a point weighted assessment allowing calculation of a risk score. Despite modification by others, these risk indices are subject to a number of criticisms; the severity of ischaemic heart disease is not properly assessed, exercise tolerance is not assessed and there is little account taken of the type of surgery to be performed. In an effort to improve risk stratification, non-invasive tests of cardiac function were enthusiastically introduced; electrocardiography, exercise electrocardiography, echocardiography and stress echocardiography, radionuclide angiography and radionuclide scintigraphy. Some of these include a dynamic component to assess the response to stress induced either physiologically or pharmacologically using inotropes or coronary vasodilators. Studies with scintigraphy demonstrated that it was only of benefit when applied to groups identified as being at intermediate risk on assessment of clinical variables. This is what one would expect from an understanding of probability theory and predictive testing - that if the outcome has either a very high or very low probability then a predictive test will merely confirm these findings and provide no further discrimination of risk. The test is most likely to be useful when the outcome is in doubt. The use of exercise electrocardiography highlighted an important factor. The patient's exercise tolerance during the test was a stronger predictor of outcome than the result of the test per se.

In summary, the fundamentals of risk prediction are a good history and examination coupled with chest radiography and electrocardiography, and a knowledge of the extent of surgery to be performed. Clearly those factors known to influence outcome must be elicited and quantified. These include prior myocardial infarction and the time elapsed since infarction, current or prior left ventricular failure, angina assessed according to a standardised scale such as the Canadian Heart Association Grade I-IV, dyspnoea again similarly assessed, exercise tolerance as measured against formal protocol such as Bruce or based on history correlated with a standardised table of daily activities.

Such an approach should allow identification of those patients at high, intermediate and low risk. Non-invasive specialised testing is only indicated from basic assessment. The test of choice under those circumstances is an exercise electrocardiograph. If for some reason the patient cannot exercise or the test is uninterpretable then a dobutamine stress echocardiogram or a dipyridamole thallium scan should be performed.

GLASGOW ROYAL INFIRMARY

Life continues at GRI under the clinical directorship of Dr Willie Frame, whose desk to bin time gets shorter every day. Proposals for a new Glasgow Royal Maternity Hospital (the one that was supposed to open in 1996) and a resiting of Canniesburn to the Royal have headed down the PFI route, perhaps never to return.

New consultant appointment include Drs. Fiona Pearsall, Shenaz Hamid, Su Tan who has an interest in chronic pain, and Alison Kilpatrick and Chris Greenhalgh, both with interests in obstetric anaesthesia. Gavin Kenny returned to the Royal at the end of the year as professor of Anaesthesia.

Both Dr Donald Brown and Dr Leslie Baird retired this year, and will be sadly missed; Leslie will of course be heading for London as President of the Association of Anaesthetists, while Donald is allegedly heading for the golf course - good luck to them both. Dr Anne Moffat resigned her consultant post after a short stay and has headed off to Australia to matrimony and Castlemaine XXXX

Sadly Professor AC Forrest, formerly of Glasgow Royal Infirmary, died this year.

ROYAL HOSPITAL FOR SICK CHILDREN, GLASGOW

1996 started with the good news that we were to have 7 new theatres and a new day surgery unit without the aid of PFI.

Building started in March and by now there is a three storey edifice occupying most of the car parking space to the dismay of most and the astonishment of our surgical colleagues.
Some of us have had the arduous task of investigating prospective new equipment from exotic sites such as Munich, Baden-Baden, and Hemel Hempstead. The theatres will be finished during 1997 and should be functioning in the Spring of 1998.

The present clinical director demits office in April 1997.

The department continues to flourish. Dr Ros Lawson has taken up a consultant post and we have two specialist registrars - Dr Kay O'Brien from Dublin and Dr David Robinson from Glasgow. In future we are likely to have only one of these posts. We await the prospect of Calmanisation with trepidation.

A further consultant anaesthetist post is advertised to cope with increasing surgical appointments- this will also help with the huge increase in invasive cardiology. We are hopeful of a close association with the new university department under Professor Gavin Kenny with a part time senior lecturer post at Yorkhill.

The summer saw the departure of Tom Hansen who returned to Denmark to join his wife and family and to take up a consultant post in Odense.

The department is to host the annual meeting of the Association of Paediatric Anaesthetists in Glasgow in March 1997 when a worldwide gathering of 200 plus will meet at the Glasgow Hilton. Interested guests will be welcome.

SOUTHERN GENERAL HOSPITAL

The past year has been a relatively quiet one for this department with no new developments or difficulties. In common with the rest of the Glasgow Acute Trusts, the financial budgets are tighter this year. Greater Glasgow Health Board has agreed a further version of its strategy up to the year 2000. This proposes little change but does indicate an intention to maintain obstetrics on this site and also to move facio-maxillary here in the next year or two. The Health Board has also declared that it wishes High Dependency facilities to be available in addition to Intensive therapy services and we hope to be able to provide a High Dependency Unit next year.

There have been some changes in consultant staff this year and for once we are up to our full compliment. Dr Regina O'Connor joined the department in January to replace Dr Arthur Davis. Dr Ian Davidson Joined us in August and his post replaces Dr Margaret Gibbon's associate specialist post; Dr Magnus Garrioch started at the beginning of October.

DEPARTMENT OF NEUROANAESTHESIA, SOUTHERN GENERAL HOSPITAL

The level of work continues at its usual hectic pace and staffing problems have become more apparent both at senior and junior levels over the last year. However in August 1996 Dr Linda Stewart, previously senior registrar in Edinburgh, was appointed as Consultant. She has a major interest in Neuro-Intensive care and

spends much of her time in ward 61. Proposals to transfer maxillo-facial services to the Southern General Hospital will involve radical changes in theatre and intensive care management of patients on the first floor of the Neuroscience building. Much discussion has gone into it and will continue to go into the planning process with a view that maxillo-facial services will join neurosurgical services in about two years time.

STOBHILL HOSPITAL

Two new consultants have been appointed to fill vacant posts - Dr David Aylmer and Dr Eleanor Walsh.

The new CT scanner is operational , and the day case unit has been expanded to accomodate the increasing workload. The new ITU has been commissioned and is due to open in Spring 1997.

DUNDEE

There have been no changes in the consultant establishment over the past year. In contrast, considerable movement has occurred at trainee level following on from the departure of four senior registrars - Damien Carson to Belfast, Charles Wallis to the Western General in Edinburgh, Sandy Binning to the Western Infirmary in Glasgow and Cliff Barthram to Perth.

Calmanisation was achieved relatively painlessly during the summer with the introduction of the new specialist registrar grade and establishment of the Dundee School of Anaesthesia. This has not affected our customary good examination rate with 10 out of 10 trainees sitting and passing the FRCA. Congratulations to Drs. Barker, Connolly, Munnoch, Stewart, Muralidharan, Hassan, Bolton, Cole, McGuire and Macmillan.

The University Department continues to develop with some definitive accommodation provided - the Professor has a window and air conditioning! However, the Department has grown at such a rate that more space is needed and looks set to arrive in 1997. On the research front, Susan Rae obtained a 2 year Fellowship from the Association of Anaesthetists to work with the pharmacologists on GABA receptors and Mathew Checketts is using an Association of Anaesthetists project grant for an MRI based study of bleeding in the vertebral canal after spinals and epidurals. After delivering his well received inaugural lecture in December, Tony now feels he belongs to Dundee! He was also instrumental in organising a successful meeting on "Challanges in Anaesthetic Training" earlier in the year in his role as Convenor of the Scottish Standing Committee.

Major reconstruction work is going on apace at Ninewells prior to transfer of services from Dundee Royal Infirmary in two years' time. Constant hammering, sawing, cutting and drilling are preparing us for the arrival of the orthopaedics, trauma neurosurgery, plastic surgery and urology. Mounting concern is, however, being expressed about the adequacy of theatre and bed provision in the new-build, especially with increasing pressures already seen on the general wards and the high dependancy and intensive care units.

DUMFRIES AND GALLOWAY

Our claim to having been the place where the clinical use of Ether anaesthesia was first demonstrated in this country was celebrated in some style on 19th December 1996, on the occasion of its 150th Anniversary. Dr.Hugh Brewster masterminded the event and our secretary, Adelaine Murray, organised the details to ensure a highly successful meeting Among others, one of the speakers was Tom Baillie, previously a Consultant Anaesthetist here in the 1960's before leaving for the Netherlands. Tom wrote the original monograph on the subject - "From Boston to Dumfries" - and, with typical business acumen, was available to personally sign copies of the new edition of the book!

During the year we were pleased to welcome two new consultants to the department. John Rutherford joined us from a senior registrar post in Cardiff, having previously trained in Edinburgh. He has taken over the Acute Pain Service and has a special interest in acupuncture. Hamish Stewart joined us later in the year as a consultant based at Stranraer where he and Ranald Spicer now 'man the fort' in the west of the region.

LAW HOSPITAL

Not much change to report here. The hospital has spent much of this year working on the implementation of a Hospital Information System which is scheduled to go live in December 1996. Our other major issue is the on-going question of a replacement for Law Hospital. The full case for a hospital at Netherton, Wishaw, under the Government PFI scheme is now before the Scottish Office.
(Ed. remember the Skye Bridge)

VALE OF LEVEN

The last update from the Vale was in the Annals of January 1995. In April of that year the hospital

successfully achieved full Trust status. The Anaesthetic and Theatre Services Directorate continues to function successfully and has recently taken over responsibility for both the new Day Units - surgical and medical. Adrian Tully has been reappointed for a second period of three years as Clinical Director, while Bill Easy continues as Chairman of Division. Alistair Cameron has also been recently appointed as hospital Clinical Tutor. Two new members of staff have been appointed within the past two years, Fiona Bryden to our fifth consultant post, and more recently, George Kashoulis to our second staff grade post.

Developments continue apace! An Acute Pain Service continues to evolve, and now benefits from the appointment of a pain nurse. To cope with the expansion of the orthopaedic service, the main theatre suite recovery ward has been substantially enlarged and a minor ops theatre added. The division has also taken over Community Dental Anaesthesia for the local area and will soon see the addition of a service for ECT when the new in-patient Mental Health Unit opens. In a broader context, work has commenced on a much needed new main entrance to the hospital. When completed this is intended to provide an area for shops, meeting rooms and a lecture theatre, not to mention easier access for patients and visitors to all areas of the hospital.

INVERCLYDE

Duncan Thomson has now joined us as a consultant bringing the establishment to six consultants. We welcome his services now that a full vascular service has been established. An Acute Pain Nurse has also arrived and we hope to further develop our Acute Pain Service. The hospital operating theatres and lecture theatres are now video-linked with Dundee, Edinburgh and a number of Glasgow hospitals.
(Ed. some of us obviously better look out - Inverclyde is watching.)

ABERDEEN

With the appointment of Debbie Mellor as resuscitation training officer, we have become the Directorate of Anaesthetics, Intensive Care, Hyperbaric Medicine and Resuscitation. We might not, therefore, have much say in the running of the trust but we are a big name. Donnie Ross has been appointed Medical Director and his place as our Director has been taken by Richard Davidson-Lamb.
Three of our senior registrars have become consultants in the past year. John Barr and Brian Stickle were persuaded to stay locally, but Sandy Hunter, after being seconded to Yorkhill for six months, has decided to take his unicyle and juggling skills to Inverness. So far, these posts have been replaced with specialist registrars and it is only when trainee numbers are cut that we will see the full effect of the Calman Report. With the return of Abdul Sheikh from Saudi Arabia and the appointment of Sandy Kidd as a consultant (previously at Frimley Park Hospital, Hampshire) we are now closer to having a full establishment.

The chronic shortage of intensive care beds, obvious to the Trust if not to the Health Board, continues to be a problem, with regular "spill over" into cardiac ITU and recovery. This has led to problems with the service commitment of the department as we try to stay within the regulations governing junior doctors hours. Margery Macnab has given up her ITU committment and is instead to concentrate her expertise in the neurosurgery theatre. The clinical input of the Academic Department is now shared between Professor Nigel Webster and Vivek Kulkarni.

The Academic Department has moved into The Institute of Medical Science opened, on the Foresterhill site, by the University in 1996. The laboratory facilities available there are a considerable step up from the previous cramped accommodation allowing the already impressive laboratory based and clinical research to continue. Brian Cuthbertson continues in a research post and has been joined by John Hunter (under the supervision of David Noble).

ELGIN

With the appointment of Ian Whitehead as a consultant, previously a senior registrar in Nottingham, there are now four consultants and one Associate specialist in the department.The workload continues to increase accordingly, with larger amounts of elective orthopaedics and trauma, for example, being carried out locally.

Phase II of the development of the new Dr.Gray's Hospital opens in 1997. This will include new departments of Accident and Emergency and Imaging with a CT scanner, as well as improved outpatient facilities.

ROYAL ALEXANDRA HOSPITAL, PAISLEY

Over the past year despite a continuing lack of available cash for staff and equipment, and a major management upheaval - "restructuring" within the hospital, the Anaesthetic Department at the Royal Alexandra Hospital, Paisley has endeavoured to maintain a "steady as she blows" course through the surrounding stormy environment.

Two new Consultants have been appointed in order to comply with the "New Junior Hours Deal" and the various additional contracts arranged for us by the management. The Department is delighted to welcome Dr Fred Davies and Dr Liz Smith, bringing our Consultant complement up to twelve.

Our High Dependency Unit has at long last been upgraded to an Intensive Care Unit and a determined bid (or squat) is being made by us to convert the old Coronary Care Unit into the new Anaesthetic Department.

The Pain Service under the dedicated guidance of Dr Tom Goudie continues to expand, - sometimes we think it over expands, to meet increasing demand from our surgical colleagues.

Finally our Education line-up has a fresh look with the appointment of a new Anaesthetic Sister and the College Tutor's mantle passing to Dr Sofia Chaudhri.

PERTH

The Anaesthetic Department at Perth Royal Infrimary has expanded with the arrival of Cliff Barthram as the ninth consultant. Cliff joined us from his senior registrar post at Ninewells Hospital, Dundee.

The work of the department has increased. The ITU has expanded. the opening of a High Dependancy Unit is imminent and the obstetrics unit is buisier than ever, with a 30% increase in anaesthetic activity in this area. The purchase of a transfer trolley for critically ill patients has improved our ability to transfer patients to and from the hospital.

On the academic front, Andrew Kutarski is enjoying life as the President of the North East of Scotland Society of Anaesthetists.

ROYAL INFIRMARY OF EDINBURGH

The Royal Infirmary NHS Trust remains poised for the move to the greenfield site of the New Royal Infirmary at Little France on the outskirts of south Edinburgh, general election and Private Finance Initiative notwithstanding. The preferred bidder is in the last stages of discussing the detailed planning. It is to be hoped that this will not result in too many cuts should the project progress.

Meantime in the old Royal Infirmary life continues apace with the appointment of several new consultants. Dr. Frank (Arnie) Arnstein has taken up a post with interests in gynaecology and ENT, Dr. Charles Morton is also working at the City Hospital and the RIE with lists in maxillofacial surgery and ophthalmology, Dr. Heather Spens has been appointed to the clinical position about to be vacated by Willie MacRae and Dr. Susan Nimmo has interests in general surgery, gynaecology and orthopaedics.

Willie MacRae retires from clinical duties this year as well as standing down from the position of Clinical Director, but it is to be expected that he will continue with many of his other activities especially in relation to the Association of Anaesthetists and the College. A large sendoff is planned for the end of February and standing room will be at a premium. Ann Whitfield retired from clinical and managerial duties this year as Chairman of the RIE Anaesthetic Department and we wish her well in her move to London. Vaughn Martin retired fully having taken part-time retirement previously. Ian Davidson finished his term as Medical Director of the RIE during 1996. Dermot McKeown steps into the position of Clinical Director and Dave Littlewood becomes Chairman of the Anaesthetic Department.
Dr. Gordon Drummond returned from sabbatical in Paris to take up a one year appointment as the John Gillies Professor sponsored by the Royal College of Anaesthetists.

This year saw the inaugural Intensive Care course under the auspices of the Scottish Intensive Care Society run in Edinburgh by Dr. David Swann. This was very successful and next year it is planned to run two complementary courses in Edinburgh and Glasgow. The ATLS course under the direction of Dr. Dermot McKeown continues to be oversubscribed. The new Part 1 course has attracted a lot of attenders and is presently run by Dr. Nikki Maran.

The Trainees Meeting of the Scottish Society of Anaesthetists was well attended in June 1996 and the well established Edinburgh Anaesthetic Festival attracted its highest attendance to date. In 1997 this will be replaced for one year by the combined Sesquicentenary Celebration of the discovery of Chloroform and the meeting of the European Academy for which plans are already well in hand.

Dr. Tim Walsh will be travelling to Vancouver as winner of the Intensive Care Society Travelling Fellowship following his recent research post in the Scottish Liver Transplantation Unit. Dr. Leslie Colvin continues her research at the Veterinary School following the award of an extension to her BJA Fellowship.

At the City Hospital Dr. Geoff Bowler has taken over command of 205 Scottish Field Hospital as well as developing day case ENT services. It is likely that Geoff will be moving his thoracic duties to the RIE later

in 1997 when thoracic services are planned to move on to the RIE site.

WESTERN GENERAL HOSPITAL

It is with regret that we note the death of Dr. Bob Pettigrew.

Dr. Dorothy Child retired during 1996, but is still providing the personal service for home ventilation that has been her forte over many years.

New appointments during the year are Dr. Charles Wallis to the Intensive Care Unit and the return of Dr. Rob Sutherland from Nottingham to Edinburgh to take up position with a major interest in neuroanaesthesia.

Dr. Ian Grant has taken up the reins as President of the Scottish Intensive Care Society and Dr. Jim Jenkinson continues as President of the Neuroanaesthesia Society responsible for recent Association guidelines on the transport of the head injured patient.

EASTERN GENERAL HOSPITAL

It is anticipated that the surgical and gynaecology services at the Eastern will close during 1997 with the move of those involved to either the Royal Infirmary or the Western General Hospitals. It remains to be seen where these services can be accommodated especially in the RIE where space is at a premium.
Dr. Jane Freshwater was appointed to the consultant staff during 1996 and Dr. Christine Robison takes up the position of Staff Grade.

ROYAL HOSPITAL FOR SICK CHILDREN

Dr. Eddie Doyle took up position at the RHSC during 1996 and a further increase in consultant staffing will take place with the appointment of a locum consultant for a period of one year in the first instance based on the new MRI scanner and additional workload occurring as a consequence of the move of paediatric ENT from the City Hospital to RHSC. Trainees are now divided between theatres (4) and ITU (1 position).

Paediatric neurotrauma services are based fully at the RHSC and the cardiac surgical programme is again very well established. Under the direction of Dr. David Simpson the ITU Extension Retrieval System is being pioneered for the transport of patients from the Western General, the Borders and Fife.

QUEEN MARGARET HOSPITAL, DUNFERMLINE

Dr. John Duncan will be retiring in April 1997. Dr. Neil Malcolm will take up a consultant position then from his present position in Canada.

Dr. John Emery Barker is now Clinical Director and Alistair Mackenzie is in charge of Intensive Care. This facility is now fully operational and multidisciplinary with additional clinical input from Dr. Peter Currie and more recently the appointment of respiratory physician Dr. Colin Selby.

BORDERS GENERAL HOSPITAL

With the steady increase in workload particularly in general surgery, medicine and cancer care there may be the requirement for further consultant staffing in the near future.
The new CT scanning facility is planned to open in April 1997 and the Intensive Care Unit has increased bed complement by 50% during 1996 with the possibility of additional High Dependency facilities in the near future. The Acute Pain Service has become established with recovery staff supporting ward staff.

VICTORIA HOSPITAL, KIRKCALDY

Morale is good at "the Vic" this year with several developments. The opening of a new coronary care facility, improved intensive care facilities in which "there is now room to swing a cat" and a forthcoming MRI scanner have contributed to this.

Jo Janczak has been promoted to Associate Specialist from her previous Staff Grade position.

ST. JOHN'S HOSPITAL AT HOWDEN

The sudden death of Dr. Alan Grace not long after his retirement from St. John's is noted with sadness by those who knew him well.

Dr. Mike Fried has taken up the positions of consultant and part time builder during the past year. Despite this he has found time to start a family and we wish Jane and Mike all the best. We are confident they will have a roof over their heads shortly.

Clinical activity remains high and research is still a prominent activity with the appointment of Dr. Duncan Henderson as research fellow.

After Hours At The Joint Meeting

SCOTTISH SOCIETY OF ANAESTHETISTS

REGISTRARS' PRIZE

The Society annually awards a prize of £250 for the best original paper or essay submitted by an anaesthetist in Scotland holding the grade of Senior Registrar or under. A second prize of £150 and a third of £75 may be awarded for other papers of particular merit at the discretion of the assessors. It is not necessary that the trainee be a member of the Society.

The conditions attached to the award are as follows:

1. The paper or essay must be original, i.e. it should not have been read previously at any meeting or published in any journal. The winning of the prize is in no way a bar to the subsequent publication in another Journal.

2. It is desirable that papers submitted show evidence of personal work, but papers consisting of surveys of the literature are eligible for consideration. The Council of the Society wishes to stress that intending competitors should not be discouraged through fear of there efforts being judged elementary. It is fully realised that junior anaesthetists in some peripheral hospitals may not have opportunities to deal with special types of cases or to employ advanced anaesthetic techniques.

3. Papers for adjudication (4 copies) **must** reach the Secretary by **28th February 1997.**

The Secretary places all entries in the hands of the Awards Committee which consists of the President, Vice President and Past President. The members of the committee have expressed the desire to be able to adjudicate without knowing the name or hospital of the writer: **it is requested therefore that the name, address, etc. of the entrant be submitted on a separate covering page. This will be retained by the Secretary, but otherwise the essay itself should give no indication as to its source. Acknowledgement of colleagues etc. should not be included.**

4. The Prize will be presented at the Annual Meeting of the Society where the winner and partner will be guests of the Society. The winner will be required to present a digest of their paper at the Annual Meeting and the Society's Trainees Educational Meeting.

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