TEACHING ANAESTHESIA IN THE OPERATING THEATRE

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The prime function of the anaesthetist (anesthesiologist) in the operating theatre is to care for the patient. This involves vigilant monitoring, adjustment of the anaesthetic and fluid and blood replacement as required. The anaesthetist should also follow the progress of the operation, watching for any untoward events which might be detrimental to the patient.

Teaching in the operating theatre has two components – practical and theoretical. There has to be a teacher and a trainee (or student). Good practical training requires thorough instruction by the teacher and all trainees should be supervised closely during the early part of their training so that they learn good habits and hopefully how to perform their tasks efficiently and safely. This puts an onus on the teacher to be active and to be present, not out having coffee or on the phone.

There are several environmental factors which differ from teaching outside the operating theatre. The most important is that **someone must be watching** the patient and the monitors. This means that one may have to forego continuous eye contact with the person with whom you are talking. If masks are worn, half the face is covered and some of the facial expression is hidden. These are important components of normal communication with others.

The surgeon may prefer a quiet environment so discussion should be conducted in low tones which are not disturbing to others. The anaesthetist must also be responsive to comments from the surgeon and to audible monitors. The pulse oximeter which changes tone when the saturation drops is a very useful warning device, but one must be aware of the tone even while talking. It is inappropriate to be chatting when tense situations are occurring. Experienced anaesthetists learn to concentrate more acutely at key times during operations such as when the chest is being finally closed during a thoracotomy or when the neurosurgeon is working around the brain stem.

A survey to which 1600 anesthetists responded indicated that 90% taught. This is a high proportion. Many will not have had instruction on how or what to teach. Some people are successful, often using their personal experience as the basis of what they can convey. We all have experiences which we can share, and some of these can be the basis of what we can teach.

Interactive teaching where there is two way discussion is more useful to the trainee. Questions can be asked which help the teacher to find out what the trainee does or does not know and therefore where the discussion can be most usefully directed. Sometimes concepts can be clarified and basic principles explained to improve understanding of why certain things are done or happen. An assessment of what has been learned can be made by asking the student to go over points that have been taught. This also re-enforces the points.

Practical teaching starts at the induction. How to handle the patient – be friendly when they arrive. Talk to him or her and try to create a relaxed atmosphere. This is mostly taught by example but can be discussed and stressed verbally. An anxious patient who has not received premedication may have an increased cardiac output and redistribution of blood flow to muscle from the sympathetic response. This is the reason why a larger dose of induction agent is needed or it takes longer to render a child unconscious when giving an inhalational induction. The redistribution of cardiac output with anxiety and hypovolaemia are very useful topics which can be discussed because they are relevant and it may save a patient's life if the trainee or student learns that the brain and heart receive relatively more of the depressant drugs when they are hypovolaemic, so less should be given in increments until the desired effect is reached.

Some practical procedures have to be taught during induction - intravenous cannulation, ventilation with the mask, insertion of an endotracheal tube or laryngeal mask airway. **Ergonomic analysis of the techniques**, which are described to the trainee in steps, makes it much easier to learn them. How and where to insert the cannula must be considered. A position which is easily accessible to the anaesthetist during anaesthesia must be chosen. How to hold the needle, insert it and then, when flashback of blood occurs, to advance the cannula into the vein should be demonstrated and the steps described. The last point is important in small children otherwise the cannula may not be in the vein when the needle is removed because the tip reaches beyond the end of the cannula. With very small cannulae kinking may occur when strapping is applied. To avoid this the needle may be left in place until the first tape is secure. Intra-arterial and central venous cannulation also require careful instruction about the techniques.

It is important to teach how to maintain an airway with a mask. Too often today an LMA is inserted and trainees cannot maintain an airway adequately with a mask. In children, an oropharyngeal airway is not often needed if the neck is extended (this usually causes the mouth to open), the mouth is opened, and then the mask is laid on the chin and then on to the face. The thumb and index finger push the mask on to the face to make an airtight fit and the little finger is used to pull the angle of the mandible forward keeping the pharynx open. This does not require tight grasping which strains the hand muscles. Gentle application of the forces in the right directions can achieve it without causing fatigue.

The most important point in endotracheal intubation is to make sure that the tube is inserted from the right hand corner of the mouth so that its tip can be seen going between the vocal cords. If this is done inadvertent oesophageal intubation is avoided. This is a serious cause of morbidity and even mortality. Check that both sides of the chest are moving and that there is air entry.

The capnograph will show a normal respiratory pattern and CO_2 level if it is in the trachea. This is a major reason why the capnograph has become a recommended monitor in countries where it can be afforded.

Regional anaesthesia and nerve blocks can be taught by demonstration or by first going through the anatomy and the layers that the needle will pass through before beginning the procedure and then guiding the trainee through the steps as it is performed. It is usually better to demonstrate first indicating the steps and then letting them do the next one. The problem is that the teacher may not have a second opportunity with that trainee. To learn the trainees must be taught and understand exactly what they are trying to do and then be guided through the procedure. Again the stepwise approach is best. Depth can be determined by knowing what layers the needle must pass through to reach the nerve. The key points are that fascia and aponeurosis can be felt by a short bevelled needle as a "pop" or loss of resistance and, secondly, that it is difficult to inject into muscle. If a nerve lies deep to a muscle there will be resistance to injection when gentle pressure is placed on the plunger of the syringe but it becomes easy to inject as the needle emerges into the space deep to the muscle where the nerve may be traversing.

Anaesthetists vary in how easily they can hand over technical procedures to learners. Experienced anaesthetists, who are relaxed and confident that they can sort out problems should they arise, are usually more willing to let others try than those who are tense and don't like to feel that they are not in complete control. It is a personal matter but trainees have to realize that anaesthetists vary in how much responsibility they pass on. As the trainee becomes more competent the trainer will allow him/her to do more.

When all is prepared the patient must be positioned for the operation. Often this is supine but sometimes special positioning is necessary for the surgeon to gain access to the operative site. Attention to detail is important and again the teacher must explain the steps – avoidance of pressure areas, having the intravenous where it is accessible and will run well, having the blood pressure cuff on the other arm, and avoiding nerve injuries. It is easy to just put the patient on the table and not point out these details but if the trainee is not made aware he/she may not think of them and eventually a complication may occur which could have been avoided. In more complex procedures such as neurosurgery, patients with an arterial line for blood pressure monitoring should have the transducer at head level so that it is measuring the pressure there. This is particularly important if the patient is positioned head up.

Usually, a trainee can become a good, practical anaesthetist if well taught provided they can develop the necessary technical ability. The onus is also on the teacher to be present to teach. There are a few people who do not have the technical aptitude for the specialty. They should be guided to a field where manual dexterity is not important.

Once the patient is on the table, all the monitors are attached and the mode of ventilation can be adjusted. There is more to squeezing the reservoir bag or putting patients on the ventilator than people sometimes realize. Prolonged inspiration can inhibit venous return, which can have an adverse effect particularly if the patient is somewhat hypovolaemic. Too short an inspiratory phase may produce uneven ventilation with V/Q mismatch. Usually a 1:2 inspiration : expiration ratio is used aiming to keep the mean intrathoracic pressure low.

Once a stable anaesthetic state has been reached more theoretical teaching can take place. This usually begins with discussion about the patient and operation being done so that all the issues can be clarified. Then one can go on to related or unrelated topics – the important applications of basic sciences to anaesthesia, other operations, or even philosophy or the cost of the anaesthetic! Significant savings can be made if people are aware of the costs of the drugs and equipment they use and try to be more careful and economical.

Sometimes the supervisor does not feel like teaching. He/she may be tired or not be a readily communicative person but if the trainee shows some interest and enthusiasm it is easier for the supervisor to be activated. An enthusiastic teacher can pass on a considerable amount of information in a short time but one must remember that the student may not have an unlimited capacity to remember it all if too much information is provided. It may be useful, having covered a dozen or so pieces of information, to run over them again briefly so that the trainee's memory is reinforced. It may then be appropriate to go on to less demanding discussion on another topic.

Occasionally there is a mismatch between teacher and trainee. The first may not be a great teacher and may not be up with the latest information and the trainee may be very bright. The teacher must just say they do not know if asked about something beyond their knowledge. This same teacher may be able to teach a few good practical points from their experience and should concentrate on them. It should not develop into a matter of conflict or an adverse view of the student because the teacher feels inferior. One brilliant trainee was labelled as troublesome by his trainers because they could not answer his complex questions. Turn the situation around and get the student to teach the teacher. Teachers often learn from their trainees. Continued learning from ideas brought up by trainees can be stimulating and be one of the joys of teaching.

At the conclusion of anaesthesia there is another period of heightened activity when practical matters become more important. If a complication like laryngeal spasm occurs, it is a good time to teach how to handle it. First apply continuous positive pressure with oxygen. It must be continuous so that any slight lessening of the spasm will allow oxygen to enter the lungs. It is better for a trainee to experience complications with an experienced teacher who knows how to handle them because it is less stressful and they learn what to do in practice. The spasm will usually break before the patient comes to harm but sometimes a small dose of suxamethonium (0.3 mg/kg) can be used to relieve the spasm. Larger doses lead to longer periods of paralysis. It is not usually necessary to re-intubate and this may lead to a recurrence of the situation.

When the patient has been transferred to the trolley they should be placed on the side unless there is a reason not to. Even at this stage teaching can continue. Why on the side? Which side – the

one that will leave them facing the nurses if complications are to be minimized. Place the upper hand under the jaw to keep the neck extended and the airway open. During transfer one can assess that the patient is breathing by observing the condensation in the oxygen mask. They are all useful, practical points.

Teaching in the operating theatre can only occur if there is someone present to teach. Beginners should always be with someone who can teach them, hopefully good habits.

Most practical teaching occurs in the operating theatre. It usually takes longer to induce anaesthesia when teaching is in progress but we should still try to make the trainees think of how they can do things in the most efficient way so that delays are minimized. It is also good practice to work in the ergonomically most efficient way and to think about how this is achieved. Too often this is neglected but it is essential if one is going to develop into an efficient and careful anaesthetist. When the teacher analyses the techniques it makes it easier for trainee or student to learn because they know exactly what they have to do to achieve their objective.

One must always remember that while teaching, one's primary responsibility is the care of the patient.

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CALCIUM HOMEOSTASIS

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Calcium is an essential ion within the human body. The maintenance of a constant free ionised calcium concentration is biologically important for the function of excitable tissues. Abnormalities in serum calcium values may have profound effects on neurological, gastrointestinal and renal function. Normal calcium concentrations are maintained as a result of tightly regulated ion transport by the kidneys, intestinal tract and bone. This is mediated by calcaemic hormones, in particular parathyroid hormone and the active form of Vitamin D. Changes in calcium transport resulting in movement into or out of the extracellular fluid will lead to hypercalcaemia, respectively. In this article the mechanisms responsible for calcium homeostasis will be reviewed.

Calcium balance

Calcium is an important nutrient. The daily intake is approximately 1000mg/day, about the amount of one litre of milk. The adult human body contains approximately 1100g (27.5mol) of calcium. 99% of the calcium is in bone. Blood calcium levels are normally 9-10.2mg/dL (2.25-2.55mmol/L). Of the total amount, 50% is free ionised calcium, 10% is combined with various anions (including bicarbonate, citrate, phosphate, lactate and sulphate) and the remaining 40% is bound to serum proteins mainly albumin. Free ionised calcium is the physiologically important component of the total calcium. In plasma, the ionised calcium concentration is normally maintained within a tight range (1.0-1.25mmol/l).

Intestinal absorption

30-80% of ingested calcium is absorbed, primarily in the upper small intestine. Absorption is related to calcium intake. If intake is low, active transcellular calcium transport in the duodenum is increased and a larger proportion of calcium is absorbed by the active process compared with the passive paracellular process that occurs in the jejunum and ileum.

Vitamin D is important for the active process. Active calcium transport depends on the presence in the intestinal cell of calbindin D9K, the biosynthesis of which is totally dependent on vitamin D. Passive absorption in the jejunum and ileum predominates when dietary calcium intake in adequate or high.

Calcium reaching the large intestine is absorbed by active and passive processes. Usually, no more than 10% of total absorption takes place in the large intestine, but this site becomes nutritionally important in conditions of significant small bowel resection.

Calcium absorption I inhibited by phosphates and oxalates because these anions form insoluble salts with calcium in the intestine.

Physiological functions of calcium

Calcium plays a central role in a number of physiological processes that are essential for life. Calcium is necessary for several physiological processes including neuromuscular transmission, smooth and skeletal muscle contraction, cardiac automaticity, nerve function, cell division and movement, and certain oxidative processes. It is also a co-factor for many steps during blood coagulation. Intracellular calcium is involved as a second messenger in many intracellular responses to chemical and electrical stimuli and required by many enzymes for full activity. Many different calcium binding proteins have been described, but the two with well established functions are troponin and calmodulin. Troponin is involved in muscle contraction, whereas calmodulin causes configurational changes to proteins and enzyme activation.

Intracellular calcium levels are much lower than the extracellular, due to relative membrane impermeability and membrane pumps employing active transport. Calcium entry via specific channels leads to direct effects, e.g. neurotransmitter release in neurones, or further calcium release from intracellular organelles, e.g. in cardiac and skeletal muscle.