Acting in anaesthesia:

Agency, participation and legitimation

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BSc (Hons), RN, ENB 182

This thesis is submitted for the degree of

Doctor of Philosophy

I declare that this thesis is my own work and has not been submitted in substantially the same form for the award of a higher degree elsewhere. The data I use in this thesis I collected when employed as research associate for an NHS funded study 'The problem of expertise in anaesthesia' (project grant number RDO/28/3/05).

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Abstract

In this thesis I examine the relationship between knowledge and action in anaesthesia. I begin by exploring the potential of Evidence Based Medicine (EBM) to guide anaesthetic practice and what implementing evidence based recommendations involves. This introduces a number of 'other' considerations that affect the course of an anaesthetic. I draw on ethnographic data of anaesthetic practice to explore how these 'other' elements contribute to shaping an anaesthetic trajectory. I consider the role of the patient who, being unconscious, can easily be overlooked. I suggest that it is the union of the patient and anaesthetic machine that affords the patient a form of agency. I then focus on the anaesthetist's work in crafting an account of a clinical situation that both renders the situation intelligible and indicates an appropriate course of action. I explore how accounts are legitimated and propose it is the legitimation of the accounts, more than their construction, which provides a lead for action. I also

explore the processes that regulate the participation of Operating Department Practitioners (ODPs) and anaesthetic nurses and its consequences. I argue that their involvement is stratified in line with the professional identity to which they aspire and I consider the effects this has in terms of initiating action. Finally, I examine how the tools and devices may be said to contribute to shaping anaesthetic care. I discuss how the anaesthetist develops an awareness of the form, position and configuration of both humans and devices, and how this body of 'normal appearances' serves as a resource to anticipate and identify impending difficulties. This exploration of 'acting' in anaesthesia has necessitated a reconceptualisation of agency, provoked an examination of what it means to participate, illuminated the importance of legitimation when initiating action, and I propose, it calls for the reconfiguration of professional accountability.

Acting in Anaesthesia:

agency, participation and legitimation

Preface

After changing into my theatre 'blues' I walk down the corridor and check the work allocation – Theatre 1, General Surgery. I begin by checking the anaesthetic machines, both in the anaesthetic room and in theatre. I turn the gases on and disconnect the pipeline supply – the alarms sound – turn on the cylinders to check the back up supply – turn them off and reconnect the pipelines. Next the breathing circuit and ventilator, any leaks? Leave it functioning but disconnected and wait for the low pressure alarm, occlude the end and listen for the high pressure alarm. Check the suction – clean, connected and working? Finally, top up the volatile agents. This work is quiet, constant and regular; there is no need to talk, the familiar routine is comforting first thing in the morning, and the solid and tangible machines, reassuring.

These are the general checks, I then need to think about the specifics – which surgeon, which anaesthetist and what procedures are on the operating list. Being mindful of their preferences I begin to set up for the first 'case'. Patients are always talked about like this in operating theatres, as 'cases' or procedures such as 'a mastectomy' or 'a hip replacement'. It might be a depersonalising technique, but for me, it is more of a specific way to think about the morning's workload; to anticipate the likely requirements of the morning. First on the list is 'a right hemicolectomy', an ET tube will be needed to secure the patient's airway, size 8.5 for a male, a size 5 face mask, a size 14 or 16 naso-gastric tube, intravenous cannula – a large grey one, 16 gauge, intravenous fluids and a fluid warmer, the warming blanket to go over the patient's upper half during surgery, flowtron leggings to prevent deep vein thromboses, and a

diathermy plate to earth the electrical current used to cauterise bleeding vessels. Providing the anaesthetist doesn't want to do anything 'fancy', he or she will require a combination of drugs: an induction agent – propofol is now almost ubiquitous, but it could be thiopentone if the anaesthetist is conscious of the drug budget, a muscle relaxant – usually atracurium, opiate analgesics – probably fentanyl and morphine, maybe a sedative – a little midazolam, and some intravenous antibiotics. If the anticipated surgery is going to be quite extensive they may also want to do an epidural, I get the 'kit' together just in case.

The anaesthetic room is over-run with 'kit' such as this – drugs, syringes, needles, cannulae, tubes and connective devices, all in 5 or 6 different sizes. Working as a nurse in anaesthetics you develop an affinity for these devices. There is something satisfying about being able to lay your hand on just the right device for almost every eventuality, and at being adept at assembling the intricate constructions required for invasive monitoring, for example. You develop personal routines, the efficiency of which relies on having the relevant item strategically placed for use.

Working with the anaesthetists is interesting, it is fascinating to learn about management of an unconscious patient both holistically and in terms of the articulated systems of the body; for example, how to take care of a patient's airways and respiratory system, the precise combination and volume of gases the respiratory system needs at a given point during anaesthesia and how to provide for this, the concatenated effects this has on the rest of the body, and how control for this system passes back and forth between the patient, anaesthetic machine and anaesthetist.

It is intriguing how so much can be gleaned from a 'reading' and a 'trace' on the monitor. As a patient exhales he or she will expire carbon dioxide, therefore, when controlling a person's respiratory system measuring the carbon dioxide levels becomes crucial. First of all, do you have a reading? If the monitor is connected and is functioning correctly and there isn't a carbon dioxide reading, then either the patient isn't breathing or the breathing tube (the endotracheal tube) is in the wrong place – the oesophagus rather than the trachea. Then there is the 'reading' to consider: the 'normal' range of measurements, for an adult, is between 4.5 and 6. For measurements outside this range it is possible to read into those figures an array of potential meanings: is the patient being underventilated (in which the respiratory rate and volume of gases supplied is insufficient to adequately ventilate the patient)? Is the patient developing septicaemia? The increased metabolic rate which results from the patient becoming overwhelmed by an infection means that an elevated level of carbon dioxide is produced. Or is the reading significant in indicating malignant hyperthermia (a rare inherited metabolic disorder triggered by anaesthetics)? Again, in this, the excessive level of carbon dioxide relates to an increased metabolic rate. Further interpretations can be garnered from the shape of the trace. As the patient exhales, the measurements are displayed on the monitor in the form of a line graph. If the line rises only gradually as the patient exhales one possible interpretation is that the patient has chronic lung disease, the gradual climb of the carbon dioxide reading corresponding to the rigid 'non-compliant' cell's irregular release of carbon dioxide.

Patients play a curious role in the operating theatres; they arrive as relatively independent individuals, and I meet the person briefly before he or she is anaesthetised. Patients are then rapidly transformed, being connected to electronic

monitoring, attached to drips and infusions, rendered unconscious, and responsibility for this vulnerable body is redistributed amongst doctors, nurses, technicians, auxiliaries, computerised technology and mundane artefacts. Once anaesthetised, however, patients do not become passive and homogenous; they continue to exert their specificity and particularity in their bodily condition and the interventions he or she requires. A simple example of this is how an extremely nervous patient may require significantly more anaesthetic to induce unconsciousness; more complex examples come in the form of a lengthy and intricate medical history of chronic disease in multiple systems, requiring a vast range of adjuncts and specifications to routine care.

Following surgery patients gradually reclaim their independence on a piecemeal basis, first breathing, then consciousness, speech and so on; a process that may continue long after the patient has been discharged from hospital. As a nurse in Recovery one can witness this initial re-emergence of the person. For me, working in recovery also has the advantage of greater autonomy, by working closely with the anaesthetists but not under their direct supervision. The patient is in a state of intense transition, moving from unconsciousness to consciousness, having been cardiovascularly destabilised by surgery, and their awareness of pain changing rapidly with their level of consciousness. This short period of instability requires concentrated nursing support, the recovery nurse must ensure that the patient's blood loss has been controlled and compensated for, their level of consciousness is adequate and not overly affected by the sedative effects of pain relieving drugs, and indeed that the measures taken for pain relief are adequate. Then there are the specific complications related to every surgical procedure for which the recovery nurse must be aware and

vigilant; vascular surgery, for example carries an elevated risk of dislodging a fat embolism and incurring a stroke. However, by taking primary responsibility for a patient in this brief period of time, the nurse is in a position to specify the interventions required, an ability denied to the anaesthetic nurse because the anaesthetist assumes principal responsibility. So in recovery I can act, I can say 'this patient requires more pain relief', I can obtain a prescription and administer it, if I think the prescribed drug inappropriate I can request a different one. In anaesthesia the anaesthetist decides and administers – I can only assist and suggest, but this rarely causes a problem.

I find it interesting how the distribution of roles and responsibilities has developed in theatres, how the boundaries of one's practice are formed, maintained, extended, and remain relatively constant, and yet, always susceptible to change. How is it that the anaesthetic nurse, in addition to assisting the anaesthetist, also takes responsibility for the diathermy, operating table attachments, the operating lights, pressure relieving devices, warming aids, and additional surgical devices such as insufflators, cameras and screens used during laparoscopic surgery. 'Scrub' nurses relinquish all claim to these duties, instead, in addition to their core duty of preparing and accounting for the surgical instruments, they complete the operating theatre register, coordinate the pace of the operating list by sending for the patients, and undertake the majority of the theatre cleaning. Sometimes these roles overlap, but there is the potential for a much greater merger, yet these role divisions, while they rarely receive explicit attention, seem to endure.

I am left wondering about the relationship of these elements I mention: the patients, the anaesthetic machines and the monitoring, the 'kit' and equipment, the team of practitioners, and the ways in which work is divided amongst them. I am inquisitive about how these elements intersect with knowledge and with action: how is knowledge generated, by whom and how does this enable one to act, and conversely, what are the limits, the restrictions, those factors that inhibit knowledge production and action?

Understanding anaesthesia:

from nurse to researcher

Working as a nurse in the operating theatres means doing one or two of three roles: anaesthetics, scrub, or recovery. 'Anaethetics' primarily involves working on a one-to-one basis with an anaesthetist to prepare a patient for both anaesthesia and surgery, and to administer and maintain anaesthesia. This entails applying of certain methods of monitoring, and inserting 'lines' and cannulae to gain access the patient's circulatory system. After inducing unconsciousness, the selection and insertion of one of the various airway devices is required, and connecting this to a ventilator and gas supply provides a secure means of ventilation. Then, working with the unconscious body of the patient to alleviate the effects of surgery, for example, administering pain relief, compensating for blood loss, and loss of body heat. And there is a need to protect the patient whilst their own protective reflexes are disabled, this involves such activities as ensuring that their limbs are safely positioned, their eyes are closed, and that areas of the patient's body exposed to pressure are couched in protective gel pads.

Much of this work takes place in the anaesthetic room; it is a small and intimate setting that engenders close working relationships and an appreciation of the

intricacies of one another's roles. Considering the close nature of the work, the combination and variation in practitioners is perhaps surprising. For example, in a morning I might be rostered to work in General Surgery, it may be with a consultant anaesthetist of 25 years, and the General Surgery scrub team and surgeons; in the afternoon I may be working in a different theatre, the Trauma theatre, with a 'trainee' anaesthetist of one or two years, who might be working alone, or be accompanied by a consultant or a more experienced 'trainee' of 6 or 7 years, there will also be the orthopaedic surgeons and the Trauma scrub team. This mix of knowledge, skills, experience, and abilities makes the work interesting; to share the experiences of an anaesthetist and to see how those experiences shape their practice, and to watch how they develop as clinicians. As I mentioned in the preface, it is also the involvement with the patient that interests me about this work, learning about how to care for an unconscious patient in terms of providing for the interconnecting systems of the body. This work, in a sense, involves acting as a guardian for a vulnerable, unconscious patient.

Once in theatre, it is a more open forum with many different practitioners simultaneously engaged in many different activities. The anaesthetist will be concerned with monitoring the patient and maintaining anaesthesia. The anaesthetic nurse will assist the anaesthetist, but will also be involved in safely positioning the patient for surgery, setting up and connecting surgical devices such as diathermy, suction, microscopes, and screens for laparoscopic procedures, and will continually be adjusting the direction of the operating lights. The surgeon will be operating, and the scrub nurse will be involved in preparing and maintaining a sterile 'field', and in accounting for all the surgical instrument and accessories. The circulating nurse's

task is to provide for the scrub nurse, to open packets of swabs, needles, and instruments so the scrub nurse can retrieve the sterile contents of the packages; the circulating nurse will also complete the theatre register, in liaison with other members of the team, will send a porter to collect the next patient, and between each operation, will clean and prepare the theatre.

The 'scrub' role, admittedly, does not hold my interest in the same way as anaesthetics and recovery. Undoubtedly, the scrub role can be as difficult, and is as important, as any other theatre role, but there does not seem to be that same connection and responsibility for the patient; a scrub nurse will rarely meet a conscious patient in the course of their work, only on those occasions where the surgery is carried out under a local or regional anaesthetic. Also, their focus is, in the first instance, to control, prepare and account for the swabs, instruments and needles; they attend more to the trolleys of sterile equipment than to the patient. For me, this apparent distancing between the practitioner and the patient is too far removed from my occupational position as a nurse.

'Recovery', however, comes the closest of operating theatre roles to exemplifying 'nursing'. 'Recovery' responsibilities begin when the anaesthetist hands over the care of the patient to a recovery nurse. This will happen at the end of the operation, either in the theatre or in Recovery. In most cases the patient will be 'breathing spontaneously', this means that if the patient has been intubated (in which a tube is placed through the vocal cords and into the trachea), paralysed and ventilated during the surgery, the paralysis must have worn off, the tube removed, and the recovery nurse must be able to observe the patient breathing adequately. Other methods of

airway management, such as the use of laryngeal masks, does not require paralysis as they are not as 'stimulating', in that they won't make the patient cough. In this case patients can still be quite deeply unconscious, with the patient's breathing requiring support rather than substitution, when the recovery nurse accepts responsibility. As a recovery nurse, I will monitor and assist the patient, as he or she regains consciousness and reclaims their protective reflexes. In a sense, working in Recovery means continuing the anaesthetist's work in alleviating the effects of surgery; in stabilising the patient cardiovascularly, replacing lost fluid, assessing their kidney function, addressing their needs for pain relief, marshalling the patient through a period of intense transition until stabilised to a degree that their care no longer requires one-to-one nursing and it is safe for them to return to the ward.

The recovery role is the only one in operating theatre practice that involves taking independent responsibility for a patient. However, there seems to be a greater sense of teamwork in Recovery than in Anaesthetics. The recovery environment is a large open room divided into 'bays'; areas equipped with monitoring, oxygen supply, and suction; and although one nurse will care for one patient, the more experienced staff will also supervise and assist the newer team members, and staff are routinely drawn into the care of another's patient, for example, repositioning a semiconscious patient after major surgery and changing the bed linen can require up to four of five people; and when a patient, cared for by an operating department practitioner (ODPs), requires pain relief, this will need to be administered by a nurse, as ODPs are not 'registered'. ODPs, who have undertaken a two year practice-based course, perform the same roles as nurses in the operating theatre, and although historically they have tended to work primarily in anaesthetics, this distinction is now less clear. It seems to

be only in Recovery there remains some differences in roles but, again, these are becoming eroded with hospitals making local arrangements regarding the extent of ODP's responsibilities, and with national initiative such as the 'Agenda for Change'(2003), nurses and ODPs are moving towards parity in promotional and financial terms.

Changing perspectives

I had worked as an anaesthetic and recovery nurse for approximately 5 years when I was invited to join a research team interested in exploring the development of expertise in anaesthesia. From the consultant anaesthetist in the team I learned that certain changes in the scope of anaesthetic practice, and to the working conditions of 'anaesthetic trainees' (medically qualified doctors who have then embarked on a seven year programme of work and education in anaesthesia), may potentially jeopardise the development of expertise.

Workloads had been increasing as a result of developments in the range of services offered by anaesthetic departments (NHS Executive, 2000); in addition to providing general and regional anaesthesia for operative procedures, anaesthetists are also primarily involved in the provision of high dependency and intensive care, obstetric epidural services, and acute and chronic pain management. Anaesthetists will also provide anaesthesia for painful non-surgical procedures such as cardioversions (in which abnormal heart rhythms are converted into normal rhythms by administering an electric shock) and electroconvulsive therapy, they will be called upon to assist in the management of cardiac arrests across the hospital, and in Accident and Emergency

departments for cases of major trauma, or where the patient requires high dependency or intensive care.

However, changes to the working conditions of junior doctors, consequences of the 'New Deal for Junior Doctors', restricted the amount of time 'trainees' spent in hospital, therefore reducing both the training and the service delivery elements of their work (Simpson, 2004). These restrictions presented difficulties in meeting the required level of 'in hours' training and supervision junior doctors should receive, and for the continued delivery of 'out-of-hours' emergency anaesthetic services, which was primarily undertaken by trainees 'on-call'. The impending implementation of the European Working Time Directive, which will introduce a 58 hour working week for all hospital employees in August 2004 (www.dh.gov.uk, 2004), will further reduce the working hours of junior doctors and exacerbate these difficulties in meeting the demand for anaesthetic services. Coupled with this reduction in the number of hours trainees worked were changes to the structure of anaesthetic training programmes, which was moving away from the traditional apprenticeship-style training that incorporates a service delivery element (Ellis, 1995), and becoming more focussed on observable and measurable compentencies (Royal College of Anaesthetists, 2000).

The concern for the research team, then, was that opportunities to develop expertise, and in particular, tacit knowledge, were being marginalised. Tacit knowledge would seem to be passed on through person to person contact and developed only by practise (Collins, 1992), consequently, if the apprenticeship-style training was being diminished, then the opportunities it provides for developing expertise would also

diminish. Therefore, as a research associate, I joined Andrew Smith, a consultant anaesthetist, and social scientists Maggie Mort and Catherine Pope, to propose we:

> observe, describe, and define expertise in anaesthetic practice, and to trace how it is acquired during the anaesthetist's education. (Smith et al, 2003a: 319)

The study[1] adopted an ethnographic approach grounded in detailed real-time observation, and followed by a series of in-depth interviews. The emphasis of the observation was to capture the details, particularities and demands of anaesthetic work that have tended to be missed in textbook accounts of anaesthesia, for example, the ways in which anaesthetists develop personal routines and practices, and their particular ways of performing a certain technique. The interviews were similarly focussed on practice, sometimes being quite general and exploratory in nature, and sometimes being focussed on a recent period of practice or a specific critical incident, indeed on two occasions we 'debriefed': tape recorded interviews using the observation transcript as an aid for reflection. With a remit to observe anaesthetic practice in its various forms and environments, and to discuss the processes by which anaesthetists have developed their styles, it was my responsibility to organise and engage in the fieldwork. In this I was guided by Mort and Pope, who between them shared seven of the 33 observation 'sessions', and with Mort also undertaking four of the 19 interviews, and conducting with me, the two 'debriefs'.

[1] Funded by the NHS North West R & D Fund (project grant number RDO/28/3/05).

Engaging in social science fieldwork, and changing my clinical role for research position, in a community of which I was already part, provoked some ethical difficulties for me. My main concern was about the potential exploitation of working relationships I had developed before the research began, in that anaesthetists might disclose to me things that they would not to an 'outsider'. I discussed these difficulties further in an article 'Ethics and ethnography: an experiential account' (Goodwin et al, 2003). I consider in greater depth the funded project design and its relationship with my own research in Chapter Two.

The point to note here is that as a result of the 'expertise' project we argued that expert practice centred on the complex and subtle aggregation of many different types of knowledge. Textbook knowledge, although a vital component of competent practice, was insufficient for the development of expertise which demonstrated an implicit understanding of the mediated nature of patient information and hence the uncertainty inherent in anaesthetic work (Smith, 2003a). For example, the electronic monitoring provides a dimension of understanding the patient, which is not available from clinical observation alone, but also introduces opportunities for misunderstanding:

> So-called 'artefacts' as a result of problems at the patient-machine interface or interference from other equipment are common, and so anaesthetic monitoring must be *'translated'* and *interpreted* in the light of other sources of information. (Smith et al, 2003a: 323, my emphasis)

So significant was this aspect of anaesthetic work that we argued

> that the skilful use of electronic monitoring depends critically not on the availability of the monitors, nor on their attachment to the patient, nor on reading numbers off a screen, but on anaesthetists' ability to make sense of the information the devices offer. (Smith et al, 2003b: 1076)

We observed how 'normal' and 'abnormal' readings were constructed in the balance of, and integration with, the other sources of information available to the anaesthetist such as the medical records or through clinical examination. Confidence and scepticism in the readings was also built in this way. Furthermore, we noted an apparent redundancy of information in the form of monitoring alarms wherein they would frequently be ignored. This would often be the case when the alarms signalled a change that the anaesthetist had already anticipated, such as the patient ceasing to breathe after administration of a certain drug. With the anaesthetist anticipating the cessation of breathing, and being already alert and attentive to this issue, the information conveyed by the alarm is rendered redundant. Consequently, we argued:

> when trainee anaesthetists begin to learn about monitoring they start with the formal, 'official' presentation of monitoring as not only fully functional (which is a justifiable belief) but also completely reliable (which is not necessarily true as they have yet to learn the skills that make it so). Only when they start to assimilate the tacit, experiential knowledge of anaesthesia from expert practitioners does their relationship with monitoring change. (Smith et al, 2003b: 1077)

We therefore felt that:

> The tacit knowledge underlying the safe use of monitoring deserves greater acknowledgement in training and practice. (Smith et al, 2003b: 1070)

We further proposed that expertise depends on its social context and so is vulnerable to changes in that context, which then led us to question how the 'complex and subtle aggregation' of 'context specific knowledge' is achieved? We identified three predominant routes:

i) *Working with experts:* We observed examples of the passage of knowledge from consultant to trainee such as a consultant insisting that a trainee try his technique, and practise it repeatedly throughout the morning.

ii) *Working alone:* This allows elements of the situated, context-specific knowledge to become embedded in personal practice. Consequently, we argued that knowledge is not simply *transferred* from the expert to the trainee; it is *'worked on'* by the learner and incorporated into his or her practice.

iii) *Development of flexible routines:* In this we suggested that practitioners moved from a piecemeal process of collecting and practising knowledge to a more structured, coherent, and individualised approach to anaesthesia. Routines, we suggested, could almost be regarded as 'route maps' which set out the expected course of an anaesthetic. Against this background of routine, unexpected events are highlighted and therefore can be recognized more readily. We observed how a routine can help a trainee learn: when the flow of the routine is disrupted, it highlights the gaps in the knowledge of the inexperienced practitioner. By incorporating learners into the routines, and making them breach the gaps in the routines, implicit

knowledge is made visible. These findings, we felt, had significant implications for the training of anaesthetists; we were concerned that:

> the restrictions placed on trainees working independently, and the over-emphasis on supervision, may hinder the development of coherent but individualised approaches to anaesthesia. (Smith et al, 2003a:327)

Moreover, we noted that as we presented the observation transcripts back to the research participants they found this a useful self-assessment tool. After one particular observation period in which I documented a 3 hour period of critical care, the anaesthetist asked me for a copy of the transcript. We subsequently 'debriefed' using the transcript as a tool for reflection. This prompted us to suggest that qualitative observational data collection methods might be of use in the training of anaesthetists (Pope et al, 2003), a suggestion accepted by the Royal College of Anaesthetist's 'Education Strategy Committee' which then proposed to include 'observation' as a competence in 'The Certificate of Completion of Specialist Training in Anaesthesia IV: SpR Years 3/4/5' and in 'College Tutors' training days' (Personal correspondence, Bowman, 2002).

Questions of 'action'

My involvement in the 'expertise' study taught me about how knowledge changes in content and form as it passes from person to person, to research paper or book, to machine or device, and back to practice as a standard, protocol, or embedded in a

routine. I came to understand how 'knowledge' in practice is thoroughly *embodied* and *situated*; a particular technique performed by one anaesthetist may yield entirely different results as the same technique in the hands of another anaesthetist. And I began to appreciate how knowledge and expertise can be seen as an effect of a particular configuration of persons, routines, environments, machines, tools and devices.

However, for me, questions remained around how knowledge relates to action, which participants 'act', in that they contribute to shaping the trajectory of an anaesthetic, how do they do so, and how is this recognised? These are questions of increasing significance in the light of 'evidence-based medicine' (EBM). EBM is the principle that the selection of health care interventions is based on research findings which testify as to their effectiveness; a principle that has now attained the status of a 'movement' and is endorsed in NHS policy (Harrison, 1998). In this sense 'evidence' refers, preferably, to the aggregated results of medical research. A 'hierarchy of evidence' ranks the studies by their design and judges their worth, in terms of the 'validity' and 'reliability' of the knowledge they produce (see Shekelle et al, 1999). EBM, then, assumes a 'rational' conception of knowledge in which knowledge is generated scientifically and then *applied* in practice. However, my experience as a nurse, and my work on the 'expertise' project, undermined this conception as too simplistic.

'The problem of expertise in anaesthesia' project emphasised how a rational position prioritises explicit and measurable knowledge whilst marginalising the role of tacit knowledge, and our study concentrated on the effects of this for the training of

anaesthetists. The 'rational' perspective, in which action follows directly from evidence, marginalises the other components and considerations of practice. And as a nurse I understood how much patients affect and constrain the way in which practitioners can act, and yet, being unconscious for the most part, patients are rarely considered as 'agents' contributing to the shape of anaesthetic care. My involvement in the 'expertise' study sharpened my awareness of how anaesthesia provides a particularly interesting position from which to interrogate the relationship of evidence, patients, machines, and practitioners. By inducing unconsciousness, disabling speech, and intervening in the ability of the body to autonomously regulate itself, anaesthesia plays with the characteristics usually assigned to an actor. Anaesthesia configures a relationship between humans, machines and devices that transforms and redistributes knowledge and agency, and stands in contrast to the figure of a rational, intentional agent. This juxtaposition enables one to question the assumptions a 'rational' position invokes and to scrutinise the conditions necessary for action. How then the anaesthetist is seen to plan, prescribe, and execute a course of anaesthetic care, is a process that requires some elaboration. Accepting that 'evidence' is not the sole, or even the foremost, determinant shaping the delivery of anaesthesia, and that patients may, or rather *will*, contribute to the trajectory of their anaesthetic, means that the work of an anaesthetist is not immediately transparent.

Being a nurse in anaesthetics and recovery, and returning to this work following the completion of the 'expertise' project, I was acutely aware that the activities of nurses and ODPs also contributed to the particular shape and quality of anaesthetic care. This distribution of work between anaesthetist and nurse or ODP, the level of energy these practitioners exert in shaping the course of anaesthesia varied from person to

person, and the way professional boundaries of practice were enacted also affected the unfolding course of anaesthesia. Furthermore, work as an anaesthetic nurse, involves developing an intimate knowledge and awareness of the 'kit'; the specific features, characteristics, purposes, possible uses, techniques of handling, and availability, of the devices used in anaesthesia. The availability of a piece of equipment, and the skill of the user, could radically change the path an anaesthetic trajectory might follow. The possibilities afforded by artefacts and devices, therefore, also have a bearing on how 'action' might be constituted. It seems then, that in the combination of these elements, 'action' emerges as the tangible product that serves to cloak its multifaceted constituents. It is this intersection of knowledge, humans, technology and devices that interests me, and how these elements are implicated in action that I examine in this thesis.

The possibilities and limitations of participants' actions become significant when considered in the light of recent efforts to reconfigure the delivery of anaesthesia. Regarding the changes, mentioned above, to the working conditions of doctors, Seymour (2004), a representative of anaesthesia's Patient Liaison Group, observes that 'there is already a shortage of anaesthetists and crisis point approaches in less than six months time'. Furthermore Simpson, the President of the Royal College of Anaesthetists (RCA), comments:

> At present, it feels as though there is a gradual progression to an ultimate meltdown of a safe anaesthetic service. This is because of a combination of greater demand, reduced junior doctors hours and no rationalisation of the out-of-hours service. (Simpson, 2004:3)

Potential resolutions to the impending 'crisis' currently under consideration by the RCA, chiefly revolve around changes to the training of anaesthetists to improve flexibility and accessibility, and around the reconfiguration of the service so as to redistribute some responsibilities and duties to specialist practitioners. Specifically, the redistribution of anaesthetic work refers to such changes as the epidural service being provided by midwives rather than anaesthetists, the development of new non-medical specialist roles in intensive care such as 'respiratory therapists', and the development of new non-medical roles in the delivery of general anaesthesia. Despite the prevalence of 'nurse anaesthetists' overseas, it is this prospective development that has engendered the most controversy. Even so, a trial of this option is currently underway with two UK hospital trusts recruiting non-medical anaesthesia personnel from oversees (NHS Modernisation Agency, 2003). Given the proclivity for reconfiguring the work and practices involved in the delivery of anaesthesia, it seems vital to understand how work and knowledge are currently distributed amongst an anaesthetic team, and when this knowledge may legitimately be taken as the basis for action.

Furthermore, if the determinants of action are distributed amongst a range of human participants, machines and devices, this then suggests that current configurations of accountability, as conceptualised in codes of professional conduct, are possibly inequitable. Codes of professional conduct tend to tether accountability to discreet and precise actions, and to particular practitioners, which means that specific participants are held to be responsible for events authored by multiple actors. This, in turn, suggests that a potential re-examination of the distribution of accountabilities is needed.

Exploring 'action' in anaesthesia: an outline

I begin my examination of how action is effected in anaesthesia by considering the role of EBM. I discuss the particular form 'evidence' takes in a context of EBM, its methods of production, and the values and potential this kind of evidence has for shaping practice. I then focus on the availability of this form of evidence for anaesthetic practice and discuss specifically what is involved in the utilisation of this evidence. This leads me to consider where evidence seems to be absent, the explanations offered to account for this, and how anaesthetic practice proceeds both with and without evidence.

In Chapter Two, I evaluate my own position in relation to epistemology. I discuss my reading of Haraway's (1991) 'situated knowledges' and consider how to conceptualise this as an epistemological framework for my research. Here, then, I discuss my own activities in producing knowledge; I debate how the approaches of ethnography and ethnomethodology have guided my inquiry and the degree to which 'The problem of expertise in anaesthesia' project shaped the design of my data collection and analysis. I give an account of my experience of fieldwork and discuss the two specific methods of data collection I used, observation and interviewing. I then outline my process of data analysis, I attempt to clarify how I generated my fields of interest, where my analysis departs from that of the 'expertise' project, and how I have used theoretical resources to examine my data. The chapter closes by identifying and debating some of the tensions inherent in the research and the claims I can make on the basis of it.

In Chapter Three I move on to analyse my data and begin by considering the role of the patient and the anaesthetic machines. I begin here because the patient, being unconscious and rendered speechless, can easily be overlooked, or considered absent, construed as the object of knowledge rather than an active participant in events. Atkinson (2002) analyses the relationship between medical technologies and patients' bodies, conceptualising the machines as 'technologies of inspection', interrogating the body and disaggregating it into signs and representations to be read by competent observers. Whilst this usefully elucidates how technology mediates knowledge of the body, in this configuration, the patient as a unique individual is almost deleted, is rendered a passive object of knowledge, and stripped of any agency. In some cases it may be this construction of the patient as a passive object that enables certain health care practices. Hogle (1999) has argued that organ transplantation practices mandate mechanisms that change the conception of the patient, that *depersonalise* the patient. She suggests that in attending to the medical technology a donor requires in intensive care, personhood and identity are progressively filtered out. However, I contend that in anaesthesia the patient is very present, and a very active agent in the unfolding performance of anaesthesia. In this chapter I grapple with how to conceptualise and articulate the contribution the patient makes.

I suggest that it is the union of the patient and anaesthetic machine that affords the patient a form of agency; the anaesthetic monitoring in particular offers a route of expression for the patient. In this I respond to Poovey (1987) who suggests that anaesthesia administered to ease the pain of childbirth during the Victorian period 'silenced' the female body. Moreover, following Latour (1999), Haraway (1997) and

Suchman (2000) I find the interface between human and non-human provides a vantage point from which to elucidate these various forms of agency, and to investigate the distributive character of speech, and actor's differentiated capacity for articulation. In Chapter Three, therefore, I question what is involved in establishing this relationship between patient and anaesthetic machine, and how, in being technologically reconfigured, the patient is furnished with new communicative resources.

Chapter Four focuses on the role of the anaesthetist, in particular how the anaesthetist crafts a situated and dynamic account of a clinical situation that both renders the situation intelligible and in doing so indicates an appropriate course of action. This work involves aligning the information offered by the monitoring with other sources of information such as the medical records and the anaesthetist's clinical examination. A predominating feature of this work is assessing the significance of the various elements that compose the accounts; the anaesthetist must adjudicate on the salience of the elements and must deliberate on how safe it is to include or exclude them from the account. It is this 'legitimation' work, I propose, that provides a lead for action.

To elucidate this process of crafting an account, or multiple accounts, and the legitimation work, I use Law's (1987) notion of 'heterogeneous engineering', and draw on Berg (1992) and Mol (1998) to develop the notion that heterogeneous engineering involves not only enrolling elements into a coherent account but also dispelling disparate elements from the account. Mol's conceptualisation of *performativity* elucidates how the links between the elements will begin to decay unless re-enacted; an account of a clinical situation, therefore, will hold only for as

long as it is being performed. In line with Berg and Mol I argue that the purpose of making these links, assembling these heterogeneous elements to tell a particular story and generate a situated interpretation of events, is to suggest a set of practical actions. Given that these strategic, purposeful accounts direct a subsequent course of action, their legitimacy must be demonstrable. Here, I propose that the more radical the intended course of action, the more work is needed to legitimate the interpretation.

In Chapter Five I examine the participation of ODPs and anaesthetic nurses in anaesthetic work. I explore the processes that regulate their involvement, the consequences this has for the generation and distribution of anaesthetic knowledge, and how the form and character of knowledge a practitioner develops and utilises affords particular levels of involvement. The continual negotiation of the distribution of work and knowledge between doctors and nurses means this boundary has remained a current and controversial subject for sociological analysis. I discuss some of the ways this boundary has been theorised: as 'ecologies of knowledge' in which the character of knowledge each professional group develops and utilises is a consequence of their daily work experiences (Anspach, 1987), as a 'negotiated order' (Svensson, 1996) in which nurses are in a unique position with knowledge that doctors depend on, and as the 'boundary-spanning' activities that nurses perform, making decisions using doctors tools, co-ordinating the movement and activities of doctors, and engaging in activity that resembles medical 'diagnosis' (Tjora, 2000).

This discussion outlines how the knowledge and practices of nurses are shaped and defined by disputes and constraints on practice, and tacit arrangements as to the boundaries of their responsibilities. I explore this theme further using Lave and

Wenger's concepts of 'legitimate peripheral participation' in 'communities of practice'. Legitimate peripheral participation refers to the 'centripetal' involvement of the individual; the process whereby newcomers move through varying levels of participation, their identity evolving as they do so. Increasing levels of participation furnishes them with different perspectives from which to interpret practice. A 'community of practice' is the setting that provides the newcomer with the resources with which to interpret this practice. Only by participating in practice can newcomers access these learning opportunities and resources.

One of the most important learning resources Lave and Wenger identify is the legitimacy of the learner to participate, and they suggest that the level of legitimacy conferred is strongly related to the degree to which the different identities are forged. This draws attention to the integral role *access* plays in the generation of knowledge. I suggest that the legitimacy of an individual's participation in anaesthetic practice is *stratified* in line with the professional identity to which they aspire. Tensions develop when practitioners stray outside accepted boundaries and the legitimacy of this practice is disputed. Averting these disputes requires continual reinforcement of the boundaries between ODPs, nurses, and anaesthetists. However, a consequence of the structural limitation of legitimate peripheral participation is that it caps the ability of ODPs and nurses to interpret a patient's condition; they become disadvantaged in terms of resources with which to account for a clinical sitatuion, and hence to influence the care of that patient.

In Chapter Six I examine the particular and specific ways in which the tools and devices used in anaesthesia are operated in the routine delivery of anaesthetic care. I

follow a line of debate in which Heath et al (2003) have argued that there still exists relatively little research concerned with the ways in which material resources and artefacts feature in the day-to-day delivery of healthcare. This reflects Button's (1993) critique of Science and Technology Studies (STS). He argues that in spite of a proposed interest in the technology it often seems that, far from being visible, the technology vanishes becoming instead one of the many arenas in which to view the manifestation of themes such as economics or gender relationships in society. Button (2000) suggests drawing on ethnomethodology to guide the analysis of practices that constitute the use of the technology. Principally, this involves the explication of 'members' knowledge'. According to Button, attending to these practices, and the knowledge and rationales that inform them, preserves the technology, and how it features in day-to-day work, at the forefront of the analysis.

Thus, I draw on ethnomethodology in my analysis of the tools and techniques of anaesthesia and propose that a significant component of an anaesthetist's members' knowledge is an acute and intimate understanding of the particularities of tools, devices, and a surgeon's techniques and habits. An awareness of how a particular surgeon operates enables an anaesthetist to anticipate their requirements, making for a smooth and efficient anaesthetic service. Moreover, understanding how a specific tool performs, affords the anaesthetist the opportunity to manipulate the tool, to develop practices that utilise the tool to best effect, for example, working out the best position from which to use the tool in a given situation.

Developing this awareness of the specificities of anaesthetic practice, an anaesthetist cultivates a body of 'normal appearances' (Sacks, 1972). I discuss how the form,

position and configuration of both humans and devices are significant elements in constituting this body of expectations. Moreover, set against this body of expectations, any departures from the 'normal' are more immediately visible; in becoming accustomed to the 'normal appearance' of a given situation one can recognise more readily the 'abnormal' or missing. This serves as a resource to anticipate, identify and prepare for, or avert, problems should they arise.

Finally, I conclude by discussing the claims I make and their relevance; I consider how the analysis I have undertaken connects with current debates in STS, medical anthropology and medical sociology; I reflect on the implications of my work for the prospective reorganisation of anaesthesia; and for health care practitioners more generally, accepting their need to account for their work, I contemplate the equity of current configurations of accountability.

Chapter 1

Guiding action: the lead of Evidence Based Medicine

A key underlying assumption of EBM is that not all evidence is equivalent

(Dopson et al, 2003:312)

Implicit in the logic of 'Evidence Based Medicine' is an assumption that 'evidence' will elucidate the most effective treatment option, which will then be implemented in practice, and further that this 'integration of best research evidence' with clinical practice 'optimizes clinical outcomes and quality of life' (Sackett et al, 2000:1). I examine what exactly constitutes 'best research evidence' and question whether it is, or should be, the predominate determinant of action. In the first part of this chapter, therefore, I look at the forms of 'evidence' with specific reference to how they are played out in anaesthesia. I then discuss how precisely 'best research evidence' informs action, in the sense of guiding anaesthetic interventions.

Constructing and locating *trustworthy* evidence

The randomised controlled trial (RCT) is frequently cited as the 'gold standard' within medical research (Pope, 2003:269); by randomly allocating patients to a

control and intervention group, and doing so in such a way that neither patient nor practitioner knows to which group they are assigned, the methodology is held to measure the differences between the groups and ascertain the effectiveness of the intervention. When informing treatment decisions, the RCT is surpassed in the 'hierarchy of evidence', a scheme for classifying the 'strength' of evidence (see Shekelle et al, 1999), only by the aggregated results of several RCTs:

> Because the randomised trial, and especially the systematic review of several randomised trials, is so much more likely to inform us and so much less likely to mislead us, it has become the 'gold standard' for judging whether a treatment does more good than harm. (Sackett et al, 1996:72)

When practitioners seek guidance from research evidence on treatment options, the most trustworthy source, the one least likely to mislead, is held to be the systematic review of RCTs: a method of systematically searching, critically appraising and synthesising research findings.

Of the 48 protocols (reviews in progress) and systematic reviews listed in the anaesthesia subject area of the Cochrane Library, all consider RCTs in preference to other types of studies. This, coupled with the explicit and rigorous methods by which studies are included, excluded, and 'synthesized', attests to the trustworthiness of their recommendations. Moreover, being collated and presented by the Cochrane Collaboration, an organisation initiated by Archie Cochrane, a British epidemiologist, and early advocate of using the randomized controlled trial to test the effectiveness of medical interventions (Pope, 2003), reinforces this authority.

Browsing through the Cochrane Library one is impressed by the 'scientificness' (Berg, 1997) of the evidence production. The reviews are organised by a standardised template listing title; authors; amendment dates; a citation instruction; abstract; background; objectives; inclusion criteria for the reviewed studies; the search strategy; methods of the review process; a description of the studies included and their methodological quality; results of the review; discussion; reviewers' conclusions; acknowledgements; potential conflicts of interest; tables detailing the characteristics of studies included and excluded; references and graphs. The bulk of the review is, therefore, given over to the methods of its production, emphasising its methodological quality. The selection and arrangement of evidence in systematic reviews is precise, with the reviewers clearly distinguishing between the process and the results of the review, and their recommendations. The recommendations section seems to be demarcated as a place for the reviewers' opinions about the relevance of their 'findings' for both practice and further research. Once familiar with the standardised format, a clinician can readily locate such details as how current the review is, the results, and the recommendations of the reviewers. This format, then, is elegantly and skilfully stylised so as to appeal to both scientific norms and the practising clinician. The Cochrane Library, however, functions as a site of evidence production and as a repository of evidence, it is relatively passive in terms of shaping the evidence for implementation; the onus lies on clinicians to consult it and incorporate the recommendations into practice. It leaves the details of aligning evidence and practice to be worked out by the individual clinician.

The 'Clinical Evidence' site of the National Electronic Library for Health aims to summarise 'the current state of knowledge and uncertainty about the prevention,

treatment, and diagnosis of clinical conditions based on thorough searches and appraisal of the literature.' It specifies that its purpose is to act as neither a textbook of medicine nor a set of guidelines; rather it aims to describe the best available evidence, should this exist. The resource, however, warns of the limitations involved in its presentation of evidence: making summaries involves discarding detail, and global statements cannot apply to every patient. Furthermore, the user is advised to interpret its estimates of treatment effectiveness as optimistic, in the acknowledgement that RCTs often secure better compliance with treatment and 'more favourable outcomes than occur in the real world' (Clinical Evidence Concise, 2002:xi).

The 'Clinical Evidence' resource translates research findings into 'categories of effectiveness', a process which is by no means straightforward. The categories represent a mix of several hierarchies: the level of benefit (or harm), the level of evidence (RCT or observational data, for example), and the level of certainty around the finding (represented by the confidence interval) (Clinical Evidence Concise, 2002). Explaining these details, the producers of 'Clinical Evidence' concede the limitations and 'blind spots' of this 'synthesised' form of evidence. Although maintaining a dominant position for aggregated evidence in guiding treatment decisions, Clinical Evidence does acknowledge that evidence syntheses are not *complete*, and recommendations will therefore not *universally* suit all patients. This, then, allows some opportunity for other considerations, knowledges, logics, rationalities, and bodies of evidence to also inform the selection of healthcare interventions.

Incorporating such other considerations into the evidence production process is officially within the remit of the National Institute for Clinical Excellence (NICE). NICE explicitly acknowledge both its location as part of the NHS and its remit to consider financial resources:

> It is a Special Health Authority and it provides guidance for the NHS and patients on medicines, medical equipment and clinical procedures based on evidence of both clinical and cost effectiveness. (NICE, 2002)

NICE provides 'guidance' in two forms: clinical guidelines and technology appraisals.

Technologies, such as pharmaceutical products, medical devices, diagnostic techniques, surgical procedures, or health promotion initiatives, are selected for appraisal by the Department of Health and the Welsh Assembly Government based on the likelihood of the technology to result in a significant health benefit, its degree of impact on health-related government policies (such as reducing health inequalities), and its significance for NHS resources (NICE, 2002). In the appraisal process, evaluating the research evidence is but one element alongside consultation with stakeholders (national bodies that represent health professionals, patient and carer organisations, and manufacturers or sponsors of the technology) and consideration of their submissions on the grounds of clinical and cost effectiveness (NICE, 2002). The resulting guidance contains details of the circumstances in which the technology is or is not recommended, dates of issue and review, clinical need, implications for the NHS and further research, implementation, clinical audit advice,

sources of information for patients, *and* the 'evidence' itself in terms of the synthesised studies.

As with the Cochrane Library's systematic reviews, NICE's technology appraisals rely heavily on the RCT as the preferred source of evidence for the critical review. However, in also tackling less prestigious subjects such as wound care, which command less publicity, research interest and funding, than perhaps new surgical techniques or new drugs, NICE are compelled to work with other forms of evidence, those lower down the hierarchy. In the case of difficult to heal surgical wounds there is no RCT evidence to support any particular debriding agent (products that breakdown and absorb dead tissue). In the absence of such evidence NICE advise that the choice of debriding agent should be based on 'comfort, odour control and other aspects relevant to patient acceptability; type and location of wound; and total costs' (NICE, 2002:128).

NICE again departs from the Cochrane Library in that where the 'evidence' is inconclusive or absent NICE will suggest advice on how to proceed, whereas the Cochrane systematic reviews tend to record that there is insufficient evidence, propose a direction for new research, and may or may not include the reviewers opinion on how practice should proceed. On these occasions, the 'other' factors involved in decision making begin to attain explicit consideration: the patient's wishes, the suitability of the treatment for the specific condition, and financial implications. Berg (1997b) argues that in medical practice there are many different ways in which considerations are weighed, and coexist. He describes how clinicians have to reconcile the patient's wishes, the scarcity of medical resources, clinical

diagnostic information and criteria, and 'evidence' in the form of statistical calculations and quantitative data. Berg suggests none of these carry more intrinsic value than the others, and that clinicians shift between these logics and prioritise one concern over another as the situation demands:

> It is futile to attempt to 'unite' these different modes of reasoning into one, 'overall' rationality. All logics are partial: there is no rationality without its blind spot. They work in *specific* situations, from *specific* points of view, for *specific* purposes. (Berg, 1997b:1084)

Composing NICE's clinical guidelines again entails consultation with stakeholders, a systematic review and critical appraisal, along with economic modelling, and consideration of patient, carer, and health professional perspectives of the condition and its management. Here, however, the evidence is selected and shaped so as to resemble and accommodate clinical practice, albeit in an idealised form; the guidelines specify recommendations for care in a linear sequence, for example in the case of myocardial infarction prophylaxis (prevention of a heart attack), the guideline specifies which drug, when to start it, the necessary monitoring, details of the continuation of treatment and rehabilitation. An evidence grading is set out and each intervention is tagged with an identifying grade of evidence. For MI prophylaxis, this runs from 'A' corresponding to a meta-analysis of RCTs, through to 'D' which refers to expert committee reports, the advice of 'respected authorities' or an extrapolated recommendation from evidence placed further up the hierarchy. These gradings may vary depending what evidence is available: in the case of induction of labour there are grades A, B, and C of evidence, and good practice points signified by

a tick. Level A refers to 'at least one randomised controlled trial as part of a body of literature of overall good quality' (NICE, 2002), and the good practice points are recommended on the basis of clinical experience of the 'Guideline Development Group'(NICE, 2002). Whereas for pressure sore management, 29 of the 34 steps are based on level 3 evidence: 'Limited scientific evidence which does not meet all the criteria of acceptable studies or absence of directly applicable studies of good quality. This includes expert opinion' (NICE, 2002:129). This mixture of different levels and forms of evidence combined in NICE's clinical guidelines serves to illustrate a comment made by Berg (1997a) in which he notes that decision support tools, such as protocols and guidelines, do not confine themselves to carrying 'rational' knowledge; rather 'political choices' are 'inescapably intertwined with the "knowledges" carried' by the tool (Berg, 1997a: 120). For example, Berg describes how a protocol's construction process will interweave a wide, heterogeneous ranges of elements: in the case of a breast cancer protocol, the number of lymph nodes, a pathological-anatomical criterion, was related to the statistical power of the trial, the workload and habits of the participating centres, the position of other protocols, financial implications, alignment with the scientific literature, and the fate of individual patients.

When under scrutiny then, the assumption that evidence syntheses will elucidate the most effective treatment options, and incorporation of these into clinical practice will result in better clinical outcomes, appears as simplistic. Hence, the closer one examines the specificities incorporated into the guideline, and the more one attends to the way 'evidence' is aligned with practice, the more visible factors such as patients'

wishes, clinical experience, tacit knowledge, clinical resources appear, and the more complex the process of evidence informing action becomes.

> Bringing such choices into sight is especially important since the way these tools are presented hides these implications from view. (Berg, 1997a:120)

The guideline or protocol, Berg (1997b) observes, underwrites the importance of that which it mentions, and contributes to the forgetting of that which it omits. A hierarchy of evidence, therefore, doesn't only attribute more value to one type of research evidence than another, but in omitting other forms of knowledge, evidence and logic, it actually diminishes their worth to the degree that their legitimacy to inform decision making, is marginalised. This, then, is the problem clinicians, and consequently patients, face: EBM prioritises the role of 'evidence' over other considerations. Lacking a *trustworthy* basis, hierarchies of evidence explicitly rank expert opinion at the bottom of a table in which patients' wishes are not even mentioned, hence, where aggregated evidence exists this should be taken as the lead for action. However, the closer one gets to practice, the more intrinsic to guiding action all these elements become.

Practising evidence based anaesthesia

Below I examine the available systematic reviews and clinical practice guidelines for anaesthesia and consider what implementing evidence based recommendations involves in this field. Defining the boundaries of anaesthetic practice, however, is rather problematic. There are systematic reviews and clinical guidelines that

prescribe the management of certain conditions (diabetes, cancers, angina, fractures) which become relevant to anaesthetic practice when patients affected by these conditions require anaesthesia. Whilst it is possible that these reviews and guidelines may recommend one anaesthetic technique in preference to another (see postoperative chest infections below) in general they do not. Therefore, although this evidence may become an additional consideration for the anaesthetist, nurse or ODP, it does not, I think, prescribe the process of anaesthesia to a significant degree. If then, the review or guideline makes no explicit reference to an anaesthetic technique I have made the pragmatic decision that these are peripheral to daily anaesthetic practice, and here I am concerned with what I take to be the core practice of anaesthesia. Nevertheless, the role of clinical guidelines on the margins of anaesthesia is particularly interesting and an issue I will return to below.

My question, then, was where and how does EBM inform anaesthetic practice, and I could only find 12 instances (11 systematic reviews from the Cochrane library and one evidence synthesis from 'Clinical Evidence') where the aggregated, systematically reviewed evidence touches core anaesthetic practice. In these twelve instances then, the evidence comes in the form of systematic reviews that make recommendations for practice. There are no clinical guidelines to advise on the daily practice of anaesthesia, and as discussed, the onus is on the individual clinician to acquaint themselves with this evidence and incorporate it into their practice. So I look now to this 'evidence' and question the way in which it informs anaesthetic practice. I consider what issues a practitioner might face when seeking to implement 'evidence-based' anaesthesia.

Neither NICE (2004), the 'Centre for Reviews and Dissemination' based at York University (2004), nor the National Electronic Library for Health's 'Clinical Evidence' site contain any reviews or guidelines that refer to anaesthesia. 'Clinical Evidence' did, however, include in the index 'perioperative care' which contained one review entitled 'postoperative pulmonary infections' (Smith, 2002). The reviewer asked 'What are the effects of interventions to reduce postoperative pulmonary infections?' and one of two interventions recommended as 'beneficial' in preventing post-operative chest infections is epidural anaesthesia in preference to general anaesthesia followed by opioid analgesia.

When seeking to follow this advice, however, I am confused as to the circumstances in which an epidural is being recommended; obviously, epidural anaesthesia can only be used if the surgery falls within the reaches of the epidural, the technique would be inappropriate for shoulder, arm, head and neck operations. But further, epidurals tend only to be used as the sole means of providing anaesthesia in very limited circumstances, primarily for caesarean sections when the patient already has an existing epidural catheter in place for pain relief during labour. If there is no existing epidural catheter, then a 'spinal' anaesthetic is the preferred option; unlike an epidural in which some sensation and movement is retained, a spinal provides a more 'complete' block, with no sensation or movement from the injection site downwards. Consequently, epidurals are more commonly used to provide *analgesia* alongside a *general anaesthetic.* Epidural *analgesia* is generally thought to be preferable to opioid analgesia in reducing the incidence of postoperative chest infection, but the use of epidurals for postoperative analgesia on a normal surgical ward (rather than in an area of high or intensive nursing care) customarily requires the support of an acute

pain service. Before following this course of action, therefore, the anaesthetist must first consider the environment in which the patient will be nursed.

The Cochrane Library is by far the most extensive 'evidence' resource for anaesthesia containing 11 completed systematic reviews. Two concern anaesthetic drugs; the first aims to elucidate which of two paralysing agents provides the optimal intubating conditions (in which a tube is placed through the vocal cords and into the trachea to facilitate ventilation during anaesthesia). The reviewers conclude that when comparing 'excellent intubating conditions' succinylcholine (the most commonly used drug in the circumstances studied) created superior intubating conditions, however, when comparing 'clinically acceptable intubating conditions' the two agents showed no statistical difference (Perry et al, 2004). Here, then, it is possible to say that as the review endorsed orthodox practice, anaesthetic practice may be considered as 'evidence based'.

The second review considered the use of premedication to alleviate anxiety in day case surgery (Smith and Pittaway, 2004). The concern here is that premedication will increase drowsiness and delay the patient's discharge from hospital. The reviewers, however, found no difference in time to discharge for patients who received premedication but cautioned about making inferences for current day case practice. They highlight that *pre*operatively sedated patients require more nursing care than non sedated patients, which will have an effect on the required ratio of nurses to patients. Implementing this evidence, again, demands the anaesthetist first consider the environment and nursing care the patient will receive.

The third review compares caudal epidural block against other methods of pain relief for circumcision. A 'caudal', injection of local anaesthetic into the epidural space at the level of the sacrum, anaesthetises the section of the body from hip to thigh. The reviewers conclude that the need for 'rescue analgesia', where methods of pain relief are insufficient and need to be supplemented with additional pain killers, is reduced where caudals were performed. However, they do equivocate somewhat, adding that there were few studies on this subject and those they reviewed were poorly designed to the extent that findings from these studies may no longer reflect practice (Cyna et al, 2004).

Review number four examines the research on the use of 'invasive methods' for estimating the needs of patients with a fractured hip for perioperative intravenous fluids. 'Invasive methods' refers to the placement of a catheter into a major vein leading to the heart which enables the measurement the 'central venous pressure', a value from which one can assess the level to which the patient is dehydrated or overhydrated. The reviewers conclude that invasive methods of fluid optimisation may shorten hospital stay, but their effects on longer term patient-centred outcomes are uncertain (Price et al, 2004). The 'patient-centred' outcomes in question are reduced pressure sore incidence, reduced postoperative malaise, more effective rehabilitation, earlier mobilisation and discharge, reduced incidence of delirium, and a reduced need for longer term institutionalised care. The authors caution that:

> Clinicians are vulnerable when seeking to extend short-term results to longer-term patient centred outcomes such as return to previous level of mobility, return to previous level of accommodation and independence in activities of daily living. (Price et al, 2004)

However, in the UK this method of estimating a patient's fluid requirement tends only to be used when a patient is critically ill, or when the loss of large volumes of blood intraoperatively can be anticipated, as the placement, care and removal of a 'central line' carries serious, if infrequent risks of its own. Although the reviewers advise caution when following this lead, it does not at this time constitute the routine treatment of patients with a fractured hip: its relevance for current clinical anaesthesia is therefore limited.

A further five reviews consider techniques of ventilation, four of which pertain primarily to intensive care. In three of the reviews the evidence was found to be insufficient and inconclusive (Hawkes et al, 2004; Petrucci and Lacovelli, 2004;Wunsch and Mapstone, 2004), one found that the intervention was not supported by the evidence (Sokol et al, 2004), and the fifth tentatively recommended a weaning strategy (gradually withdrawing mechanical ventilatory support) although added an 'insufficient evidence' caveat (Burns et al, 2004). Hence, on ventilation techniques in intensive care, the reviews equivocate allowing for practice to be neither evidence-based nor 'counter' evidence.

The tenth review considers the drugs used in spinal anaesthesia and conclude that 'lidocaine' is more frequently associated with adverse effects (Zaric et al, 2004). However, 'lidocaine' is rarely used in spinal anaesthesia in the UK, in which case orthodox practice may continue, confident of being evidence based.

The eleventh and final review considers pulse oximetry, a technology for measuring the percentage of oxygen carried by the blood, as a method of perioperative monitoring (Pedersen et al, 2004). In this case the reviewers conclude that pulse oximetry can detect hypoxic (low oxygen saturation) events but there was no evidence to suggest that this had a bearing on the outcome of anaesthesia. During anaesthesia, problems with oxygenating the patient tend to arise rapidly and are accompanied by an abrupt fall in oxygen saturation, a change that is easily visible by the pallor of the patient's skin and colour of the patient's lips and nails. Possibly, then, pulse oximetry is another instance of the monitoring providing 'redundant' information (Smith et al, 2003b); that of which the anaesthetist is already aware. Moreover, in an editorial in *Anaesthesia,* Saunders (1997) argues that successive monitoring devices are pressed upon anaesthetists with an implicit 'fail to use it at your medicolegal peril', but warns that 'a far more insidious danger' is the misinterpretation of monitoring information. In spite of this quiet concern about the proper use of monitoring, pulse oximetry has become an essential item of monitoring without which it is now considered unsafe to practice anaesthesia. Although the reviewers do not suggest it, following this line of reasoning suggests that pulse oximetry could be potentially detrimental to care. However, to withdraw pulse oximetry from standard anaesthetic monitoring would indeed be a radical, and tremendously contentious, 'evidence based' step.

In contrast to a view that this aggregated and synthesised evidence provides clear, authoritative responses to clinical questions, I find this evidence to be steeped in cautions, caveats, qualifications, considerations and specificities: the reviews on some areas do equivocate (notably ventilation in ICU), some reviews confirm orthodox

anaesthetic practice (in the case of succinylcholine for paralysis, caudal epidurals for pain relief after circumcision, and not using lidocaine for spinals), some cautiously dispel myths (that premedication for day case surgery will delay discharge), and some question the appropriate use of technologies (the circumstances when central lines should be used for fluid optimisation and the effect of pulse oximetry on the outcomes of anaesthesia). In many of these reviews practical questions and considerations, 'practical' in that the queries arise from clinical practice rather than the RCTs they examine, are raised by the reviewers that either qualify their conclusions or caution the use of them. On reading the reviews, rather than just the abstracts, one can find hints and comments on how the recommendations should be interpreted. However, as an 'evidence base' it is admittedly thin and patchy.

Explaining absent evidence

How is this apparent lack of evidence explained by anaesthetists, and how is it managed? Professor Philip Hopkins of the Anaesthetic Research Society explains the situation in terms of insufficient primary research. He argues that the 'Large, expensive studies to determine the best way to manage patients haven't been done' and that this is because of a lack of financial investment (Hopkins, 2001:2). Accordingly, in his description of the current situation:

> Individual anaesthetists are doing the best according to their own experience, whereas what we should be doing is to investigate what is the best, and then disseminating that information so everyone can provide the best for patients. (Hopkins, 2001:3)

Hopkins, therefore, describes a situation in which, owing to the lack of research, what constitutes optimal anaesthetic care remains an unknown, therefore, practice proceeds on the basis of an individual clinician's experience. According to Hopkins, sufficient financial investment in anaesthetic research, once aggregated and processed, would guide the practice of anaesthesia. In this, Hopkins follows a *rationalist* perspective in which knowledge presupposes intent, which presupposes action. However, my discussion of how aggregated evidence needs to be manipulated and supported in order to align it with practice, illustrates how action does *not* follow directly from knowledge. Where 'evidence' has the potential to improve anaesthetic care, in terms of premedication for those day case patients that would like it, and reducing the likelihood of postoperative chest infections by the use of an epidural, implementing these recommendations first requires consideration of the environment and services that support anaesthetic practice.

Nevertheless, the 'lack of primary research, therefore lack of evidence' explanation of the current situation persists. Horan (1997), an anaesthetist writing in *Anaesthesia and Intensive Care,* outlines some of the difficulties in obtaining accurate and relevant scientific evidence in anaesthesia. He locates the source of these difficulties in anaesthesia's uniqueness as a medical speciality. In the 'therapeutic' specialities of medicine and surgery the efficacy of a given treatment can be measured by outcomes such as length of intensive care stay, length of hospital stay, requirement for blood transfusion, and survival measures, whereas for anaesthesia outcome measures are not nearly so discriminating. Horan explains that in anaesthesia the commonest adverse outcomes are minor, such as nausea and vomiting, headache, and sore throat, all

within the range of common human experience. More serious adverse outcomes, death or serious injury, are now rare occurrences in anaesthesia. As the range of 'real' outcomes is limited, 'surrogate' measures are substituted, and the relevance of these measures for absolute outcomes is inferred but not demonstrated empirically. Horan therefore argues:

> The scarcity of information about the effects of anaesthetic interventions on absolute outcome contrasts markedly with the situation in medicine and surgery and limits the application of EBM to anaesthetic practice. (Horan, 1997:681)

Using anaesthesia's uniqueness as a medical speciality Horan seeks to limit the relevance of EBM for anaesthesia deflecting its gaze towards the 'therapeutic' specialities. He suggests that outcomes of anaesthesia are difficult to measure because they are indistinct, however, I find this easy abdication of EBM a little defeatist. The management of postoperative pain, for example, is central to the work of anaesthesia, many scales exist to assist the measurement of pain, and these are measurements routinely recorded by nurses. Couldn't the reduction of postoperative pain be considered a reasonable 'end point' for anaesthetic research? Moreover, the incidence of postoperative chest infection can be associated with the choice of anaesthetic technique and it is distinctly related to the operative occasion rather than general human experience, again a suitable 'end point' to measure in anaesthetic research?

Horan further argues for consideration of the skills and abilities of the individual anaesthetist. He asserts that a patient's outcome can be adversely influenced by the individual giving the anaesthetic:

> Caution must be exercised in assuming that anyone can reproduce published outcomes, and hence that one technique will always have better outcomes than another just because it has the support of evidence from the literature. (Horan, 1997:683)

In this Horan raises a particularly salient point; evidence, in and of itself, cannot ensure a particular outcome, it is knowledge in a situated, and in this case, an embodied sense that manipulates its effect. So in addition to evidence being, not the sole but one of many, determinants of action, evidence also does not specify the *quality* of that action. Although, on this point a proponent of EBM might argue that this does not invalidate the aims of EBM, rather, it simply indicates those techniques worth becoming skilled at performing.

Goodman (1998), one of anaesthesia's more vociferous commentators on EBM, also acknowledges the lack of 'hard' outcomes and the difficulties in extrapolating from 'surrogate' outcomes. Moreover, he suggests that these difficulties are compounded by lack of 'ownership' of patients, with patients being labelled as either 'medical' or 'surgical' rather than 'anaesthetic', which further inhibits the generation of primary research studies in anaesthesia. However, Goodman's (1999 and 1998) main concern is that EBM will become a 'new and unchallengeable dogma in medicine'. Following Charlton (1997), he argues that, in privileging epidemiological data, EBM does not provide the information necessary to treat individual patients. The problem,

according to both Goodman and Charlton is intractable, which no amount of 'statistical jiggery-pokery' with large data sets can overcome. Goodman stipulates that epidemiology is a tool, not a science, and he takes issue with the value attached to the results of an RCT.

> Statistics, which are at the heart of evidence-based medicine, are not even proof; they are only probabilities. (Goodman, 1998:364)

For Goodman the danger is that the 'evidence' will overshadow other knowledges, logics and rationalities in medical decision making, recapitulating the concern raised above: that EBM may potentially marginalise the legitimacy of other knowledges and incur difficulties for the practitioner when accounting for decisions on those occasions when 'other' knowledges do achieve greater priority.

In response to such comments, Moller, Smith and Pedersen, all anaesthetists and members of the 'Cochrane Anaesthesia Review Group', maintain that:

> evidence-based medicine is more than scientific results. It has a large component of clinical experience and empathy, which has to be used in conjunction with evidence in clinical decision-making. Many critics seem to have overlooked this point. (Moller et al, 2000:657)

It seems to be the positioning or ranking of 'evidence' alongside other logics and considerations in decision making that is the point of contention. However, they then go on to support a primary position for 'evidence':

> If anaesthetists are to practice evidence-based medicine, the recommendations derived from the evidence must be widely accepted as the most authoritative statement that is currently available. This would involve an agreed strategy between the major research funding bodies and anaesthetic groups such as the American Society of Anaesthesiologists (ASA), the European Society of Anaesthesiologists (ESA), the European Academy, the European Society of Intensive Care and the national societies. (2000:658)

These anaesthetists acknowledge that achieving evidence based anaesthesia will require dissent to be sidelined and a united position to be held by anaesthesia's professional associations, precisely the kind of authoritarian weighting that concerns anaesthetists such as Goodman.

Crafting boundaries, guiding action

The Royal College of Anaesthetists (RCA) affirms a large part of its work is to 'suggest guidance' on 'difficult issues' which, by definition, are not issues where evidence speaks clearly and decisively, these tend to be the issues in which evidence is complex, ambiguous, or absent, and where anaesthetic practice lacks consensus. The careful wording, 'suggest guidance', implies an assumption that the anaesthetist will consider and judge the appropriateness of the proposed course of action rather than be obliged to adhere to advice. The RCA offers guidance on both a departmental level, which advises on the organisation of anaesthetic services, and individual level (RCA, 2002), which is what I am interested in here. The guidance tendered to the individual anaesthetist concerns the use of Non Steriodal Anti-Inflammatory Drugs (a form of analgesia) in the perioperative period, on implementing and ensuring safe

sedation practice for health care procedures in adults, on local anaesthesia for intraocular surgery, and on the use of epidural injections for the treatment of back pain and leg pain of spinal origin. Considering the lack of evidence and the level of uncertainty that is said to characterise anaesthesia (Klemola and Norros, 1997), these are strangely isolated occasions in which guidance is offered, and it appears to touch anaesthetic practice only lightly, in that there is apparently no obligation to follow the guidance, simply to consider it.

So, to reiterate, the 'evidence' available to inform anaesthetic practice is scarce, with the occasions on which it might be taken as an authoritative lead for action being few. The evidence base, therefore, does not provide a coherent approach to the daily practice of anaesthesia. Furthermore, the guidance offered by the RCA to individual anaesthetists does little to consolidate the situation. So the question remains, how does anaesthetic practice proceed in the absence of evidence? The RCA and Association of Anaesthetists (AA) (1998) state:

> It is widely accepted that the practice of individual anaesthetists may vary where evidence supports a range of different techniques.

For the larger part of day-to-day anaesthetic practice the professional associations endorse a state of variation in which other logics, rationalities, knowledges, and considerations can vie to inform anaesthetic practice.

The RCA and AA do, however, mark out a certain territory where the use of guidelines, to structure decision making, is considered particularly appropriate. They

suggest that the use of guidelines is suitable in three sets of circumstances: i) life threatening circumstances; ii) where a problem is unusual; and iii) where a problem is routine but managed by non-anaesthetists. In anaesthesia, 'life threatening circumstances' would encompass, for example, the management of a difficult airway. The particular shape of a person's mouth, jaw, teeth and throat can make the management of their airway extremely difficult. In most cases it is possible to anticipate this difficulty, however, on occasions such as an extreme emergency the lack of a preoperative assessment prevents anticipation and preparation. In these circumstances a 'failed intubation drill' exists, a set of instructions designed to be learnt by rote to guide action in the aim of achieving airway control and maintenance. The circumstances where a problem is unusual, are also marked out as appropriate for the use of clinical guidelines, this might be where a diagnosis of malignant hyperthermia is made. Malignant hyperthermia is a rare genetic disorder, characterised by a climbing temperature, and triggered by certain anaesthetic agents (Gwinnut, 1996). Again, there exists a set of instructions to script the anaesthetist's actions. Finally the professional associations advise the use of guidelines where a problem is routine but managed by non-physicians, such circumstances might include algorithms for nurses to use in the management of postoperative pain.

This territory, where clinical guidelines are thought fitting, marks the peripheries of anaesthetic practice. Where it touches the core clinical practice of anaesthetists it is on infrequent occasions, such as rare illnesses or life threatening conditions, these are uncommon situations in anaesthesia, not daily practice. Where daily practices are thought, by anaesthesia's professional associations, to be amenable to structuring by clinical guidelines, those are the daily practices of non-anaesthetists, namely nurses.

The example I gave above, of nurses managing postoperative pain relief is the territory in which anaesthesia and nursing merge. Hence, by locating the circumstances where the guidelines are advocated on the boundaries of an anaesthetist's clinical practice, anaesthesia's professional bodies affirm the *status quo*: doing little to inform an anaesthetist's daily practice and leaving the variation of techniques it encompasses untouched. In suggesting where guidelines are appropriate, the RCA and AA correspondingly indicate where they are not. Therefore, by endorsing the use of guidelines on the margins of anaesthetic practice the RCA and AA simultaneously protect core anaesthetic practice from their imposition.

Thus far, the picture of anaesthetic practice is one in which little synthesised and authoritatively endorsed evidence exists to guide anaesthetic practice. Where it does exist, it either endorses customary practice or its recommendations are tentative and require consideration as to their utility for a particular situation. In this context anaesthetists draw on many different sources of knowledge and evidence to guide decision making, consequently, variation in anaesthesia becomes an accepted feature of the practice. Anaesthesia is seen as a unique medical specialty, its particular characteristics problematising the presumptions and foundations of EBM and limiting its applicability. The professional associations of anaesthesia do concede some place for guidelines but these are not 'evidence-based' guidelines issued from the authoritative EBM organisations such as NICE or the Cochrane Collaboration, these guidelines are issued from the professional associations and seek to prescribe actions in situations of rare conditions or life threatening events. If they prescribe activities of standard practice then it is the standard practice of non-anaesthetists.

Consequently, at the margins of an anaesthetist's practice where the anaesthetist relinquishes care of that patient to another clinician, the reach of the anaesthetist's authority to shape ongoing care is extended by the guidelines.

An interesting development in this scenario is the introduction of nurse anaesthetists. Unlike nurses working in anaesthesia who 'assist' the anaesthetist, nurse anaesthetists administer the anaesthetic themselves, generally working to an anaesthetic prescription planned at the preoperative assessment by a consultant (RCA, 2004). This initiative is currently being trialled in the UK using qualified nurse anaesthetists from oversees. Here then, is a situation which runs counter to the one described above; daily anaesthetic practice, which is thought to yield only reluctantly and problematically to evidence based practice, is being formally prescribed by a protocol for the use of non-physician anaesthetists. After considering the systems of anaesthetic delivery in other countries that utilise nurse anaesthetists, the RCA concludes that these systems work well with good outcomes, and it is one of the options being considered to alleviate the impending 'crisis' in matching supply and demand for anaesthetic services (Seymour, 2004). Potentially, then, guidelines, prescriptions or protocols – essentially sets of instructions for anaesthetic care – may be used to organise the delivery of daily anaesthetic practice. This necessitates an examination of the workings of these tools.

Guidelines in practice

Berg's (1997a) work identifies how the interweaving of many different logics, rationalities, evidences, and knowledges that characterises the construction process of

clinical practice guidelines continues when the tool becomes part of the local work routines. Berg identifies how, for example, nurses 'tinker' with the tools prescriptions so that blood tests are done on time whilst, seemingly simultaneously, the patient is wheeled to the X-ray department. However, Berg insists:

> This is not a deplorable and preventable outcome of the "corrupting" processses of getting a tool to work: it is the only way for the tools to work in the first place. Delegating the task of producing the tool's demands in real time to medical personnel requires leaving them the leeway to digress from the tool's prescribed steps, to skip or skew input, or to sometimes just avoid the tool completely. .... It requires allowing medical personnel to adjust the tool to their ongoing work. It requires that the tools become part and parcel of local work routines. It requires, thus, a further *localisation* of the tool: a moving away from its ideal-typed universality and uniformity." (Berg, 1997: 152, original emphasis)

Consequently, the proper functioning of a guideline depends on the practitioners' expertise in rearticulating the tool's instructions to fit the demands of practise. Berg goes on to contend that the introduction of protocols and guidelines does not denigrate medical expertise, rather, the tool transforms practice by redistributing responsibilities amongst staff; nurses' responsibilities may be enhanced whilst physicians are relieved of duties they did not cherish.

Thus Berg presents an image of 'decision support techniques' such as guidelines and protocols that transforms and redistributes existing knowledge, responsibilities and expertise; they are neither a transparent synthesis of the best available evidence

resulting in enhanced patient care, nor do they strip practitioners of their expertise replacing it with a mediocre rule-governed approach to care. Berg illustrates how the tool, which contains an explicit prescription for action, becomes thoroughly imbued with the personal knowledge of the practitioners, the local organisational routines, assumptions about the type of patient to whom it applies, and estimates of the workload it incurs when the prescription is accomplished. This work shows how knowledge and practice mutually transform one another in their own image, a process Berg calls 'convergence'. The functioning of the tool depends on the abilities of practitioners to interweave the tool with all of these different elements of practice.

However, this view overlooks the difficulties that may arise from the 'tinkering' and rearticulating of the guideline's prescriptions. Although the tool's functioning may depend on this, often this 'tinkering' will require nurses to operate outside their official responsibilities, to contravene written guidelines which, in turn, renders them vulnerable to disciplinary action. The implications of EBM recommendations and clinical guidelines for legal and professional accountabilities are now beginning to be debated (Woolf et al, 1999: Hurwitz, 1999; Harrison and Dowswell, 2002; Timmermans and Berg, 2003a). Hurwitz (1999) advises that, legally, guidelines cannot function as a substitute for expert testimony. He explains that the existence of a guideline does not establish that compliance with it, in all circumstances, is reasonable, or that non-compliance is negligent. He goes on that the law requires 'sensible discretion' to be used in adhering to clinical guidelines. In this case, 'evidence', in the form of a guideline, should not be the sole determinant of practice, *judgement* is intrinsic to its use. It is this *judgement* that nurses employ when working with guidelines that Berg labels 'tinkering'. However, hospital disciplinary

hearings are not the rigorous proceedings of a court of law, where the necessity for the subtle use of judgement with the implementation of guidelines may not be appreciated.

Is it evidence? Does it guide action?

In McCook's study of the field sciences during the early part of the twentieth century he describes how 'collectors' would be employed to bring sketches, drawings, information and notes of their travels back to the scientific community who would translate the 'data' into 'evidence'. One individual attempted to bypass the scientific institutions, and author his own scientific knowledge. This was almost universally rejected by the scientific community. McCook argues that for the field sciences of Victorian England: 'Anybody could discover the truth, but as far as scientists were concerned, only scientifically trained people could turn that truth into evidence.' (McCook, 1996: 197).

Hence, the composition of 'evidence' is far from transparent. In this chapter I have examined the form 'evidence' takes within a context of EBM with reference to the practice of anaesthesia. Rhetorically, at least, 'evidence' appears to be defined rather narrowly, referring primarily to the aggregated, synthesised results of RCTs. However, on examination of the evidence base for anaesthesia, this rarely provides an authoritative lead for practice, and the more closely one considers the alignment of evidence with practice, either by scrutinising the construction of clinical practice guidelines, or by speculating on what issues a practitioner might face when seeking to implement evidence based recommendations, the greater priority is commanded by

other elements in decision making. 'Other' considerations that have arisen thus far are: the patient's wishes, the practitioner's embodied skills and expertise, financial implications, material resources, availability of nursing support, and suitability, or palatability of the treatment. 'Evidence', then, is one of many elements informing of action and, moreover, the way in which it does so would seem to hinge on local contingencies. If, as in anaesthesia, 'evidence' is less than authoritative, how then do 'other' elements contribute towards organising action?

Chapter 2

Producing knowledge:

Researching anaesthetic practice

different agents would have experienced the same event differently.

(Timmermans and Berg, 2003a:22)

My discussion, in the previous chapter, about the composition and functioning of evidence, leads me to evaluate what I consider to be rational, trustworthy knowledge, and the efforts I have made to produce this. In this chapter I discuss the theories and practicalities that have informed my own attempt to produce reliable knowledge. I address how theories, methods, techniques, events, personalities, and histories have informed my epistemological position, how this was manifested in my research practice, and the effects this has for its product: the arguments and claims I make in this thesis.

Knowledge: situated, located and accountable

The examination of 'evidence' I presented in the previous chapter builds on a research tradition that has investigated, and deconstructed, scientific practice to illustrate the social and contextual specificities that permeate every stage of scientific inquiry.

Mulkay (1979), for example, had criticised the assumption that scientific knowledge was based on a direct representation of the physical world; he showed how factual statements depended on speculative assumptions, how linguistic categories guided observation, and the acceptance of knowledge-claims involved indeterminate and variable criteria. Haraway acknowledges that as a result of these critiques of science there emerged a 'very strong social constructionist argument for all forms of knowledge claims, most certainly and especially scientific ones' (1991b:184). This is the argument that the work of science is not free from 'social influence', scientists do not *decipher* existing natural laws, rather scientists actively *construct* their explanations of nature, as with other systems of knowledge, scientific explanation is achieved through social and technical negotiation, interpretation and recognition, (Webster, 1991).

My understanding of the constructivist position has developed in relation to three lines of sociological inquiry, and although the concerns and research techniques overlap, each I think makes a distinctive contribution. In my reading, the 'interests' approach to the sociology of scientific knowledge, sought to demonstrate the thoroughly 'social' nature of scientific knowledge by relating the 'interests' of scientific schools of research to the content of the knowledge produced by these groups (Pickering, 1992). This approach is exemplified by the 'controversy study' which seeks to illustrate how ideas, shaped by disciplinary, political, professional and ideological interests, are implicated in scientific debate (Webster, 1991). The 'laboratory study' became the hallmark of the 'microsocial approach'; studying the practice of scientific research revealed the local and contingent circumstances of knowledge production, circumstances that, once the facts have been established, all references to which are

erased (Latour and Woolgar, 1986). The feminist contribution to the constructivist argument elucidated these processes of erasure; Longino (2001), for example, focuses on the use of the passive voice (as in 'it is concluded that....' or 'it has been discovered that....') and the attribution of agency to the data (as in 'the data suggest....') in reports of scientific research, and Hubbard (2001) notes how scientists omit to acknowledge their relationship to the 'objects' they study, she argues that scientists describe their actions as though they existed in a vacuum. Hubbard (2001) contends that in neglecting the relevance of time, location, social and political influences, human authorship, and personal responsibility, scientific knowledge *appears* to transcend time and place, to be universal and objective.

However, an inadvertent effect of the social constructivist orientation is that the emphasis on *construction* deflects attention from the *consequences*: on what effects the constructed entity has on people's sense of self, the qualities of everyday living and for the distribution of power in society (Winner, 1993). For Haraway, this position is paralysing:

> Feminists have to insist on a better account of the world; it is not enough to show radical historical contingency and modes of construction for everything. (Haraway, 1991b: 187)

She goes on to argue for 'enforceable, reliable accounts of things' that are 'not reducible to power moves and agonistic, high status games of rhetoric' (Haraway, 1991b:188). So while accepting the value of the social constructivist argument that

demonstrates the specificities of knowledge, she notes that it stops short of making an overt political argument for change[2].

Haraway attempts to find some middle ground between social constructivist and traditional accounts of science. She articulates this problem as:

> how to have *simultaneously* an account of radical historical contingency for all knowledge claims and knowing subjects, a critical practice for recognising our own 'semiotic technologies' for making meanings, *and* a no-nonsense commitment to faithful accounts of the 'real' world... (Haraway, 1991b: 187, original emphasis)

Consequently, Haraway's paper 'Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective' is an attempt to develop an alternative epistemology, one that recognises the socially constructed nature of knowledge but is not disarmed by it, and one in which a commitment to the 'real' world is not incongruous.

In shaping this pathway Haraway considers both the critiques of 'objectivity', namely the opposition to the presentation of knowledge as transcendent of time and place, value-neutral and unauthored, and the criticism of relativism charged at social constructivist accounts. Therefore, fundamental to the epistemology which Haraway develops are calls for accountability and attention to location and positioning:

[2] Haraway is not alone in finding the social constructivist argument restrictive politically, the merits of various positions within this field are discussed by Collins and Yearley, Woolgar, and Latour and

> Feminists don't need a doctrine of objectivity that promises transcendence, a story that loses track of its mediations just where someone might be held responsible for something, and unlimited instrumental power. We don't want a theory of innocent powers to represent the world, where language and bodies both fall into the bliss of organic symbiosis. We also don't want to theorise the world, much less act within it, in terms of Global Systems, but we do need an earth-wide network of connections, including the ability partially to translate knowledges among very different – and power-differentiated – communities. (Haraway, 1991b: 187)

Therefore, Haraway is suggesting not universal knowledge, but partial knowledges that can relate, converse and interact with one another.

Haraway proposes, as a way of engaging with this notion, to reconceptualise, or rather reclaim, the metaphor of vision. She insists on the embodied nature of vision, in contrast to the version that signifies an all encompassing, universal and anonymous 'conquering gaze from nowhere' (Haraway, 1991b:188) which she associates with positivist science. Haraway charges this latter version of infinite vision with being an illusion, a 'god-trick of seeing everything from nowhere' (1991b:189), a charge similar to that which she directs at the social constructivist argument:

> Relativism is the perfect mirror twin of totalization in the ideologies of objectivity; both deny the stakes in location, embodiment, and partial perspective; both make it impossible to see well. Relativism and totalization are both 'god-tricks' promising vision from everywhere and nowhere equally

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Callon in the 'epistemological chicken' debate (1992).

> and fully, common myths in rhetorics surrounding Science. (Haraway, 1991b: 191)

In insisting on the embodiment and particularity of vision, that it is a view from somewhere, Haraway crafts a version of science, or method of knowledge production, that is not innocent or anonymous, but located and accountable. Situating scientific knowledge production involves learning to acknowledge specificities in 'dimensions of both mental and physical space (that) we hardly know how to name' so that 'we might become answerable for what we learn how to see' (Haraway, 1991b:190).

Situated knowledge, by definition, must also be partial, rather than universal. Partiality, she argues, provides the grounds on which knowledges can connect and map on to one another, to partially translate. Haraway (1991b:193) proposes 'a split and contradictory self' as a means of achieving this:

> The split and contradictory self is the one who can interrogate positionings and be accountable, the one who can construct and join rational conversations and fantastic imaginings that change history. ... The knowing self is partial in all its guises, never finished, whole, simply there and original; it is always constructed and stitched together imperfectly, and *therefore* able to join with another... (Haraway, 1991b: 193, original emphasis)

The 'split and contradictory self' might mean a feminist committed to realism whilst also persuaded by a constructivist account of knowledge. Haraway suggests that in being persuaded by seemingly conflicting theories, the 'split and contradictory self' is

able to hold a critical dialogue between these 'fields', to work towards connections and partial translations of these knowledges. Furthermore, Haraway insists that in acknowledging how knowledge is always, inevitably partial, and imperfectly constructed, the potential for connection and conversation with other viewpoints is secured.

For Haraway, being situated is to be accountable, it is co-existent with interpretation and partiality, which is the basis for crossing the boundaries of 'fields', and these are the grounds on which to claim 'rational' knowledge:

> Above all, rational knowledge does not pretend to disengagement: to be from everywhere and so nowhere, to be free from interpretation, from being represented, to be fully self-contained or fully formalisable. Rational knowledge is a process of ongoing critical interpretation among 'fields' of interpreters and decoders. (Haraway, 1991b: 196)

So situated knowledge is engaged, identifiable and accountable; it cannot be free from interpretation. Interpretation, and therefore partiality, is the condition for dialogue between the different fields. Universal knowledge does not allow room for other partial knowledges and thus stifles dialogue. Haraway stresses that working across fields towards a network of 'webbed accounts' is the only way to a fuller, more comprehensive version of scientific knowledge: 'the only way to find a larger vision is to be somewhere in particular' (1991b: 196).

Haraway recognises that partiality involves resisting closure, it precludes being 'fully self-contained or fully formalisable' complete knowledge, and that this generates

vulnerability. From this position political and ethical struggles over what may count as rational knowledge follow. Haraway's claim is that moral, ethical and political discourse, not neutrality, should be the grounds on which to base knowledge production.

> I am arguing for politics and epistemologies of location, position, and situating, where partiality and not universality is the condition of being heard to make rational knowledge claims. (Haraway, 1991b: 195)

Haraway presents an image of knowledge, the content, production, the very nature of which is firmly identifiable and locatable. In contrast to the version of 'evidence' promoted within EBM, wherein the more 'bias' eliminated during the knowledge production process, the more privileged its resultant epistemological status, and in which 'weak' studies are equated with 'expert opinion', Haraway suggests some principles for generating 'rational' knowledge in which knowledge production is authored, more, it is embodied, and the specificities of its manufacture are laid bare. The agency of the researcher is acknowledged, the relationship between the researcher, the researched, and the spatial and temporal location, is considered, probed, and the dimensions of these relationships are charted. In these admissions knowledge becomes accountable. In my reading of Haraway's proposals for 'situated knowledges', I find an epistemological position that addresses the issue of accountability in knowledge production, it does not obscure the author's involvement, and that this *strengthens* the claims of the research, it identifies the conditions on which it speaks and thus can connect with other partial knowledges.

Hence, in Haraway's 'situated knowledges' I find methodological principles to follow in my own research practice: to reflect on my agency, to acknowledge the agency of the practice I study, to identify the location and methods through which I produce knowledge. Indeed, whilst I have endeavoured to observe these principles throughout the thesis, the remit of this chapter is to be explicit about the above mentioned elements of my attempt to produce trustworthy knowledge; to account, and become accountable, for the details on which I make my knowledge claims. Sharing the intricacies and contingencies of knowledge production, moreover, resisting presenting a whole, comprehensive account does, however, incur vulnerabilities for the author. Knowledge of this kind, situated and partial, does not map neatly onto the criteria set down in the hierarchy of evidence, and thus limits its perceived value; a tension long felt by social researchers (Hammersley and Atkinson, 1995). However, it is recognised, even amongst the advocates of EBM (Sackett et al, 2000), that to answer questions such as I raise about the ways in which different knowledges generated by various people and things relate to action, demands techniques of knowledge production other than those endorsed in EBM's hierarchy of evidence; other techniques are used to judge the quality of the research, and to weigh the value of the knowledge produced. It is to these techniques I now turn.

From ethnography to ethnomethodology

A starting point for the 'expertise' project was the assumption that understanding the development of expertise hinged on accessing the minutiae of anaesthetic practice, on witnessing the changes knowledge exhibits as it moves through its many manifestations. This perspective mandated a research approach that privileges the use

of observation as a method of data collection. Therefore, the research approach we selected for the 'expertise' project was ethnography, as it encompasses observation as one of its primary techniques.

Following an anthropological tradition, a central concern of ethnography is to understand culture from the 'inside' (Button, 2000), through 'first hand experience' (Atkinson et al, 2001). Atkinson and colleagues (2001:4-5) suggest that, although ethnographies may be diverse in nature and analytical perspective:

> They are grounded in a commitment to the first-hand experience and exploration of a particular social or cultural setting on the basis of (though not exclusively by) participant observation. Observation and participation ... remain the characteristic features of the ethnographic approach.

They go on to acknowledge that whilst in many cases the term 'fieldwork' will incorporate a diverse repertoire of methods and techniques, it is the protracted first-hand engagement in the research setting that gives ethnography its abiding character. Hess (2001) concurs, granting that even though the practices of fieldwork and the conventions of writing vary dramatically, ethnographies continue to be characterised as ethnographic by their basis in fieldwork: data collected through first hand involvement.

Ethnography provided, for the 'expertise' project, a template, a suggested set of methods suitable to yield the type of data necessary to elucidate the questions we posed about the development of expertise in anaesthesia. Data collection then, was ethnographic: I spent the first year of the 'expertise' project engaged in fieldwork,

learning to *do* ethnography. Hammersley and Atkinson elaborate on what this involves:

> In its most characteristic form it involves the ethnographer participating, overtly or covertly, in people's daily lives for an extended period of time, watching what happens, listening to what is said, asking questions – in fact, collecting whatever data are available to throw light on the issues that are the focus of the research. (Hammersley and Atkinson, 1995:1)

Therefore, the 'expertise' project guided the data collection: my remit was to observe anaesthetic practice in as many of the different environments in which anaesthesia takes place, to observe as many different grades of anaesthetist and combinations of staff as possible, and to interview a selection of clinicians about the intricacies of their involvement in anaesthetic practice. How I organised the daily activities of this fieldwork, who, what, where and when to observe, and what questions to ask of whom, was my own undertaking, and this I return to below.

Consequently, the approach to data collection was designed to meet the needs of the 'expertise' project, and informed by my reading both for the project and for the questions I develop here, the emerging ethnography began to assume a distinctly 'STS' character, in contemplating the construction of expert knowledge, and the role of technology within this (Hess, 2001). Subsequently, however, in pursuing questions around the way knowledge relates to action, my understanding of anaesthesia, and my analytical perspective developed somewhat, being informed by a further research approach: ethnomethodology. Unlike ethnography, which is most easily characterised by reference to the practical activities it involves,

ethnomethodology tends to be explained in the first instance by reference to its analytical orientation. Heath and Luff (2001) acknowledge that ethnomethodology does not provide a 'method', in the sense of a set of procedures, but it does involve a number of analytical commitments which Pollner and Emerson (2001) identify as a focus on:

> the skills, practices and assumptions constituting social settings, their deployment in particular temporally unfolding courses of activity, and the experiences for which they provide. (Pollner and Emerson, 2001: 119)

According to Silverman (2001) this orientation differs from that of ethnography on the grounds that ethnography traditionally emphasises meaning and intent (how people *see* things) whereas ethnomethodology emphasises observable actions (how people *do* things). Hence, for ethnography, an underlying meaning is extrapolated from speech and action, whilst for ethnomethodology, it is the directly observable activities that render the situation intelligible. The 'expertise' project, however, did not conform so neatly to this classification, perhaps due in part to its focus on the passage of knowledge and the development of expertise, the project did tend to privilege observable actions in preference to meanings. It was this emphasis I sought to develop in my own work by drawing on ethnomethodology.

Suchman (1987) explains how ethnomethodology's focus is said to invert a 'traditional' sociological approach. Social scientific theories, it is said, attempt to take a common-sense view of the world and improve on it, remedying its shortcomings. Ethnomethodology, on the other hand, grants common-sense a

fundamentally different status, rather than it being a resource on which to build a theory, it becomes the topic of sociological investigation. Consequently, the notion that humans act in response to an objectively given social world, is replaced by the assumption that everyday social practices render the world publicly available. In turn, ethnomethodology's focus then becomes the methods through which members of a society come to know and make sense out of the everyday world of talk and action (Suchman, 1987).

Furthermore, Button (2000) argues that in building on common-sense explanations 'classical ethnography' has tended to produce theories that *miss* the phenomenon itself. He explains that the aim of ethnography has not simply been to describe the participants' ways of life but also to provide an interpretation or 'explanatory framework' that accounts for what was observed. Button (2000) suggests that 'classical ethnography' involves collecting 'data' through first hand participation, and then organising this data in terms of a social theory. However, he criticises this approach on the grounds that although ethnography purports to be articulating the arrangements of society from within, it actually discards a 'lay' description in favour of an abstraction, a secondary account (Button, 2000). Button cites the example of Becker's ethnography of jazz musicians, whilst replete with intimate detail on their habits, clothes, lifestyle and how they differentiate themselves from the rest of society, nowhere is there an account of how they make music together, of the interactional and improvisational 'work' of playing together. In keeping with ethnomethodologists such as Garfinkel, Sacks, and Lynch, Button (2000) argues that

'classical ethnography' *misses* how the actual work under study is constituted and achieved[3].

As a remedy to the 'missing' or 'vanishing phenomenon' Button proposes an analysis informed by ethnomethodology. To reiterate slightly, Garfinkel, the pioneer of this approach, argues that 'Although sociologists take socially structured scenes of everyday life as a point of departure they rarely see as a task of sociological inquiry in its own right the general question of how any such common sense world is possible' (Garfinkel, 1972:2). Garfinkel points out that a member of a society uses 'background expectancies', those 'seen but unnoticed' features of everyday scenes, as a scheme of interpretation, they form the intelligibility of conduct, yet remain unaddressed and unexplicated:

> The study of common sense knowledge and common sense activities consists of treating as problematic phenomena the actual methods whereby members of a society ... make the social structures of everyday activities observable. (Garfinkel, 1972:30)

Therefore, Garfinkel directs analytic attention towards 'members' knowledge': what people have to know, and how that knowledge is deployed in the ordering and organisation of their work.

[3] How Button applies this argument to STS is discussed in chapter seven, along with further discussion as to how I have used ethnomethodology as a tool to analyse the tools and technologies of anaesthesia.

A principle guiding the explication of members' knowledge is that of 'indexicality' in which it is held that words, statements or actions do not contain unequivocal meanings, instead meaning arises from the circumstances of their use (Lynch, 1993). Suchman (1987) elucidates this with reference to speech, explaining that the communicative significance of an expression, not a definition of the words but an interpretation of what the speaker means to convey in a particular instance, always depends upon the circumstances of its use. This principle also holds for action: in order to know what is intended by an action, for action to be mutually intelligible, it must be related to its embedding situation. So for ethnomethodologists, the interest lies in how the mutual intelligibility of the social world is achieved. Consequently, Heath and Luff (2000) note that the situation of action takes on far more significance for ethnomethodology, than the notion of 'context' found elsewhere in the social and cognitive sciences; actions are treated as inseparable from, essentially dependent for their meaning upon, the 'context at hand', not as framed or influenced by characteristics of a context (Heath and Luff, 2000).

I have discussed two of ethnomethodology's principles, there are others (Lynch, 1993) but it is these in particular that have informed my understanding of anaesthetic practice. Maynard and Clayman (1991) point to the importance of these two principles, *members' knowledge* and the *indexicality* of actions, when recounting how ethnomethodological studies have elucidated such things as the way instrument readings, which initially had an indeterminate sense, came to signify an independent physical phenomenon through organised courses of inquiry. This resonates with my observation of anaesthetic practice in that the sensations of inserting a needle into a patient's body, initially meaningless, gradually become discernable as physiological

structures – skin, muscle, and bone – and that the significance of readings from anaesthetic monitoring is attained in its coupling with the functioning of specific physiological systems, as the blood pressure 'represents' the functioning of the cardiovascular system. Ethnomethodology's emphasis on the significance of observable actions offers a potential link between what I learnt during the 'expertise' project about the character of knowledge and the questions I pursue here about the way action is constituted and achieved. This is not to eschew the theoretical orientation of STS; the STS repertoire and ethnomethodology offer many complementary resources to analyse the constituents of action, and in my analysis I make use of both of these perspectives.

Silverman endorses an analysis informed by these two approaches, he suggests that 'researchers have more to learn by exploring the interstices between analytic positions than by dwelling on one side of fine-sounding polarities' (Silverman, 2001: 76). Moreover, Pollner and Emerson (2001) recommend drawing selectively on ethnomethodological insights to the benefit of ethnography. A dialogue between ethnography and ethnomethodology may be contentious but, they propose, it also holds the potential to expand and develop an appreciation of the depth, limits and complexity of both ethnographic practice and the practices of those they seek to understand. The purpose of the above discussion, then, is as Haraway suggests, to locate and acknowledge the genealogy of this study's methodology, to facilitate a thorough exploration and explication of the principles and theories informing it. For Hess (2001: 239) this is a marker of 'good' ethnography: 'good ethnographies are positioned explicitly with respect to a social science research tradition'. Therefore,

whilst it is possible, even preferable perhaps, for the design of a study to draw on multiple research approaches, it is necessary to be clear about how one does so.

Fieldwork

The relevance of identity

The starting point of the 'expertise' project was to explore the role and development of knowledge, and how it featured in practice. This focus meant securing access to the clinical environment, primarily, the operating theatres. A formal approach was made, firstly, to the Department of Anaesthesia: the research proposal was presented at their monthly meeting, providing details of what participation would mean, and their approval sought and obtained. Secondly, approval from the hospital ethics committee was mandatory; an application outlining the potential ethical implications and the steps taken to address these was submitted and approved. Here, we felt that my identity as a nurse was advantageous in addressing ethical considerations arising from the need for confidentiality, 'informed consent', and the specific demands of the operating theatre as a clinical environment. Finally, a further presentation sought and obtained the endorsement of the theatre management and staff.

These formal access negotiations were eased significantly by Dr Andrew Smith, a consultant anaesthetist and member of both the department of anaesthesia and the research team. Andrew acted as a gatekeeper, who, in contrast to many gatekeepers (Smith, 2001), was an advocate, an ally. The anaesthetists we approached were unaccustomed to, and sceptical of, the research methods we proposed, therefore, having a consultant anaesthetist initiate and support both the aims and methods of the

research assuaged some fears and countered some scepticism, and within the context of the hospital, Andrew leant the project a certain degree of credibility.

However, the work of securing access is often more complex; in spite of having attained departmental and hospital clearance, there was also a more subtle, ongoing process of negotiating access, on an individual level. Each time I observed in the clinical areas I had to secure the consent of the individuals concerned. Here I was my own gatekeeper. Having worked in the theatre department as an anaesthetic and recovery nurse for the previous 5 years, I had an appreciation of the range and variety of personalities within 'the department' and thus an inclination of how best to approach them. I began with those anaesthetists who looked favourably on the project and who were enthusiastic to share their knowledge and expertise. These tended to be practitioners with whom I had enjoyed working as a nurse, with whom I had an easy rapport, and were less likely to be concerned by my presence. After a while I began to receive invitations to observe from some anaesthetists who were initially less forthcoming. By this time the novelty of the project had worn off slightly and the suspected ominous presence of the observer in the anaesthetic room had never materialised, tempered by my familiarity with the environment. It seemed almost as though these anaesthetists had become a little affronted they hadn't attracted my research attention. This reflects an observation of Suchman's whereby the anthropological gaze renders exotic those on whom it is turned, 'transforming the banal and ordinary activities of the working day, into the mysterious and correspondingly interesting' (Suchman, 2002:2).

However, there was one anaesthetist who was not swayed by the transformation of his work into something mysterious and interesting. Although at liberty to decline to participate in the study, he was also the regular anaesthetist on the bronchoscopy list. This is a list that necessitates the accomplishment of a specific anaesthetic technique, and to rapidly assimilate this into a routine that balanced the competing demands of a fast-paced list and a sharing the anaesthetist's working domain – the patient's airway – with the physician. Ascertaining this anaesthetist's cooperation required a skilful appproach, indicating the importance of this session for my research whilst maintaining the normality of this request to observe.

The clinical side of anaesthesia, that is, life in the operating theatres, was familiar to me, it was my territory. I had a native's knowledge of the environment, I could move about the hospital and its departments relatively unquestioned, unchallenged in my right to be there. What was unfamiliar to me, and often hidden, was the work required of anaesthetists once the operating lists were finished and they left the theatre department. To demystify this aspect of anaesthesia I negotiated office space in the department of anaesthesia to use as my working base.

Office space in 'the department' was enormously beneficial in one respect as I could then observe how the department of anaesthesia functioned as a body within the hospital, and how individuals – managers, consultants, secretaries, clinical nurse specialists, anaesthetic trainees – functioned within this. I now had access to observe how managerial, bureaucratic and organisational decisions were made, inscribed into documents, presented to 'the department' and the clinical ramifications of these decisions. I was able to observe how the department organises, maintains and polices

itself, and how personal narratives of clinical practice were brought back to the department, discussed informally, infused with theories, contrasted with anecdotes, and solidified into learning experiences.

Therefore, all these issues shaped the boundaries of my empirical 'field', by the growth of the project from concerns about the training of anaesthetists, by the relative ease of access, by my familiarity with the operating theatres, and by the strangeness of the anaesthetic department. These early influences and factors gave the study certain characteristics, which I did not wholly appreciate at the time, characteristics that in some ways are contrary to my personal perspective on anaesthesia. I will elaborate upon this shortly, but I note here that this does point to my personal history being in some respects problematic. I have thus far discussed my identity and its legacy in a positive light, focussing on the advantages it offered. However, as Peshkin (1985) observes, a researcher's identity will have simultaneously 'enabling and disabling' qualities, opening some research possibilities whilst closing others.

One such aspect is my local knowledge of the setting. The merits of this are uncertain and have a long history within methodological debates. For example, anthropology promotes bracketing any familiarity with a setting and apprehending as strange that which is taken-for-granted, a position extolled in Latour and Woolgar's 'Laboratory Life' (1986). And, as Garfinkel (1972) points out, for 'background expectancies' to become visible one must either be a stranger to the 'life as usual' character of everyday scenes, or become estranged from them. Potentially then, my familiarity with anaesthetic practice may blind me to the significance of members' knowledge. This prospective difficulty was recognised by the team and seven joint observation

sessions, in which I was accompanied by one of the two social scientists, were conducted to assess the differences between 'insider' and 'outsider' accounts. However, the main difference was in the level of detail I incorporated into my account specifically *because* of my familiarity with the setting. Marcus (1998) indicates the value of such local knowledge when promoting the achievement of 'near native competence' as a marker of 'good ethnography'. Hess (2001: 239) elaborates:

> the standard of near-native competence means that good ethnographers are able to understand the content and language of the field – its terminology, theories, findings, methods, and controversies – and they are able to analyse the content competently with respect to social relations, power structures, cultural meanings and history of the field.

In the criteria laid out by Hess I was at an advantage, and in terms of writing fieldnotes and asking questions, my familiarity with the abbreviations, terminology, the abundance of conditions, drugs and technological devices, I found useful. During the fieldwork, then, I sought to utilise and advance my knowledge of anaesthesia, and stepping out of my role as a nurse, being relieved of the need to *act* as a nurse, afforded the opportunity to note and examine that which is taken for granted.

Watching anaesthetic work

Guided by the 'expertise' study design, approximately three times per month over a 12 month period, I would join an operating list, a morning or afternoon session, an on-call period, during the evening or at the weekend. The aim in organising this clinical observation was to appreciate the variation that anaesthetic work encompasses and to explore how an anaesthetic practitioner develops by experiencing these different

settings. I therefore observed anaesthetic practice in each of the surgical specialities, particularly those that necessitate specific anaesthetic techniques, and in the various environments in which anaesthesia is practiced, to assess how different theatre layouts and equipment might affect the practice of anaesthesia. Advised by the team, I also chose operating lists to which a combination of anaesthetists were assigned – ie a lone consultant, a consultant and trainee, experienced trainee and novice anaesthetist, a lone trainee. This captured some of the variation of anaesthetic practice but also rendered visible some of the differences between anaesthetists at varying stages of experience. The sessions with two anaesthetists were particularly useful to observe as the need for anaesthetists to articulate their actions to a greater degree resulted in their practise being more amenable to scrutiny.

In these observation periods I took running fieldnotes; my mandate was to record as much detail as possible, not only of what was said but also actions, features of the environment, and the role of anaesthetic technology. The focus of our study was to investigate the processes through which anaesthetists access and practice knowledge, therefore my attention was sensitised to those taken-for-granted practices, the body of assumptions and conventions on which everyday anaesthetic practice proceeds. And, as I suggested above, my knowledge of the setting, in some ways, facilitated this process; in describing a scene I could quickly focus on its significance for a practitioner, the object of a practitioner's attention, or an unusual or novel circumstance, and when I questioned these circumstances the responses I received were technical ones aimed at developing my 'nurse's knowledge'. Furthermore, in working from the anaesthetic department when transcribing these fieldnotes, I was

able to elaborate and clarify my understandings, discussing issues with, for example, the anaesthetist at the next desk.

Supporting and informing this body of 'clinical' fieldnotes are my notes of what I alluded to above as 'the non-clinical side of anaesthesia'. Not being part of the original study design, the significance of this element in the data collection only emerged as the fieldwork progressed. In using the anaesthetic department as my working base I was initiated into the busy informal networks of anaesthetic learning, where 'difficult cases' were talked about in an opportunistic manner, over a sandwich at lunch, viva practice and tutorials for the trainees were carried out, journal clubs took place, and where the departmental meetings occurred in which policies are discussed and anaesthetists are invited to share their recent 'critical' experiences. Again, wherever possible I would take overt fieldnotes, which for the examination and viva practice, and the departmental meetings was straightforward but was more difficult for the opportunistic occasions. These unprompted, spontaneous conversations in which experiences and concerns were shared with colleagues would occur unexpectedly around me, often the significance of which I would only appreciate in retrospect.

However, I realised that in noting these conversations my fieldwork had inadvertently developed a duplicitous quality. Consequently, I questioned whether I was abusing my position in the department, exploiting the relationships I had established prior to the research beginning. I was most concerned about this with my 'key informants'. These were the individuals I found it particularly illuminating to talk to and question, although, these relationships stemmed from friendships and alliances I developed as a

nurse. Peshkin (1985) recognised that identity has both enabling and disabling features except for me, paradoxically, where rapport was at its best, and my identity most 'enabling', was also the point at which it was most 'disabling'.

Dewalt et al. (1998), Dingwall (1980) and Fluehr-Lobban (1998) imply this is a familiar scenario when using observational methods. Nevertheless, this issue enhanced my awareness of the ethical implications of undertaking research in a familiar environment with familiar people. Hence, I was charged with practically resolving this issue in such a way that allowed me to capitalise on the insights I gained through working from 'the department' but without this undercurrent of duplicity. My response was to reiterate my identity as a researcher regularly and to negotiate consent every time I formally observed anaesthetists. Incidents and issues that came to my attention informally I would try to follow up during the formal data collection where the ambiguous status of the data, whether on or off the record, was clarified. For example, over lunch a conversation developed between three consultant anaesthetists in which they chatted about their opinions of the clinical abilities of some new trainees – the ones they knew would be 'all right' and the ones they had concerns over. When subsequently I 'formally' observed one of the consultant anaesthetists involved in the assessment conversation I brought up the subject of competency-based assessment and how he personally approaches this topic. Feeding the informal data through these formal channels both enhanced the candour of the fieldwork whilst also improving the quality of the data.

In a paper 'Ethics and ethnography: an experiential account' (Goodwin et al, 2003) I explore the ethical implications of my position in more depth. In discussing this and

other situations in which their ethical nature concerned me, I came to appreciate, first-hand, that although I might try to alleviate the duplicitous quality of my fieldwork, I alone could not control the situations I was included in and excluded from, the information that participants revealed or withheld, the participants also exert their agency and in doing so contribute to the shape and character of the data. Writing this article coincided with the conclusion of the fieldwork and in some ways marked a departure from the 'expertise' project: for me, it signified both my own distinctive contribution to the research team, and a point at which I began to pursue my own line of inquiry.

Talking 'common sense'

My remit, to ascertain the tacit aspects of practice, what counts as 'common sense' for anaesthetic practitioners, proved challenging to attain when it came to the interviews. The difficulty was that my interest lay in the mundane routines of everyday practices – the things that people become so accomplished at it no longer takes a great deal of concerted effort; how then to encourage people to articulate the deeply embedded practices they no longer have to think about? I found the most successful approach was to anchor the discussion to personal practice, how their practice developed, how it came to look the way it does. This achievement was enhanced when I asked respondents to take me through their last clinical session or when we discussed a specific critical incident they had recently experienced. In this way I gained accounts of the daily practices, and the knowledge required to accomplish these, of three nurses, four ODPs, four trainee anaesthetists (their level of experience varying from

six months to six years), and six consultant anaesthetists. These interviews lasted between 30 minutes and two hours and were tape recorded and transcribed.

Towards the end of my fieldwork an element of the original study design took on a new form. Part of the study design was to 'debrief' following an observation session, this was originally conceptualised as a short period at the end of the operating list, an opportunity to ask questions and clarify details of the observation. However, due to contingencies such as the operating list overrunning, and the need to review the patients on the next operating list, this form of debrief only occurred on three occasions. The opportunity to debrief, albeit in a different guise, did arise late in the fieldwork: I had been observing in intensive care, following a routine ward round when, in the process of modifying a patient's treatment, the patient's condition deteriorated and became critical. After several hours of intense work the patient's condition was stabilised. The anaesthetist suggested he would find it valuable to look at a copy of my transcript, as a form of self assessment. I agreed and proposed we 'debrief': use the transcript as a resource to guide reflection. The subsequent interview lasted over two hours and was tape recorded; it was replete with detail, the anaesthetist was able to contribute features that I had missed or did not have access to, for example, what he had seen down the bronchoscope or the pressure he had felt when ventilating the patient. He also talked of the interactions between the different members of staff and the role X-rays, ventilators and chest drains played in this situation.

This technique has much to offer both analytically and methodologically. In terms of the quality and depth of the primary data – the transcript of the fieldnotes – a debrief

provides the opportunity to compare accounts, to clarify misunderstandings, to elaborate the description. It also presents an interesting analytical position, a layering of researcher and participant's experiences, accounts, and reflections. On this occasion debriefing offered benefits for both participant and researcher, however, this process was extremely time consuming and demanding for the practitioner. Despite the potential of this technique, the demands it places on the practitioner coupled with the impending conclusion of the fieldwork, meant it was only possible to debrief, in this way, on one further occasion.

Tensions

By locating myself in the anaesthetic department my focus was both broadened and narrowed. My focus broadened in that I became aware of how the practice of anaesthesia was not solely a clinical endeavour; I could now view the professional, political, bureaucratic, and educational duties that also constitute the work of anaesthesia. However, my focus narrowed as it centred 'anaesthesia' on the work of anaesthetists. This is somewhat at odds with my perspective on anaesthesia as something that is produced in practice by an array of actors such as nurses, operating department practitioners, medical devices and technologies, local routines, and includes but is not reducible to, the activities of anaesthetists. To rectify this problem, I might highlight how although in the anaesthetic department I watched anaesthetists, in the clinical setting I also recorded the actions of the other participating actors. As a consequence of my background in nursing I found I was sensitised to the contribution of 'others' in the production of anaesthesia. Nevertheless, the bulk of the observation remains weighted in favour of anaesthetists and thereby undervalues the involvement

of these 'others'. Another option would be to accept and live with this tension. However, as Law and Singleton (2000) remark, to talk in a certain way helps to produce a particular version of the world; so to live with this tension would be to reify the dominant view of anaesthesia as the sole province of anaesthetists. A further alternative would be to displace this version of anaesthesia, writing of another version, perhaps one that valorises the role of the materials and devices of anaesthesia, but this is not satisfactory either. The 'expertise' project was born out of concerns for the training of anaesthetists, and it was the anaesthetists, more than the materials, which supported the development of the project, as such I feel an obligation to reply to these actors. Perhaps, then, to write a version of anaesthesia that incorporates both of these elements, however, this implies an underlying aspiration to write the 'whole story', an incongruous approach in view of 'the privilege of the partial perspective' (Haraway, 1991). As Law indicates, being partial 'accepts or recognises, embraces its own *incompleteness*, not simply as a technical matter to be remedied, but as a part of being' (Law, 1997:5, original emphasis). The challenge, therefore, is how to be partial, which partial perspective to accept and promote.

My response, then, in this thesis is to admit that, shaped by the requirements of the 'expertise' project, the data collection centres anaesthetists, however, in my own analysis I looked for the presence of the 'others', and to the most prominent of these, patients, nurses, ODPs, technologies, machines and devices, alongside anaesthetists, I devote a chapter. There remain 'others' I have not addressed, the most notable omission being surgeons. To facilitate the work of surgeons was the reason for anaesthesia's development, its fundamental purpose, how is it possible not to discuss this? The simple answer is that there were other things I wanted to talk about more.

The relationship between the anaesthetist and the surgeon is an important one that has been discussed by Moreira (2002) and Fox (1992, 1994a), however, although I touch on the role of surgeons in chapter six and seven, in this partial perspective, considering my focus, the data I collected, and my interests, I felt it more important to examine the contribution of those lesser discussed elements.

Analysis

Beginning during the 'expertise' project, the early stages of my analysis was guided by the team approach: 'coding' involved each member of the team individually, reading and annotating the transcripts, highlighting incidents and attempting to name them, in a manner which loosely corresponds to the coding stages of a grounded theory approach. We then collectively, through discussing and comparing our readings of the data, developed categories and subcategories and refined the dimensions and boundaries, and organised them in a thematic framework. We discuss our ordering of the themes and their relations in 'Expertise in practice: an ethnographic study exploring acquisition and use of knowledge in anaesthesia' (Smith et al, 2003a). However, whereas grounded theory offers a prescriptive format with precise directions for completing each step, the process of our team analysis was more amorphous and interwoven, with the details of our coding and theorising worked out and generated in the process of our team meetings rather than prescribed from the start. This reflects the experience of Charmaz and Mitchell who discuss the process of marrying ethnography with grounded theory. They list a sequence of analytic activities but are careful to add the caveat 'In practice, the process is less linear, more

multi-dimensional and considerably less clear-cut' (Charmaz and Mitchell, 2001: 162).

The 'expertise' study design and the process of analysis incorporated techniques, 'triangulation' and 'respondent validation', aimed at enhancing the quality of the data and strengthening the project's claims. Triangulation is the use of different kinds of data (eg quantitative and qualitative), or different methods (eg observation and interviews) to assess whether they corroborate one another (Silverman, 2001). Triangulation in the 'expertise' project was achieved by generating our codes from the observation transcripts and then assessing their 'fit' on the interview data, evaluating the degree to which the interview data supported the codes. Respondent validation refers to returning the data or findings to the research participants for verification (Silverman, 2001). As one member of the team was a consultant anaesthetist all the data were viewed by at least one anaesthetist. A further five anaesthetists were involved in respondent validation either through reflecting on fieldnotes of their practice, participating in the initial coding of transcripts, or through their response to the resulting themes.

A criticism often levelled at qualitative analyses is their failure to acknowledge implicit theories which guide work at an early stage (Silverman, 2001). Literature, personal and professional experience did indeed inform the development of my codes, however, I found these elements became increasingly significant when my work departed from that of the team. In the 'expertise' project we studied the role knowledge plays in the development of the anaesthetist; in my study, I develop an analysis of the way knowledge relates to action, and in addition to the anaesthetist, I

examine more fully the contribution to anaesthetic practice of less obvious actors: patients, anaesthetic machines, nurses and ODPs, and tools and devices. Exploring the field of STS directed my attention towards the machinery, tools and devices, and my nursing education and experience heightened my awareness of the role of the patient, nurses and ODPs. Alongside the anaesthetist, I took each of these interests as a location from which to explore the 'action' of anaesthetic practice. Departing from the 'expertise' project, then, I organised the data according to my thematic framework, sorting it underneath the headings of patient and anaesthetic machine, the anaesthetist, the nurses and ODPs, and the artefacts, tools and devices. For each of these categories I selected a theoretical approach or analytical resource suited to elucidate the role of that particular actor, and then attempted to explain selected vignettes, events, scenes and scenarios using the theoretical resource. The occasions where this process gave rise to questions, or left details unexplained, I took as an opportunity to develop, elaborate and localise the tool to my needs.

Research Claims

This leads me to consider what can be said of my own attempt to produce trustworthy knowledge; what are the claims I can reasonably make based on the work I have done? I follow Haraway's (1991) proposition, that the knowledge I produce is situated in that it can be traced to a particular location, it is authored in that it bears the marks of its producers, and it is partial in that it is incomplete, and does not apply to all. In this chapter I have tried to reference, explicitly, my motivations and their sources, to illustrate how my identity and theoretical influences, inspirations, and resources have informed my interactions with the participants of the study, shaped the

data, the way it has been analytically worked, and the product of these labours. I have tried to illustrate how, in Haraway's terms, how 'vision is embodied'. I outlined some of the tensions and politics of this position, there is an onus to craft this knowledge in a responsible way, with a mind to the effects this may have, to be accountable. It is with this in mind that I have chosen to write about patients, technologies, nurses and ODPs as well as anaesthetists. In doing so I acknowledge that my research is shaped, not given, that I have the leading hand in this, and accept that there are omissions.

Indeed, a necessary feature of being situated is being partial. In this chapter I have tried to outline the dimensions of this study by explicating the choices I have made. Each choice renders this crafted knowledge more and more partial. But as Haraway (1991) argues, this *should* be the ground on which to be heard to make 'rational' knowledge claims. Haraway insists it is only through knowledge being partial and constructed, that the potential for conversation with other fields, discourses and viewpoints, can be secured. Only in accepting partiality can one connect with other knowledges and achieve a wider vision.

In the context of STS this philosophy is indeed judicious, but in the context of the NHS and the canons of EBM how would this study be evaluated? The criteria for quality specified by the norms of evidence-based medicine are different to those laid out above, namely 'objectivity', 'reliability', 'validity' and 'generalisabilty'. Haraway's proposals address the goals of objectivity and generalisability, but in her paper 'situated knowledges' she does not outline any criteria for measuring the quality of research. Questions of quality feature prominently with the NHS codes of

orthodox knowledge and if I wish to enter these debates, connect with these 'other' knowledges, this issue of assessing quality should be addressed.

Nevertheless, this aim is not incommensurable with the philosophy proposed by Haraway; her starting point is:

> how to have *simultaneously* an account of radical historical contingency for all knowledge claims and knowing subjects, a critical practice for recognising our own 'semiotic technologies' for making meanings, *and* a no-nonsense commitment to faithful accounts of the 'real' world... (1991: 187, original emphasis).

So whilst this research is a construction, it is not 'pure' invention, I have drawn into my fabrication the words, thoughts, theories, and actions of others. This then raises the question of how 'faithful' to these others I have been? Whilst triangulation and respondent validation have been criticised, even Silverman (2001) is sceptical of their appropriateness, treated cautiously they do speak of a certain degree of 'faithfulness'; accepting that my observations are partial and embodied, that is seen through a particular lens, returning the data to the participants for their endorsement, and their involvement in the sorting of this data, does at least suggests my account is recognisable. What I have seen and documented is, to some degree, common to what is seen by anaesthetists, nurses, ODPs and so on. As to the product of my analysis, the arguments I make, their 'faithfulness', I think, is supported by my extensive use of data: I take the reader through each stage of the arguments using illustrations and explanations of anaesthetic practice. What remains to be judged is the *worth* of this

endeavour, a subject to which I return when considering, in the conclusion, the utility of the arguments I make.

Part 2

Introduction

In chapter one I considered the role EBM played in guiding the delivery of anaesthesia; the ideology of EBM suggests that 'evidence' will provide a clear, authoritative lead as to which interventions are most effective and should be utilised, however, I found that where practice could be said to be 'evidence based' were those occasions in which the 'evidence' endorsed customary anaesthetic practice. There were occasions, however, when the 'evidence' had the potential to improve care, for example, by undermining the belief that premedication, to relieve anxiety, delayed the discharge of day case surgery patients. Although, where 'evidence' indicated a direction that was in some way different to orthodox practice, then thorough consideration of the elements and systems that support anaesthesia, most notably the level of nursing provision, is needed before following the evidence based recommendations.

When making evidence based recommendations, NICE explicitly weigh 'other' considerations alongside the 'evidence', primarily the financial implications and the position of leading 'stakeholders'; and when 'evidence' was scarce, as in the case of pressure sore management, then 'other' considerations achieved greater priority. It seemed as though the closer one attends to the way evidence works in practice, the more one must weigh factors such as the patient's position, the availability of

equipment, and the feasibility of implementing the intervention, in terms of the skill of the practitioner, and the nursing implications that follow from the intervention. Even when 'evidence based' recommendations have been organised into clinical practice guidelines, Berg's work shows how the process of weighing evidence alongside the other elements continues as nurses, for example, judge how, in what ways, they will follow the advice of the guideline.

In the 'rational' framework of EBM, these 'other' elements, that compete for significance in decision making, are often construed as 'barriers' (Feder et al, 1999) to evidence based practice. However, following Berg, and many other STS scholars, I propose that these 'other considerations' are as much a part of practice, and as worthy of attention in decision making as any other logic or rationale; they do not 'obstruct' the path of evidence-based anaesthesia, rather they contribute to the unfolding trajectory of the patient's anaesthetic journey. Accepting this means that pursuit of my questions: 'how does knowledge relate to action?' and 'how is action constituted and accomplished in anaesthesia?' necessitates an examination of the clinical practice of anaesthesia to explore the involvement of these 'other' elements, and how they inform an anaesthesia trajectory.

Gaba (1994), an anaesthetist studying 'human error', also explores how knowledge relates to action, and how action is constituted in anaesthesia. He proposes that the work of an anaesthetist is to 'execute a planned sequence of actions' and to 'detect and correct perturbations from the desired course' (Gaba, 1994:203). He goes on that 'The plan acts as a guide for future action' (Gaba, 1994:204). He argues, therefore, that action follows from knowledge, that the anaesthetist will plot the course of the

anaesthetic and action will ensue. Gaba does, however, acknowledge that at least 18% of anaesthetics involve unanticipated problems that could harm the patient, and that require intervention. Not infrequently, then, do 'obstacles' prevent the smooth flow of action from knowledge. Gaba thus presents a model of anaesthesia as action planning and problem solving, and he describes many of the 'preconditions' and 'constraints' involved.

Gaba proposes that the anaesthetist has 'a requirement to command and control *all* the resources at hand' (1994:217, my emphasis). But are *all* the resources amenable to 'command and control'? To what degree can the anaesthetist *control* all the elements of practice? What of those elements that themselves 'act'; do they necessarily conform to the anaesthetist's command? Gaba goes on that to 'command and control':

> is, in essence, the ability to translate the *knowledge* of what needs to be done into effective *activity* in the real world. (Gaba, 1994: 217-8, original emphasis)

and whilst he mentions some of the factors involved (prioritisation of tasks, distribution of workload, leadership, communication, to name but a few), and identifies that:

> much of the suboptimality that can be identified resides not in the decisions and actions themselves, but in the complex way in which they are linked together. (Gaba, 1994:220)

he does not give any clear explanation as to how decisions and actions are linked together.

An alternative approach is proposed by Suchman (1987): that action is an emergent property of a variety of elements. Suchman suggests that whilst the course of action can always be projected or reconstructed in terms of prior intentions and typical situations, the prescriptive significance of intentions for action are inherently vague. In this view, plans are resources for action, but they do not, in any strong sense, determine its course:

> It is frequently only on acting in a present situation that its possibilities become clear, and we often do not know ahead of time, or at least not with any specificity, what future state we desire to bring about. (Suchman, 1987:52)

The coherence of situated action is tied in essential ways not to individual predispositions or conventional rules, but to local interactions contingent on the actor's particular circumstances. In this sense EBM is but one of a range of elements informing action, others might include materials, devices, technologies, humans in various roles, different forms of knowledge, the spatial arrangement of the environment, and organisational constructs. Suchman's approach, then, requires the analysis of how local circumstances are used to achieve intelligent action.

In the second part of this thesis I propose to examine precisely how certain elements of the local circumstances work to inform action in anaesthesia. I start, in Chapter Three, with the relationship that is established between the patient and the anaesthetic machine. As I have suggested, it is easy in anaesthesia to consider the patient as

absent or a passive element by virtue of his or her unconsciousness, however, I propose the patient plays a more active role and that this is facilitated by the anaesthetic machines. Starting from this position enables me to explore how unconscious patients enact a form of agency and how anaesthetic practice is shaped by their contributions.

I then move on to focus on the work of the anaesthetist – how does the anaesthetist construct an intelligible account of the clinical situation, and how does he or she organise their activities? What happens when the multifarious elements of practice diverge rather than cohere, obstructing rather than producing an intelligible account? Here, then I consider the anaesthetist's involvement in shaping the patient's anaesthetic trajectory. The 'decisions' regarding a patient's ongoing anaesthetic care, which are distributed spatially, temporally and amongst many participants, can be difficult to achieve, and they have weighty consequences. What guides the anaesthetist in this process, and what of the risks? These are questions I pursue in Chapter Four.

The anaesthetist might appear to be the most obvious character involved in ordering an anaesthetic trajectory but he or she is by no means the only participant of anaesthesia to do so. In Chapter Five I explore the role nurses and ODPs, attending specifically to the resources at their disposal to guide the course of an anaesthetic. I scrutinise how these resources are accessed and metered, and the potential such resources extend to nurses and ODPs to contribute to the shaping of the patient's anaesthetic trajectory.

Finally in Chapter Six, I consider the artefacts of anaesthesia, how do these tools and devices contribute to the shaping of anaesthetic practice? What possibilities for action do these tools afford? I focus on the practices and members' knowledge necessary to realise the contribution of anaesthetic tools and devices.

In Part Two I scrutinise some of the elements of anaesthetic practice and discuss their contribution, not as background, or context, or additional considerations, but to foreground them as legitimate constituents of anaesthetic practice. Starting from a position in which these elements are not marginalised or predetermined, provides an opportunity to develop a nuanced understanding of how anaesthetic practice is constituted, what is involved in decision making, and how these elements inform action. I have selected events and scenarios from the data I collected, and for which I present an analysis. I have already discussed the process and my experience of data collection, and I attempted to be explicit about why I have chosen to focus on certain elements, and the theories and experiences that have informed these choices. Here, I would like to explain some aspects of my presentation and analytical treatment of the data.

The excerpts of my transcribed field notes, which I present, are inevitably incomplete; recording these by pen and notebook, I was unable to capture entire conversations, what I have recorded of a participant's speech will often tail off – represented as '…' – as another person begins speaking. Similarly, the activities of participants overlap, my account reflects the activities to which my attention was drawn. In the field notes I also make use of the terminology and jargon used in anaesthesia, both in an attempt to be precise and as a form of shorthand, as naming items of equipment was quicker

than describing them. Therefore, in presenting excerpts of the transcripts here, I have added, in italics, explanations of most of the terms I use. Also indicated in italics are my summaries of the activities I have edited, and where I have omitted sections of the data I have indicated this by a broken series of dots (... ... ...).

Another feature of the data presentation I would like to explain is how I refer to the participants. To preserve anonymity, all the names I use are pseudonyms. When participants have referred to one another by first name I retain this informality, however, when I myself refer to participants I address anaesthetists as 'Dr', and ODPs and nurses either by their position or occupation or by their first name. I will also refer to a patient as 'a patient' unless a clinician uses their name to address them. Unfortunately, this does impose a rather rigid, and to some degree, artificial order on the data; having worked in the operating theatres where I conducted my fieldwork I would ordinarily address all the ODPs and nurses and most of the anaesthetists by their first name. My reasons, then, for doing this is to assist the reader. Over the course of the next four chapters many different characters will be introduced and by retaining their titles I hope to clarify their roles. And, again, where it lends the data some clarity, I have indicated a doctor's hierarchical position, be it a 'Senior House Officer' (SHO – the most junior level of 'specialist' doctor), a Specialist Registrar (SpR – in which the doctor will have completed between 3 and 7 years of their specialist training) or a Consultant. Finally, in analysing these episodes of anaesthetic activity I use several theoretical resources. In each chapter I introduce the resource and discuss how I have used it in my analysis.

Chapter 3

Refashioning bodies, reshaping agency

Epistemologically, the "unresisting body" offers no impediment to the doctor's interpretation (Poovey, 1987:141).

In the process of anaesthesia the patient is rendered unconscious and often paralysed to allow optimal conditions for surgery. This necessitates a reconfiguration of bodily boundaries and a redistribution of bodily functions; different methods of communicating must be developed, requiring altogether different tools of speech. Anaesthetic machines are called upon to assume some of these responsibilities, for example, frequently the patient is paralysed using muscle-relaxant drugs and once the physiological capacity to breathe has been disabled, the anaesthetic machine will assume this responsibility. Furthermore, the fundamental purpose of anaesthesia is to temporarily, by chemical means, insulate the patient's senses from the trauma of surgery. An effect of this is that the process of anaesthesia removes the ability of the patient to speak verbally. The body of the patient must then find other methods of making its needs known, must communicate in other languages and in this the anaesthetic machine is again enrolled to fortify this communicative attempt. Monitoring devices are connected and their 'readings' and measurements displayed on the anaesthetic machine's monitor.

The patient, therefore, is reliant in many ways on the close relationship that is forged with the anaesthetic machine, indeed, the patient is technologically extended and augmented. In a very practical and material sense the patient becomes a hybrid, a mix of organic and technological components, in other words, a cyborg. Haraway recalls that 'a cyborg is a cybernetic organism, a creature of social reality as well as a creature of fiction' (1991a: 149). She reminds us that although the cyborg figure features prominently in the imaginary of science fiction, the cyborg also takes a material form in one's 'lived social relations', and particularly the lived social relations of modern medicine. Modern medicine, she says, 'is also full of cyborgs, of couplings between organism and machine' (Haraway, 1991a: 150). Gray, Mentor and Figueroroa-Sarriera (1995) concur; stories of cyborgs are not just fictitious tales told for entertainment, they state that 'there are many actual cyborgs among us in society' and those they cite are the creations of medicine – persons with artificial organs, limbs or supplements (such as a pacemaker), those immunized and thereby reprogrammed to resist disease, and those pharmacologically reordered to think, feel or behave differently. In this chapter, therefore, I want to explore how anaesthesia's cyborgs are produced and the ways in which they contribute to anaesthetic practice. I want to question how this relationship between anaesthetised patient and anaesthetic machine is established, what is involved in the way of boundary transformations, and how, in being technologically reconfigured, the patient is furnished with new communicative resources.

Articulating bodies and technologies

Medical sociologists Nettleton and Gustafsson (2002:13) highlight the relevance of questions regarding the relationship between humans and technologies:

> As we develop our knowledge, expertise, technologies and activities associated with the body, the more uncertain we become as to what the body actually is. The boundaries between the biological, social and technological become less clear. Boundaries, such as the distinction between life and death, that once appeared immutable, are no longer clear-cut.

Distinctions that had previously been made with confidence and clarity, such as life/death, human/machine and natural/social are now clouded and uncertain. Lock (2002) attributes this ambiguity to advances in medical science, such as those that have enabled blood transfusions and organ transplantations. These advances, she argues, have brought about 'a confusion of body boundaries and mingling of body parts never before possible' (Lock, 2002:1406). This ambiguity has opened up a theoretical space for debates about bodies, technologies, and the location of agency. Gray et al (1995) note that whilst many contemporary arguments have been developed, which grant machines agency and deny humans subjectivity, the traditional allocation, which casts humans as intentional agents and machines as inert, is tenacious. The analysis of cyborg relationships offers the opportunity to reshape this traditional view of agency and subjectivity.

Hogle (1999) examines the redistribution of subjectivity in her ethnographic study of organ transplantation practice. In this she observes how concerns about the inviolability of the body and personhood collide with issues of technological progress and medical authority. She suggests that organ transplantation practices mandate new

processes to enable the reconceptualisation of the human body as existing in an altered state, a 'brain-dead' state. One such means is the depersonalisation[4] of the body:

> Transferring or displacing the person while focussing on targeted body parts is one strategy used to deal with the ambiguities of the living cadaver while allowing access to bodily materials. (Hogle, 1999:149)

This process of transforming the patient into a donor involves attending to the body through its relation to the technology needed to sustain it; performing activities such as observing monitor changes, administering medications and fluids, inserting arterial lines, moving limbs to better accommodate lines or enhance blood pressure, suctioning lungs and withdrawing blood for testing. Hogle observes that in the course of these constant manipulations 'the body, as a patient's body seemed to disappear' (1999:148), an impression aided by the visual dominance of medical devices and equipment. She remarks, 'Visually, the body was barely evident under a forest of equipment' (1999:148) being obscured by an electronic warmer, and connected to a ventilator, monitors and intravenous syringe drivers.

The altered state necessary for organ transplantation, one might surmise, is a particular cyborg state in which the attributes of personhood and identity are actively and progressively filtered out. Hogle detects how the body is dispossessed of its identity, which is disaggregated and displaced into a separate material form – the medical records. This process is accomplished by 'collecting personal and bodily

[4] Hirshauer (1991) has observed similar practices at work in the depersonalisation of the body for surgery. See also the following 'depersonalisation debate'.

information, manipulating the body, and recreating the person and her body on paper' (1999:148). Hogle concludes that the body as a whole entity disappears and what remains is an identity without a body, and presumably, a body without an identity.

In an earlier paper Hogle (1995) argued that the technological practices aimed at enhancing the transplant quality of a donor's organs creates a 'donor-cyborg'. The classification of this particular cyborg identity, she suggests, enables one to apprehend what kind of entity it is, what it is used for, and how it 'fits' within the *human* social schema. In the work of preserving the donor's organs Hogle suggests that the human recedes as more and more of the organic is technologised and new social relations develop. Visual inspection by clinicians is eschewed in favour of data representations, the entire body is covered with electronic warmers, and when various procedures require manipulation of body parts these are handled both gingerly and quickly.

> By covering the markers of human-ness, the body becomes a more anonymous part of the equipment; literally faceless and genderless. (1995:211)

She then presents the question 'how much human-ness needs to remain in order for the entity to be a cyborg and not merely a commodity?' from which, for Hogle, many questions follow: 'Can bodies phase in and out of cyborgism depending on momentary positions in social, physical and textual space and time? Or is there an ontological change once the process is begun, which becomes a permanent part of who and what we are? Can we not say there are differing conditions which create varying types of cyborgs and are they transient in character?' (Hogle, 1995:213).

Hogle contends that the answers to these questions have profound implications for how we treat bodies and persons.

Hogle's questions are salient for my inquiry and might illuminate an analysis of anaesthesia's cyborgs. In contrast to the donor-cyborgs Hogle describes, in which the interventions to produce a cyborg state incur permanent or irreversible effects, in anaesthesia the aim is for transformations to be effected and then *reversed* all in the period of a few hours. In response to Hogle then, I propose that cyborgs may indeed be transient and studying anaesthesia's cyborgs provides an opportunity to concentrate on how the transformation processes are accomplished, what capacities are gained and lost, and the work entailed in reanimating the human by *reversing* these technological transformations of the body.

Nettleton and Gustaffson (2002) observe that within the sociology of health and illness much of the debate about bodies and technologies has focused on the ways in which medical knowledge of the body is created or produced. This was indeed the focus of Atkinson's study of haematology. Atkinson (2002) argues that the body is a site for medical inspection which is aided by a range of 'intermediary technologies'. The body is interrogated by a 'powerful armamentarium of investigative machinery' which disaggregates the body into 'numerous traces and fragments' which then 'may then be read by competent observers' (2002:19). Atkinson describes how 'The body is thus transformed into a series of signs and representations, by means of a complex array of technologies of inspection' (2002:20) and he discusses how haematologists learn to read these signs. This perspective usefully elucidates how medical technologies are enrolled by practitioners to interrogate the body of the patient.

However, from this position the patient becomes an object of knowledge rather than an agent in the generation of knowledge and by focusing attention on the interactions between doctors and medical technologies it obscures the interactions between patients and medical technologies and how this relationship may also *enable* patients to speak as well as assisting doctors to interpret. Therefore, the purpose of this chapter is to begin to articulate the communicative efforts of patients and medical technologies in anaesthesia.

The importance of studying the nature of communication emitted from an anaesthetised, technologically reconfigured patient is suggested by Poovey's (1987) historical study of the administration of Chloroform (an early anaesthetic) to women, to ease the pain of labour, during the Victorian period. She suggests that anaesthetising the women 'silenced' the female body and once silenced the female body could offer no resistance to interpretations of its behaviour. Poovey states:

> The point is that the silenced female body can be made the vehicle for any medical man's assumptions and practice because its very silence opens up a space in which meanings can proliferate (Poovey, 1987:152)

Poovey, therefore, argues that an anaesthetised body is a silent body dispossessed of the ability to construct a defence against the interpretations and 'readings' of doctors. The voice with which a Victorian woman may protest is temporarily disabled by the administration of anaesthesia which then offered little in the way of substitutes. However, much has changed in anaesthesia since the Victorian period, and the anaesthetised patient, I suggest, is no longer quite silent. As I will illustrate, rather than being disabled, the anaesthetised patient's ability to communicate is thoroughly

transformed, as is the language and matter that can be communicated. The technological extension and augmentation of the body creates different methods of communication that attempt to compensate for the loss of language use during anaesthesia. Therefore, unlike Victorian physicians, in my observation of anaesthetic practice, the anaesthetists could not impose just any interpretation on a given situation; the interpretation had to 'fit' with what the patient offered in the way of communication.

Studying hybrids and cyborgs: theoretical resources

Analysing the interrelations of humans and technologies is central to Latour's work and consequently he offers some useful analytical resources with which to begin my analysis. Latour (1999) argues that when studying relations between humans and artefacts it is a fundamental mistake to start with 'essences,' what might be called for the human 'natural' properties, and for the artefact 'technical' properties. Latour traces how humans and nonhumans are 'folded' into one another. He suggests that 'whenever we learn something about the management of humans, we shift that knowledge to nonhumans and endow them with more and more organizational properties' (Latour, 1999:207). Moreover, the opposite process is also at work, 'what has been learned from nonhumans is reimported so as to reconfigure people' (Latour, 1999:208).

This proposition is nicely illustrated by Prout's (1996) study of the metered dose inhaler (MDI). Prout highlights the interactive processes that gave rise both to attempts at reconfiguring humans in line with the competencies the MDI demanded

and the production of modified versions of the device itself (Prout, 1996:214). For example, the MDI needs users who can coordinate the action of pressing the valve-release button and slowly inhaling. Prout argues that:

> It should be clear that such competencies do not occur 'naturally' but arise because a requirement for them is inscribed in the MDI. The MDI can, therefore, be seen as having defined a *new* ability against which the performance of different human users could be assessed. (Prout, 1996: 208, original emphasis)

However, for some users, operating the device presented persistent difficulties which were variously characterised as a 'seriously inadequate technique', 'misuse' or 'errors' (Prout, 1996:209). A particular problem was the tendency for users to breathe through the nose instead of the mouth. Consequently:

> New versions of the MDI encoded new programmes (based on different constructions of the human users) intended to defeat some of the most commonly found anti-programmes of the human users. They did this by delegating some of what had been human work in the original MDI to new non-human agents. There was an attempt to remove user choices by routinising them into the mechanism of the device. (Prout, 1996: 213)

Thus, Prout emphasises how technologies and humans interact together transforming one another in the process.

Latour is adamant that there is no plausible sense in which an artefact and a subject can be distinguished, there are only successive crossovers through which humans and nonhumans have exchanged their properties and folded into one another. Latour posits that whenever we talk of 'matter' we are really considering a package of former crossovers between social and natural elements, so that what we take to be primitive and pure terms are belated and mixed ones. He warns of the futility of distinguishing between subjects and objects, humans and nonhumans, the properties of which are so enmeshed that the distinction is more ideological than classificatory. Of humans and nonhumans he says 'they are us' (Latour, 1999:214).

Hence, Latour offers a useful analytical principle in the study of human-machine relationships: humans and artefacts are not stable, given entities but are constructed in their relationships with one another, they are said to be 'mutually constituted'. There is constant and continued traffic between humans and artefacts in which properties are exchanged. Rather than try to define and capture what is essentially human or essentially technological, following Latour, it makes more sense to study how humans and machines are moulded by their relationships – what they give to one another and how they do so. This is indeed the objective of this chapter; to explore how the marriage of human and machine required in anaesthesia refashions the patient into a cyborg, and thereby transforms the ability, means, language and matter of articulation.

However, one might argue that a basic asymmetry between humans and nonhumans persists in that an artefact must be seized and activated by a human, a purposeful, intentional agent. Latour counters that what is true of the object is still truer of the subject. He uses the example of a military gunner – what would a gunner be without

a gun? And similarly, how can an anaesthetist anaesthetise without anaesthetics? Latour argues that 'Purposeful action and intentionality may not be properties of objects, but they are not properties of humans either' (1999:192). He argues that we must learn to attribute, to redistribute, actions among many more agents, to abandon the subject-object dichotomy that prevents the understanding of 'collectives'. Action, he argues is simply not a property of humans but of an association of actants. We should consider, he suggests, the prime mover of an action to be a distributed, nested set of practices.

Latour does, however, take care to note that in abandoning the dualism the intent is not to throw everything into the same pot, to efface the distinctive features of the various parts of the collective. He acknowledges that the properties of humans and nonhumans cannot be swapped haphazardly:

> The name of the game is not to extend subjectivity to things, to treat humans like objects, to take machines for social actors, but *to avoid using* the subject-object distinction *at all* in order to talk about the folding of humans and nonhumans. (Latour, 1999:193-4)

In this Latour extends his analytical advice: in the study of humans and nonhumans, one should endeavour to avoid the subject-object dichotomy and to redistribute agency amongst an assemblage of actors – a collective. Furthermore, Latour stresses that this should not be at the expense of the specificity of the actors, that the properties of humans and nonhumans cannot be swapped indiscriminately or arbitrarily. Therefore, when studying anaesthesia's cyborgs I should be mindful not to elide the differences between the human and machine components and the

distinctive attributes each brings to the reformulation of communicative capacities of the cyborg.

Suchman (2000), however, observes that in conceptualising machine agency many studies do precisely that – animate machines with human-like agency:

> My concern, in sum, is that far from recognizing the deep interrelations of humans and artefacts, contemporary discourses of machine agency simply shift the site of agency from people to their machine progeny. This does not mean that human power is lost. Rather, as in claims for the independent voice of nature in the practice of positivist science, the assertion of autonomy for technology depends upon the obscuring of human authorship. (2000:9)

Suchman takes the position that whilst humans and machines are mutually constituted, and that the boundaries between them are discursively rather than naturally affected and therefore always available for refiguring, she emphasises that 'mutualities are not necessarily symmetries' (Suchman, 2000:6) meaning that humans and machines do not necessarily constitute one another *in the same way*.

In referring to her earlier work Suchman argued that human interaction succeeds to the extent that it does because of the abilities of each participant to mutually constitute intelligibility, in and through interaction which includes, crucially, the detection and repair of misunderstanding. To do so humans can make use of a wide array of interactions whereas the machine, on the other hand, only has access only to a very small subset of the observable actions of its users.

> the machine could quite literally only 'perceive' that small subset of the users' actions that actually changed its state. This included doors being opened and closed, buttons being pushed, paper trays being filled or emptied, and the like. But in addition to those actions, I found myself making use of a very large range of others including talk and various other activities taking place around and in relation to the machine, which did not actually change its state. It was as if the machine were watching the user's actions through a very small keyhole, then mapping what it saw back onto a prespecified template of possible interpretations. (Suchman, 2000:3)

Her analysis, in the first instance, located the problem of human-machine communication in continued and deep asymmetries between person and machine. In reconsidering this position Suchman seeks to preserve this sense of human-machine asymmetry whilst balancing it with the correctives offered in recent STS work regarding 'the distributive and performative character of agency and the fallacy of essentialist human-nonhuman divides' (Suchman, 2000:4).

Suchman suggests the difficulty lies in our language for talking about agency in which agency is treated as something contained within singular entities, whether humans or artefacts. Our language, therefore, places an implicit impediment in the path of attempts to reconceptualise agency. This poses a difficulty when following Latour who, as discussed above, suggests that authorship of actions should be distributed among many actors, in 'nested sets of practices', the difficulty, I propose, being that in anaesthesia, and health care more generally, accountability for those actions tends not to be distributed but crystallises at certain points and on certain actors (Goodwin, 2002). Therefore, the decision to focus not on single actors but on

their relationships introduces the risk of obscuring the authorship of actions and neutralising issues of accountability. Suchman does, however, imply that the notions of distributed agency and accountability are not irreconcilable:

> The point, however, is that the price of recognizing the agency of artefacts need not be at the denial of our own. Agency – and associated accountabilities – reside neither in us or nor in our artefacts, but in our intra-actions. (Suchman, 2000:8)

Consequently, she proposes that accountability could be relocated in the 'intra-actions,' within the nested sets of practices, within the relationships. Suchman argues for a certain restoration of the boundaries between humans and machines, not a restoration of 'natural' boundaries but of historically and culturally specific acts of refiguring which will serve to recover authorship and restore accountability to human-nonhuman relationships.

This problem prompts the question of where to draw the boundaries of the cyborg; is the anaesthetist, who responds to the readings the patient and anaesthetic machine produces, part of the cyborg? What of the nurses and ODPs who check and maintain the machines? The threads of these workers whose practices relate to the locus of patient and machine union can be traced indefinitely, where, then, should the dispersement of accountability end? I have drawn the boundaries of anaesthesia's cyborgs around the patient and the anaesthetic machine. I do this for three main reasons; firstly, this position focuses attention on the contributions of the patient and machines, two crucial elements fundamental to anaesthetic practice but easy to overlook by virtue of their ambiguous capacity to act. Secondly, I want to analyse

this capacity to exhibit agency, and to examine the character of cyborg agency in anaesthesia. The anaesthetised patient and anaesthetic machine are both devoid of the characteristics usually attributed to an agent:

> agents are those entities able to choose, to attribute significance to their choices, to rank or otherwise attribute 'preference' to those choices; the idea that agents have goals, that they are able to monitor and assess what is going on, that they are reflexively able to make connections between what they take to be going on and those goals; and the idea that, at least some of the time, agents are able to intervene – to act – in order to (re)create links between their goals and the actions that they cover. (Callon and Law, 1995:490)

Here then, is an opportunity to scrutinise, and to delineate the forms of agency exhibited by a cyborg, the parts of which, neither organic nor technological, can be said to demonstrate intentionality. To add other conscious, intentional actors into this mix would only serve to cloud this analysis. Finally, although anaesthesia requires an anaesthetist, nurse, and ODP to interact with the patient and the machine, they are not connected in the same way as the patient and the machine. The bodily boundaries of anaesthetists, nurses and ODPs are not transgressed in the same manner as the patient and the machines. The combination of patient and machine, then, provides a discrete entity for analysis.

To summarise, Latour offers some powerful theoretical resources, however, somewhere in the focus on collectives and the dispute with essentialism, the issue of boundaries escapes. Suchman seeks to redirect attention to boundaries as a way of restoring accountability to relations between humans and nonhumans. Haraway

(1991) has argued that which human-machine relationships are forged, and the boundaries that are drawn within, around and between entities, are issues that matter. Specific human-machine alliances and their boundaries, work in particular ways to enable some practices and constrain others, to promote some modes of living and being and denigrate others, to give voice to some actors and silence others. In short, the political and ethical effects of *which* human-machine unions are promoted, and *where* and *how* their boundaries are drawn, have consequences and should be questioned. Haraway (1997) contends that these political and ethical questions can be attended to by using the imagery of the cyborg. The cyborg invokes images of fantastic couplings of human and nonhuman, and that the success of these couplings rests not on essences but on the ready union of humans and nonhumans. Cyborg figures, she states, 'are the offspring of implosions of subjects and objects and of the natural and artificial' (Haraway, 1997:12). These images emphasise the extent of possibilities and how the fashioning of such cyborgs is subject to historical and cultural contingences. The cyborg image enables one to hold in focus both that things could have been otherwise, and that they are not (Haraway, 1997:97).

Studying cyborgs, therefore, provides a means of analysing the space where humans and machines meet and interact, and allows for a tandem focus on the flexible production of boundaries between these actors and on their enabling union, on their collective identity and capacities. Studying cyborgs directs attention to the fusion of humans and nonhumans without effacing their difference, it does not displace the focus on boundaries, but instead offers the opportunity to reconfigure these boundaries. As Haraway puts it:

> Cyborg anthropology attempts to refigure provocatively the border relations among specific humans, other organisms, and machines. The interface between specifically located people, other organisms, and machines turns out to be an excellent field site for ethnographic inquiry into what counts as self acting and as collective empowerment. (Haraway, 1997:52)

The interface between human and non-human, then, the boundary territory, offers an advantageous position from which to elucidate various forms of agency, who can speak, how they do so, and the conditions necessary to achieve a voice. It provides a vantage point from which to investigate the distributive character of speech and actors differentiated capacity for articulation. This chapter is, therefore, an attempt to explore the degree to which anaesthetised patients and anaesthetic machines, together, can be said to speak, to communicate, and to contribute to the shaping of the patient's trajectory through anaesthesia.

Transient cyborgs: transforming voices

My intention, then, is to study, in close detail, the workings of the patient-anaesthetic machine union, to analyse what each gives to the other and what their collective identity facilitates. In doing so, as Latour recommends, I avoid an analytical position founded on a division of human and machine characteristics and abilities. The aim is not to animate the machine with human-like agency but to look at what they accomplish together and how they do so. Establishing this relationship is dependent on the concerted work of a number of actors whose labour produces certain pathways and linkages between the patient and anaesthetic machine. It is to how this relationship is established, how these pathways and linkages are produced, and how

the boundaries of both patient and machine are transformed that I now attend. First, I analyse the initiation of the patient-machine union, the 'induction' process. I will then question in what ways this union of patient and machine can act and communicate, and what new capacities this merger makes possible. In analysing the communicative capacities of anaesthesia's cyborgs I take account of Suchman's insight that machines and humans have access to different communicative resources. However, Suchman's analysis rests on a communicative attempt by humans to machines and from machines to humans, each acting as separate entities. My analysis focuses on the communicative attempt of the patient and machine, together, to other humans. Secondly, then, I focus on the 'operative' phase of anaesthesia, when work has ceased on producing a cyborg and the emphasis turns to the functioning of this patient-machine union. Finally, I look at the dissolution of this union, how it is achieved, and the work that is necessary to re-establish the human and to shed the technological. This is the 'recovery' phase of anaesthesia, in which the 'transient' nature of anaesthesia's cyborgs can be said to be achieved. Success in anaesthesia is often measured in terms of an uneventful 'emergence' from anaesthesia, with the patient reclaiming all of their former (pre-cyborg) capacities, with adequate pain relief, and without developing any of the complications of surgery. I follow anaesthesia's cyborgs to this point to chart the disaggregation of patient and machine, and the re-emergence of the 'person'.

Fashioning anaesthesia's cyborgs

Induction takes place in the anaesthetic room; a small ante-room attached to the operating theatre specifically for the purpose of inducing anaesthesia. This is where

work begins on achieving the patient-machine union, where pathways and linkages between the two are established.

08.18

As I walk down the corridor towards the anaesthetic room, I see the patient arrive on his bed, which is wheeled into the anaesthetic room. In addition to the patient, an ODP (Mark Gibson) and an anaesthetist (Dr Butler) are present.

ODP "Which is the problem side?"

Patient "Right"

ODP "The correct side has not been recorded on the consent form." (to Dr Butler)

Dr Butler "fentanyl, please" *(an opiate pain killer)*

The ODP moves round the room, takes a set of keys from his pocket and opens the controlled drug cupboard which is wall mounted above the work bench. He then returns to the right-hand side of the patient.

ODP "Just sort your pillows out." He takes 2 of the pillows away and rests them on top of a trolley. He then sits the patient forward and unties the strings at the back of the patient's gown.

Dr Butler "needle in the back of your hand. Can you just clench and unclench your hand". As he says this he fastens the tourniquet around the patient's left arm.

The ODP is applying monitoring to the patient, he works quickly and efficiently.

Dr Butler tapping the patient's forearm. "Local anaesthetic" he says. As he injects there is no change of expression on the patient's face. He then inserts a cannula smoothly.

During this the ODP has moved round the room to the left hand side of the patient and connects a drip that had already been prepared. He then secures the cannula with a dressing.

Dr Butler "Have you had your tablets?"

Patient "Yes, and 2 blue ones"

Dr Butler "they are just to make you feel more relaxed, looks like they've worked". The patient does indeed look quite calm and sleepy. "Nerve stimulator" he says as he leaves the anaesthetic room through the connecting door to the operating theatre. He returns a moment later, unable to find one.

ODP "I'll find you one."

Before doing so he takes an endotracheal tube out of the cupboard, opens the packet, cuts about 2 inches off the end of the tube, pulls the blue plastic connector off the discarded bit and inserts this to the now shorter ET tube.

Dr Butler injects from a syringe with an orange label *(an orange label signifies an opiate, I presume it is the fentanyl which he asked for)*. Dr Butler addresses the patient "A gin to go with the tonic. (then to the ODP) Have we seen a surgeon yet?"

ODP "I'll go and have a quick look." He leaves the anaesthetic room.

Dr Butler "Need to see the whites of the surgeon's eyes before we start."

The patient points to the screen "What are these figures up there?"

Dr Butler runs through all the readings on the monitor explaining which readings refer to his heart rate, oxygen saturation, and blood pressure.

We wait.

The anaesthetic machine beeps 3 times, no-one responds. The patient is asking Dr Butler about the surgery. His speech is slurred slightly now. Dr Butler explains 'they sew it ... patience and a very fine needle and thread'

Dr Butler "we are all ready to go now"

The patient points to the drip "is that the antibiotic?"

Dr Butler "no, just fluid, you haven't had any drinks for a while, we are also getting ahead in case you lose a bit of blood".

Patient "I met an awful lot a people yesterday and I can't remember their names."

Dr Butler "I wouldn't worry, it's a need to know basis, Mr Prasad, he's the important one, he's the one doing the operation, very smart gent in a suit."

Dr Butler takes a drug box out of the cupboard labelled Glycopyrolate *(used to increase the heart rate)* draws some up and injects into the cannula. The drip is running very quickly. Pulse 42, oxygen saturation 91%, blood pressure 153/81.

(... Dr Butler and the patient chat about the size and functions of the hospital while they wait for the surgeon to arrive ...)[5]

Going back to the moment when the patient is wheeled into the anaesthetic room, the ODP and anaesthetist begin work immediately on transforming the body of the patient from a (more or less) sealed unit to something that can incorporate and connect with technological devices. The ODP begins connecting the patient and the anaesthetic machine via monitoring. This entails wrapping a blood pressure cuff around the patient's arm and connecting this to the monitor. The blood pressure is a numerical value that represents the volume of blood ejected by the heart and the resistance to this flow by the blood vessels. He unties the patient's gown so as to place three electrocardiogram (ECG) leads on the patient's chest (towards the right and left shoulders and one towards the bottom of the ribcage on the left hand side). Connecting this to the monitor enables the machine to represent a trace of the electrical activity of the patient's heart. Finally, the ODP places a pulse oximeter probe on the patient's finger. This device measures the proportion of oxygen carried

[5] DG Obs 01/06/00.

by the red blood cells by emitting a light that is transmitted through the tissues, its resultant intensity is then correlated to a percentage indicating the degree of oxygen saturation of the blood.

Being connected to the anaesthetic monitoring in this way endows the patient with new additional ways of communicating with the anaesthetist. This can be seen when the anaesthetic machine emits three beeps to signify that the heart rate was only 42 beats per minute and had fallen below the monitor's preset limits. Shortly afterwards the anaesthetist administers glycopyrolate, a drug that increases the heart rate. This takes place without any verbal reference being made about the activity by either patient or anaesthetist. So this is a form of communication that is non-verbal, it consists of numbers and diagrammatic traces, and it is supplemented with auditory and visual alarms. At this point, the monitoring provides a number of communication pathways that exist in tandem with use of language and the patient's attempts to speak convey more to the anaesthetist than comprehending the spoken word. By this I mean that the patient's slurred speech indicates the activity of the drug fentanyl, an interpretation consistent with a lowered oxygen saturation reading of 91%. The monitoring, therefore, provide an additional three communication techniques at the cyborg's disposal.

The anaesthetist, Dr Butler, begins work on modifying the patient's bodily surfaces to incorporate an 'entry' point to the patient's circulatory system for drugs and fluids. As he explains it to the patient, this involves inserting a 'needle in the back of your hand'. He instructs the patient to open and close his fist, places a tourniquet around the patient's arm, and taps to engorge the veins. He injects some local anaesthetic to

alleviate the pain of inserting a large bore cannula. The cannula is inserted into the vein, connected to a prepared drip, and then secured. The cannula, then, is the 'entry route,' a portal, to the physiology of the patient's body. The 'entry route' is less concerned with a patient-anaesthetic machine union than with providing the conditions (a standardised connection) for linking with other machines, devices and artefacts. The cannula, therefore, provides the means of delivery of an opiate drug, fentanyl, beginning the combination of drugs that will induce anaesthesia.

The ODP prepares for a further connection between the patient and anaesthetic machine when he 'sorts the pillows out' which involves removing two of them. Of the boundary transformations detailed here this is the most difficult to achieve, it connects the airways of the patient and the anaesthetic machine by the placement of an 'endotracheal' tube that runs from the patient's trachea to just beyond the patient's mouth where it connects with the breathing circuit of the anaesthetic machine. In order to establish this connection the ODP positions the patient's head and neck in the 'sniffing the morning air' position that allows for the optimal view of the vocal cords (Gwinnutt, 1996:65) through which the tip of the tube will be placed. ODP then prepares the endotracheal tube, cutting it so that once positioned it will not extend too far beyond the patient's lips thereby preventing the tube from bending and occluding at this point. This tube fortifies the section of the pathway between the patient's lungs and mouth, providing a direct route for gases to travel from the anaesthetic circuit to the patient's lungs. Below the ODP returns to the anaesthetic room wherein work commences on establishing this airways connection.

ODP enters holding a nerve stimulator, he attaches some stickers on the patient's right wrist. He addresses the patient "We've found a surgeon now so we're going to get started now."

Dr Butler "Going to give you some oxygen" he stands at the head and holds the black mask gently over the patient's face. "Your job is to keep your eyes open as long as you can." Dr Butler is injecting propofol (a white substance from a 20 ml syringe – *a drug for inducing anaesthesia*) into the cannula slowly, as he speaks. The patient is still talking.

Dr Butler "You'll wake up about a minute after they have finished (The patient's feet are still moving. It is quiet.) Open your eyes". No response, patient has now stopped moving and talking. Dr Butler ventilates; he squeezes the grey bag with his right hand and holds the mask on the patient's face with his left.

The ODP attaches the nerve stimulator to the stickers he put on the patient's wrist and then folds the patient's arms across his chest and wraps them up in the patient's gown. He takes some absorbent paper towels and rests them on top of the patient's abdomen.

Dr Butler lifts the mask off and inserts an orange (size 3) guedal airway *(This is short piece of white plastic, about 4 inches long. It is shaped like an oval tube which begins horizontally then droops down. It is used to prevent the tongue from falling back and occluding the airway)*.

Dr Butler "Classic tooth right at the front, perfect intubating tooth" He replaces the mask and ventilates, there is a slight leak where the mask does not quite fit the shape of the patient's face. The ODP presses the patient's face up to meet the face mask, the leak stops. Dr Butler injects atracurium *(muscle relaxant)*. The ODP moves to uncross the patient's legs.

Dr Butler "quite useful, that finger, Mark". He repositions the face mask and the ODP returns to pressing the face of the patient to meet it. Dr Butler chats socially to the ODP, about the ODP's son playing cricket.

Pulse 44, oxygen saturation 98%, blood pressure 143/70. The drip is running slower now.

08.36

Dr Butler looks at the clock and continues ventilating. The anaesthetic machine beeps – pulse 38.

Dr Butler "... he's a big guy and it will take a while, so I thought I would go for a tube."

ODP "slow, isn't he?" *(gesturing towards the monitor)*

Dr Butler "he's on betablockers. I've given him some glycopyrolate already, good blood pressure though."

The anaesthetic machine beeps – heart rate 40. The ODP picks up the laryngoscope. They both seem to be waiting for the blood pressure reading before intubating. Dr Butler takes the laryngoscope and inserts it, the ODP pulls the right side of the patient's mouth further to the right. Dr Butler inserts the endotracheal tube and replaces the guedal. The ODP inflates the cuff on the endotracheal tube and then places a piece of tape over each closed eye.

Dr Butler "If I only had one tooth left, I'd be inclined to whip it out." The ODP ties in the tube. Dr Butler sets the ventilator.

Dr Butler "Do you know what Jim *(another surgeon)* has got on tomorrow?" (to the ODP)

Dr Butler opens the cupboard and gets out a Gelofusin *(a bag of fluid for infusion)* and hangs it on the drip stand. The ODP puts the absorbent paper towels sheets under the patient's right leg (which will be operated on). He pulls the canvas on which the patient is lying to the edge of the bed on the right.

Dr Butler "Can we have a blood warmer and a warming blanket as well, it'll be quite a while."

The ODP leaves the anaesthetic room and returns with a 'hot line'*(a device that warms the fluids being infused)*. Mr Prasad *(surgeon)* enters, says good morning

and leaves through the connecting door to theatre. The ODP prepares the hot line. Anaesthetic machine making lots of beeps. Dr Butler injects something, he then takes the stethoscope hanging on the anaesthetic machine and listens to the patient's chest. The ODP works quickly and purposively.

ODP "... Gelofusin?"

Dr Butler "Yes, we'll start it when we get in there."

The ODP runs the Gelofusin through the hot line giving set. Dr Butler chats to the ODP. Dr Butler replaces the oxygen saturation probe. The ODP opens a temperature probe and inserts it down the patient's nose. *I don't think he had been asked to do this.* He tapes it to the patient's forehead. He then puts a white paper blanket over the upper half of the patient, removes the backing strip and sticks it down to just below the patient's ribs. *(During the operation this will be connected to a device that will inflate the paper blanket with warm air.)*

ODP "Right!" signifying he is ready to go through to theatre.

Dr Butler unplugs the hot line. The ODP disconnects the monitoring and takes the brakes off the bed. A staff nurse enters and asks for another anaesthetist, Dr Butler says he hasn't arrived yet. This seems to distract Dr Butler and he says, 'what was I doing, oh yes', he disconnects the breathing circuit.

08.48

The patient is wheeled into theatre and transferred onto the table by 6 people. The ODP picks up a sandbag from a stand close to the anaesthetic trolley. He positions the sandbag between the patient's calves, then bends the right leg and rests the foot into the sandbag placing the patient's leg in the position required for surgery. Dr Butler connects the monitoring and programmes the ventilator. An orderly asks the ODP about putting a diathermy plate on. He holds the diathermy cable which already has a plate attached, the ODP nods. The orderly peels off the backing and sticks the plate on the patient's left thigh. Dr Butler and the scrub nurse talk. The ODP is working at the head end of the patient, he inserts

the tube holder and fits the breathing circuit into it. He unravels the white paper blanket so that the upper half of the patient is completely covered. The orderly brings in the hot air blower. The ODP moves the hot line from a drip stand and hangs it on the hot air blower. He then attaches the hot air blower to the white blanket. Mr Prasad *(surgeon)* paints the patient's leg with pink antiseptic solution. The orderly holds the patient's leg up to aid the surgeon.

As demonstrated here, establishing the connection between the patient's and the machine's airways must be tied as closely as possible to the commencement of anaesthesia. Anaesthesia disables the protective reflexes of the body, other means must then be found to protect the patient's airway and deliver oxygen. Dr Butler administers oxygen to the patient through a face mask in advance of induction, this is known as 'pre-oxygenation'. Pre-oxygenation loads the patient with oxygen in anticipation of the inevitable short period of time when the patient is unable to breathe independently and before the patient and machine airways are connected. Dr Butler then injects propofol, the induction agent, this works very quickly and within seconds the patient has stopped talking and no longer responds to verbal stimuli. Dr Butler must now support the patient's breathing until the airways connection has been accomplished and the anaesthetic machine can take responsibility for the regular exchange of gases.

To support the airway Dr Butler holds, with one hand, a tightly fitting mask over the patient's nose and mouth, this should form a seal so that when he squeezes the reservoir bag, with the other hand, gases are forced out of the reservoir bag, down the connecting tubing, into the black mask and from there into the patient's airway. To facilitate the movement of gases in the patient's airway Dr Butler inserts a 'guedel'

airway; a plastic tube which sits along the tongue and down into the pharynx. This prevents the tongue from falling back and occluding the airway. Dr Butler and the 'airway adjuncts,' as they are known, are not entirely successful at ventilating the patient; gases can be heard escaping where the mask does not fit the patient's face. The ODP presses the patient's cheek to the mask and the leak stops. At this point Dr Butler administers atracurium through the intravenous cannula. Atracurium is the muscle relaxant, a drug that will paralyse the patient thereby facilitating the placement of the endotracheal tube, this drug takes approximately 3 minutes to have an effect. Dr Butler, airway adjuncts and the ODP are then committed to their present task for the duration of this time. Dr Butler and the ODP chat, Dr Butler checking the clock, he explains his reason for opting for an endotracheal tube.

As the commencement of anaesthesia temporarily disables the patient's ability to speak verbally, the cyborg-patient must 'represent' itself through other communicative techniques. An instance of this can be seen when reading the patient's heart rate as only thirty eight beats per minute, and therefore falling below the lower default setting, the monitoring sounds an alarm. The ODP comments on this: 'slow, isn't he?' Dr Butler responds that the patient has been taking betablockers, drugs that slow and regulate the heart rate, this explains the heart rate of around 40 beats per minute. Furthermore, he adds that he has tried to increase the rate by giving glycopyrolate and balances this against the 'good blood pressure'.

As the required three minutes pass, attention returns to securing the airways connection. The ODP stands ready with the laryngoscope, Dr Butler takes it and inserts it into the patient's mouth so as to lift the lower jaw, and the ODP drags the

patient's open mouth a little further over to the right. These activities are aimed at visualising the vocal cords through which the tip of the endotracheal tube will be passed. A balloon at the tip of the tube is inflated both to seal the connection and to prevent movement of the tube back through the vocal cords. The tube is subsequently secured by a tie placed around the neck of the patient and around the tube. Once the tube is placed, secured and connected to the anaesthetic machine's circuit, gases can be delivered from the anaesthetic machine directly into the patient's lungs, a task to which Dr Butler attends when he programmes the ventilator adjusting the rate and volume of ventilation. With the machine ventilating Dr Butler verifies the placement of the tube using a stethoscope to listen to the air entry into each lung. In addition to its primary function, to deliver gases to the patient, the accomplishment of the airways connection provides another communicative resource. By analysing the inspired and expired gases, the machine can now clearly articulate the concentrations of the various gases delivered to and retrieved from the patient.

Having established this patient-machine airway connection, the ODP is then able to move about the anaesthetic room and attend to other tasks. He places absorbent paper towels under the patient's leg to prevent the bed linen from becoming soaked with blood or other fluids during surgery. It will be a long operation, the patient will be vulnerable to hypothermia, the ODP therefore prepares a 'hot line,' as requested, that warms intravenous fluids and attaches a paper blanket to the patient's abdomen that will be inflated with hot air. The communicative pathways established by the application of the monitoring, and which have already been augmented with a nerve stimulator (a device that delivers a series of small electric shocks to stimulate the nerves to contract – a test of the efficacy of the muscle relaxant) and the airways

connection that articulates the composition of gases is now further supplemented with a temperature probe that measures the patient's core, rather than surface, temperature. It is passed through the nasal passage and down into the stomach.

The ODP's 'Right!' gives the signal to move from the anaesthetic room to the operating theatre which requires a concerted effort; patient-machine connections and pathways that have taken this last thirty minutes to establish must be disconnected in certain ways and in a particular order, the final disconnection being between the patient's and machine's airways. This order is threatened by the interruption of a staff nurse trying to locate another anaesthetist. With the patient-machine connections temporarily dislocated, the patient is wheeled on his bed through to the operating theatre, transferred onto the operating table and the connections rapidly re-established. Final preparations for surgery are then completed such as stabilising the machine's airway tubing, attaching a diathermy plate, connecting the warming devices and positioning and 'prepping' the leg with antiseptic solution.

The extract above gives a detailed account of the routine ways in which connections between the patient and anaesthetic machine are forged in the event of anaesthesia. These links are the communicative resources of the cyborg. In inducing anaesthesia the more usual modes of communication are lost; by rendering the patient unconscious the use of language and gestures, which require intentionality, are disabled. But the patient must still communicate, to indicate his status to the anaesthetist, for example, whether the body is responding to painful stimuli of surgery, or whether the blood lost during surgery requires replacement. It is, I argue, the alliance the patient makes with the anaesthetic machine that enhances the ability

of an unconscious patient to convey his or her status. Moreover, this particular excerpt demonstrates the specificity of such connections and how both skill and improvisation are involved in the marriage of standardised pieces of equipment with the infinite variation of human anatomy, for example, even though the face masks and guedel airways are available in different sizes, the anaesthetist and 'airway adjuncts' still require the ODP to press the patient's cheek against the face mask and so achieve a seal. This suggests that the crafting of the cyborg involves incorporating such specificity into the boundary transformations and so gives the cyborg its individual character.

Cyborg speaking

Having explored how these communicative resources are accomplished it is possible now to pursue how they are employed during the course of anaesthesia. The following is taken from a different observation session involving an entirely different cast of actors. In this, the cyborg's communication pathways are already established, and surgery has been ongoing for some time. Dr Smith is the consultant anaesthetist.

> 3 beeps from the anaesthetic machine.
>
> Dr Smith looks at the anaesthetic machine "Oh, what now? (He then looks at the surgeon.) You're hurting him, his block has worn off... lets give him something... (to the ODP) 50 of tramadol..."
>
> 11.50
>
> The ODP goes into the anaesthetic room and returns with an ampoule and syringe. Dr Smith cracks the ampoule open and draws it up, labels it and injects half of it. He disconnects the temperature cable from the anaesthetic machine.

Blood pressure 131/78, pulse 59, oxygen saturation 98%, carbon dioxide 4.4, Isoflurane on 5%, VE flashing 6.2.

(Later, as I typed these field notes in the anaesthetic department, I ask another anaesthetist, who was sitting next to me, what 'VE' flashing '6.2' means. She said that it stands for 'Volume Expired' and 6.2 is a fairly normal measurement. The anaesthetic machine measures the volume expired and then if it changes from that norm it flashes to alert you. For example, if there is a painful stimulus the patient's respiration rate will increase, the volume expired will increase, and the reading will flash. Or, after administration of fentanyl, the respiration rate will fall as will the volume expired and again it will flash to alert you. These are normal responses.)

Dr Smith turns the Isoflurane back down to 1.5. Blood pressure 160/98. He injects the rest of the syringe and throws it in the yellow bin bag and then writes on anaesthetic chart. I ask Dr Smith about why the isoflurane was on 5%. He said it was just to 'dampen the bp' until the tramadol *(a pain killer)* worked. He said the resp rate was back to 14 now as well. Dr Smith writes on anaesthetic chart. Blood pressure 144/87.[6]

This demonstrates that even though anaesthetic agents induce unconsciousness they do not alone obviate the trauma inflicted on the body during surgery. The body responds to the pain surgery incurs in various ways, often by an increase in heart rate, blood pressure, respiration rate or changes in other bodily parameters. To offset these responses, and address the pain to which the patient's body is reacting, some method of analgesia is usually included as part of the anaesthetic plan. Here, the anaesthetic

machine beeps three times. This is followed by Dr Smith's comment that the surgeon is 'hurting him' and the assumption that the 'block' has worn off. A 'block' is a shorthand term for a procedure in which local anaesthetic is injected around a nerve pathway thereby preventing the conduction of nerve impulses. The cessation of pain relief provided by the peripheral nerve block necessitates the administration of further analgesics. Dr Smith chooses 'tramadol' and asks the ODP for an ampoule. At this point I look at the anaesthetic monitoring and record the various readings displayed. The blood pressure and pulse at this time still fall within 'normal' parameters and it is the flashing 'VE' that elucidates the situation. If, in response to painful stimuli, the patient's respiration rate increases then so will the volume expired, thus triggering the alarm. Consequently, by drawing attention to an increase in the volume expired the cyborg indicates the presence of pain. This overcomes a delay inherent in one of the other communicative techniques as the blood pressure is usually measured at 5 minute intervals, accordingly the next measurement displays an increase in blood pressure to 160/98. The cyborg, therefore, has a number of communicative resources at its disposal of which two are demonstrated in this field note. The blood pressure and VE measurements temporarily exceed the normal limits for this patient, the readings are displayed on the monitoring, and auditory and visual alarms convey this departure from the norm.

The anaesthetist's response is twofold. In the first instance he injects '50 of tramadol' (an ampoule contains 100 mgs) and following the subsequent blood pressure reading of 160/98 he administers the remaining 50 mgs. Concurrently he increases the dose of isoflurane (an inhalational anaesthetic agent) with the intention

[6] DG Obs 28/09/00.

of 'damping down' the blood pressure until the tramadol takes effect. So by deepening the level of anaesthesia the anaesthetist hopes to lessen the painful effect of surgery. The excerpt ends with a lower blood pressure reading of 144/87, thereby indicating the anaesthetist's strategy is beginning to combat the pain incurred by surgery.

Next is a sequence in which the anaesthetist is distracted by a colleague midway through the operation. Meanwhile the patient, through her union with the anaesthetic machine, is bidding for the anaesthetist's attention prompting questions for me as to what counts as speech.

> Dr Edward Law is working in the orthopaedic theatre, another anaesthetist enters to explain to Dr Law why a trainee is absent.
> Dr Law "Whilst you're here, can I just have a confidential chat in your capacity as college tutor." The two anaesthetists move to the corner of the room by the register to talk.
> I notice the antibiotic has run through and the giving set is gradually emptying.
> I look at the monitor: pulse 79, oxygen saturation 99%, blood pressure 91/60.
> A really loud noise comes from the other side of the drapes, some sort of drill.
> *(Sterile drapes are attached to a dripstand either side of the patient, level with her shoulders, to form a barrier between sterile and non-sterile. This allows the anaesthetist access to the upper part of the patient without contaminating the surgical field.)*
> 12.10
> The two anaesthetists are still talking at the corner of the room.
> I look at the reservoir bag, it is quite flat, which makes it difficult to tell whether the patient is breathing. I look at the carbon dioxide trace on the

monitor, it shows a regular wave formation, the patient is breathing regularly.

12.12

Blood pressure flashes 80/39. The green pump beeps. The ODP brings in a syringe of morphine and places it on the anaesthetic machine. She then turns round and turns the alarm off on the pump.

Dr Law walks from the corner of the room, still talking to the other anaesthetist, picks up the drip, throws away the empty antibiotic.

Dr Law "Stop dropping her BP" (loudly in the direction of the surgeon) He connects a unit of gelofusin to the giving set, pulls the giving set taut and flicks it, the air rises to the top, back into the chamber. Dr Law then turns the dial on the pump. Blood pressure flashes 68/30.

The second anaesthetists asks "Have you got a spare half hour for interview practice for Rachel?"

Dr Law "Consultant interview? She needs practice? Rachel? I would think she would teach me a thing or two." He turns the oxygen up to 4 litres and air up to 2 for a few moments and then back down again filling the black reservoir bag.

Dr Law asks the ODP "Did you bring some morphine?"

ODP "Yes, behind you. I also brought another propofol syringe. You'll have to sign for these." She hands him the controlled drug book.

Dr Law turns to me "All these distractions. (Then to the other anaesthetist) Will I have time, the answer is yes but I'll have to see what is going on in ICU"

The second consultant leaves.

12.20[7]

[7]DG Obs 220900.

With the anaesthetists engaged in conversation at the corner of the room to I attend to the activities of the cyborg. I note the heart rate, blood pressure and oxygen saturation. I then notice that the reservoir bag is flat. Here the patient is not being mechanically ventilated but is 'breathing spontaneously', in that the stimulus to breath is generated by the patient not the machine. However, 'breathing spontaneously' does not mean breathing independently, the airway of the patient still requires 'adjuncts' to support it and still depends on a connection with the anaesthetic machine for a supply of gases. When a patient is breathing spontaneously the reservoir bag will inflate and deflate as the patient inhales and exhales, however, when the bag is flat and almost empty this movement of gases is difficult to discern. Instead I look at the monitoring display and in particular the carbon dioxide trace. As gases are exhaled a monitoring device measures the concentration of carbon dioxide. Rather than looking at the numbers, however, I look at the wave formation displayed (a graphical display of the rising and falling concentration of carbon dioxide). It shows a smooth undulating trace and from this I conclude that the patient is breathing regularly. Another way to ascertain whether the patient was breathing regularly would be to look at the patient, to watch the patient's chest rise and fall, however, as the patient is covered with sterile drapes it makes this option more difficult. The technologised communicative resources of the cyborg, therefore, are in many cases preferable due to their immediacy, and visual and auditory, priority.

As the blood pressure falls the reading '80/39' flashes on the screen, then the green pump emits an auditory alarm. The 'green pump' is a syringe driver that delivers the anaesthetic contained in 50 ml syringes. It is connected to a cannula in the patient's hand via a giving set. It is alarming to signify that it has reached the last few

millilitres contained in the syringe. So the cyborg is speaking, signalling the precariously low blood pressure status. The green pump, working to maintain a constant level of anaesthesia, is running out of materials with which to work, and it alarms to indicate this. These efforts of the cyborg eventually solicit a response from the anaesthetist. Amid many competing demands – the imminent end of the anaesthetic infusion, the continuing conversation with the other anaesthetist, signing the controlled drug register – the anaesthetist attends first to the low blood pressure: he clears the giving set of air and connects a bag of gelofusin, which is a particular type of fluid specifically used to combat low blood pressure, and ironically faces the surgeon and loudly says 'stop dropping her BP'.

Some communicative attempts are successful at engaging the anaesthetist in dialogue and others the anaesthetist ignores. How can we know when the cyborg's attempts to speak and communicate are successful? Of all that activity what constitutes a successful attempt to communicate? Perhaps the cyborg's communications are successful when followed by action which addresses the communicative attempt. For example, the low blood pressure readings are tightly coupled with the administration of gelofusin and the words 'stop dropping her BP'. So the coupling of the cyborg's communicative efforts and the corresponding action on the part of the anaesthetist indicates speech has been heard and understood.

Cyborgs in transition: reclaiming the ability to breathe

Below is a description of a critical part of the transition period from unconscious cyborg to conscious patient. This is a gradual transition effected over time and place. It begins in the operating theatre with the cessation of anaesthesia and the relocation

of the responsibility to breathe from the ventilator to the patient. Retaining the communication pathways established by the monitoring connections, the patient will then be transferred to the recovery room for a period of close observation. On returning to the ward these monitoring links are disconnected although portals such as intravenous cannulae remain in place for continued use on the wards. This excerpt describes the beginning of this transition wherein the patient recovers control of her breathing. The data begins after the operation has finished. The patient has been moved from the operating table to a trolley, turned onto her side as is customary when extubating (a precaution taken to reduce the risk of inhalation of stomach contents should the patient vomit after the removal of the endotracheal tube).

> Dr Woods "Can we have her feet to the door and her head to the anaesthetic machine, that way I can reach the anaesthetic machine." The patient trolley is wheeled so as it is at a right angle to the operating table. A recovery nurse covers the patient with the sheets. Dr Woods opens another suction tube, turns the suction on.
>
> Dr Woods "She's not quite on her side is she?" (to a nurse) The nurse and Dr Woods reposition the patient's shoulders. The nurse is then called away to prepare for the next operation. The anaesthetic machine beeps.
>
> Dr Woods talks to a medical student "we might have to wait for the CO2 to rise before..." Dr Woods ventilates. She then takes the tape off the endotracheal tube. Machine beeps (a single beep signifying it has just recorded the blood pressure). The patient moves, carbon dioxide trace now undulating.
>
> Dr Woods says to the patient "Claire, deep breaths." The recovery nurse prepares the oxygen mask.

Dr Woods "Claire (then to the medical student) I'll take the tube out when I'm happy that she is breathing regularly, not quite yet." Patient is still again, the carbon dioxide trace now flat.

Dr Woods "Claire" The patient is gagging on tube, begins to chew it then stops and rubs her eye. The carbon dioxide trace goes up and down again.

Dr Woods "Deep breath in" she squeezes the reservoir bag and pulls the tube out. The recovery nurse puts the oxygen mask on the patient. Dr Woods takes a litre of 'Hartmans' *(fluid for infusion)* out of the trolley drawer.

Dr Woods addresses the medical student "So we know she is breathing because the mask is steaming up and you can feel her abdomen moving" The recovery nurse and Dr Woods disconnect the monitoring and wheels the patient to the recovery room.[8]

First, then, some manoeuvring of the trolley is required to obtain a feasible position in which the anaesthetist can reach both the patient and the anaesthetic machine, and then some further repositioning of the patient to ensure a safe position for extubation. Dr Woods explains to a medical student that it might be necessary to wait for the level of carbon dioxide to rise before the patient will begin to breathe for herself, the stimulus to breathe in most cases arising not from a lack of oxygen but from an increase in carbon dioxide, she therefore continues to manually ventilate the patient. Spontaneous patient movement is accompanied by an undulating trace on the monitor displaying the carbon dioxide readings, this indicates that the patient is breathing and the effect of the anaesthetic is diminishing. The recovery nurse, anticipating extubation, prepares the oxygen mask. However, the patient becomes still again and the carbon dioxide trace flat. Dr Woods explains to the medical student that the

[8] DG Obs 051200.

patient is not quite ready to be extubated, to be disconnected from the anaesthetic machine and resume control over her own breathing. Although there are signs that the patient is beginning to emerge from anaesthesia these signs are capricious, one moment the patient is breathing, the next she is not. The anaesthetist cannot remove the tube until these signs have stabilised and the ability to breath can be firmly located within the patient.

The cyborg's subsequent attempt to communicate, consisting of movements and the readings displayed on the monitor, signal that it is now an appropriate time to remove the tube and disaggregate this patient-machine union. Dr Woods instructs the patient to take a deep breath and then extubates. The recovery nurse places an oxygen mask on the patient's face and Dr Woods explains to the medical student, now that the patient and machine are disconnected thereby losing a communicative resource, how they can know that the patient is breathing; the oxygen mask steams up as the patient exhales and it is possible to feel her abdomen rise and fall as she breathes. They disconnect the monitoring and transfer the patient to recovery. In Recovery the monitoring will continue for a short period but the balance of communicative abilities within the cyborg-patient has changed and will continue to change. As the patient emerges from anaesthesia and regains consciousness she is less reliant on the monitoring for communication, some forms of electronic monitoring being exchanged for her pre-cyborg modes of communication such as language use.

Based on communication emanating from the cyborg the anaesthetist must adjudicate on when to begin this dissolution of patient and machine. There must be careful consideration of the signs – have they settled sufficiently to indicate a stabilised

relocation of responsibilities within the patient? The skill of the anaesthetist lies in interpreting this language, the anaesthetist cannot impose any explanation on the situation, it has to be consistent with what the cyborg endeavours to communicate. Unlike the situation Poovey describes with patients unable to resist the anaesthetist's account of the situation, modern day cyborgs in anaesthesia have some resources at their disposal to assist the anaesthetist in understanding their needs. Much rests on an account that accords with what the cyborg aims to convey; in the scenario above misinterpretation would have resulted in a patient that was unable to breathe independently and dislocated from the resources to facilitate this, a situation requiring rapid reintubation. So the cyborg communicates through the connections and pathways established in the patient-machine union, and in a language that consists of numbers and diagrammatic traces. The anaesthetist must learn to set these communicative signs, signals, measurements, and diagrammatic traces, into an explanatory narrative that can safely inform the continuing action.

Resistance: a cyborg's contribution

The fusion of patient and machine necessitated by present day anaesthesia transfigures the boundaries of both patient and machine, the union redistributing some existing abilities, disabling others, and creating new ones. Gray et al classify four kinds of cyborg: 'restorative', in that a cyborg state replaces lost organs or limbs; 'normalizing', in that a cyborg state means returning to indistinguishable normality; 'enhancing', an union with technology improving the abilities of the human; and cyborgs might be 'reconfiguring' which is where I would locate anaesthesia's cyborgs.

According to Gray et al (1995:3) 'reconfiguring' cyborgs create 'posthuman creatures equal to but different from humans'. A cyborg state in anaesthesia transforms methods of communication; with the application of monitoring devices the cyborg can communicate such details as heart rate, blood pressure, oxygen saturation, a diagrammatic 'representation' of the heart rhythm, and the core body temperature, greatly adding to the patient's repertoire of communicative resources. However, the induction of anaesthesia incurs a silencing of the patient's capacity to speak verbally and the patient becomes dependent on the alliance forged with the anaesthetic machine. Moreover, inducing unconsciousness necessitates a further merger of patient and anaesthetic machine. A secure pathway between the lungs of the patient and the anaesthetic machine's ventilator must be established. The responsibility for the regular exchange of gases can then be relocated from the human, to the machine. In addition to the responsibility for breathing, this connection of patient and machine serves to further expand the communicative techniques of the cyborg in that the volumes and concentrations of gases delivered to and retrieved from the patient can be ascertained. Taken together with the more primitive communicative resources such as the colour and feel of the patient's skin, and the size of the pupils, and when allied to situational knowledge, for example, of the stage of the surgery, and the preoperative physiological condition of the patient, these expressions can convey the needs of the cyborg.

Therefore, these boundary transgressions enhance the anaesthetised patient's contribution to anaesthetic practice, they are the means through which an unconscious patient can speak. As the methods of communication are transformed, so the

language changes and correspondingly that which can be communicated. Measurements such as blood pressure, heart rate, oxygen saturation, and respiration rate may be impoverished forms of communication in comparison to the ability to verbalise, but they can express enough to enable the anaesthetist to construct an account of the patient's physiological condition and needs. Therefore, these boundary reconfigurations provide the conditions for resistance, in that the union of patient and machine creates new communicative resources with which the cyborg can resist other articulations of the situation. Poovey (1987) describes how Victorian women had no such resources and physiological responses to anaesthetics were interpreted as uninhibited sexual desires and fantasies mandating some form of control. In my observation of anaesthetic practice the patient, technologically extended and transformed, that is, the cyborg has a voice, can speak, has some resources with which to contribute to an interpretation of the cyborg's conduct. Hence, the anaesthetist cannot impose just any explanation on the situation, it is critical that the account is consistent with what the cyborg means to convey because the consequences matter, as discussed above, a patient unable to breathe and disconnected from the machine that performs this function quickly induces a life threatening situation.

An uneventful reversal of the human-machine union and return to a pre-cyborg state, is not only important for anaesthesia but a measurement of its success. The transition is not easily effected and facilitating the transition is the dedicated work of both anaesthetist and recovery nurse. Hogle (1995:213) asks 'Can bodies phase in and out of cyborgism depending on momentary positions in social, physical and textual space and time?' On the basis of my analysis of anaesthesia's cyborgs I suggest that bodies can phase in and out of cyborgism but such transience is precarious, easily disturbed,

and therefore closely marshalled by a team of practitioners. My point then, is to propose that agency is not only demonstrated by conscious, intentional actors. Callon and Law (1995) argue for agency to be distributed amongst a 'hybrid collectif' (much like Latour, cited earlier) but concede that often agency will be attributed to a certain part of the hybrid collectif, and that language use and intentionality are important elements in these attributions. They say that 'The agents we tend to recognize are those which perform intentions ... but it does not have to be so...' (Callon and Law, 1995:502). Anaesthesia's cyborgs, I think, demonstrate how an unconscious being is not necessarily passive but can enact a form of agency. I suggest that it is the union of human and machine that enhances this demonstration of agency. It is a different form of agency, lacking the characteristics of language use and intentionality, but it is still a contribution, one of the factors that shape how anaesthetic practice may proceed.

Chapter 4

Contriving action:

skilful and precarious engineering

In Chapter Three I looked at how the patient, in an alliance with the anaesthetic machine, might be said to contribute to anaesthetic practice. I sought to disturb the view that anaesthetised patients are passive, stripped of agency, virtually absent from the proceedings in which one may consider them central. Technologically refashioning the patient into a cyborg, I suggested, enhanced the patient's ability to inform the course of their anaesthetic. Here I focus on the work of the anaesthetist; what does an anaesthetist do with the cyborg's contribution, how does it guide the anaesthetist's actions, what other elements and resources inform the anaesthetist's actions and how does this shape the unfolding course of anaesthesia? I suggest the anaesthetist's work involves crafting an account, or even multiple accounts, that lend the situation some intelligibility and in doing so indicates an appropriate course of action. The elements I refer to include the patient's medical history, details of the surgery, organisational practices as well as the cyborg's communicative resources such as measurements displayed both graphically and numerically, clinical signs and symptoms.

However, these heterogeneous elements, when at play in anaesthesia do not necessarily fit together harmoniously; there will often be discrepancies amongst them.

Such discrepancies will require the anaesthetist to adjudicate on their significance; how integral to the account are these elements and if they do not 'fit', how safe is it to exclude them? I examine how the anaesthetist works to contrive an account, or multiple accounts, which can be taken as the lead for action. I propose that the greater the risk involved, and the more radical or interventionist the proposed course of action, the more work is required to legitimate this path.

In suggesting that the anaesthetist need not contrive a singular account, that multiple accounts might also 'work', in that they provide a lead for action, I am saying that action in anaesthesia need not depend on 'convergence', on assimilating all the informative resources into one all-encompassing account. As will be discussed, possibilities are multiple, and can remain so, as long as they can be made to connect a situation to a consequent course of action. Where they cannot perform this link, the possibilities decay.

Generating 'situated' knowledge of medical encounters

Atkinson (1995) proposes that the production of 'situated medical knowledge', knowledge produced and utilised in practice that renders everyday situations intelligible, is a neglected theme in the social scientific literature on medical work and medical encounters. He notes how the sociology of medicine and the sociology of science have developed largely in isolation from one another resulting in a 'stunted' sociological treatment of medical knowledge (Atkinson,1995:37). He goes on to point out that 'all too frequently in sociological studies of expert communities *everything but* esoteric and everyday knowledge is explored' (Atkinson, 1995:37, original italics).

Atkinson argues that sociological studies of medicine have portrayed the medical encounter as an arena for the play of class inequalities, gender differences, professional dominance and manipulative control, all of which are important themes, however, this leaves medical knowledge itself, as a core sociological topic, untouched. This argument has also been proposed by Berg (1992), who has suggested that the cognitive domain of medical action has been regarded as self explanatory, not needing and denying sociological scrutiny. This development in the study of medical knowledge and action follows a course set by early attempts to study science: Webster (1991) recounts how, after the Mertonian explanation of science, the traditional belief that science was in some way 'outside' society began to be questioned, with both accounts of scientists' behaviour and scientific *ideas* being challenged.

Atkinson attends to this shortfall in his ethnographic study of haematology, his work contributes to an understanding of how knowledge is produced and reproduced in particular local settings. He approaches 'knowledge' as the outcome of everyday work, much of which is enacted through talk and shared among medical colleagues. Atkinson begins by describing the work that goes into rendering the body of the patient visible and legible, how the body is manipulated, transformed and fixed into a series of representations and enumerations and from these representations 'cases' are constructed. Assembling a 'case', he argues, is:

> a device whereby the diverse types and sources of knowledge and actions derived from different time-frames, are brought together under the auspices of a single discursive organization and made available for the collective gaze of medical colleagues. (Atkinson, 1995:149)

Therefore, Atkinson presents the narrative construction of a case as a mechanism for constituting intelligibility in the 'representations', 'enumerations' and 'signs' that circulate in clinical medicine. In actively constructing a case, the physician enrols knowledge from various sources – personal experience, research publications, textbooks, laboratory reports and so forth. These 'voices', Atkinson describes, may then concur or they may compete for legitimacy, used as contested warrants for diagnosis and actions. This raises the interesting question of *how* legitimacy of diagnosis and action are achieved, a question I address in this chapter.

Heath, Luff and Svensson (2003) identify a further gap in the sociological studies of health and illness. They argue that although digital technologies have transformed health care over the last two decades:

> The sociology of health and illness, indeed sociology in general, has been a little reticent in exploring the ways in which information and communication technologies feature in everyday practice in work and organisations. (Heath et al, 2003:76).

They do, however, discuss some significant studies that question the ways in which technical tools are shaped. One of these is Pasveer's (1989) study of X-ray imaging. Pasveer argues that the technology has to be considered with regard to current patterns of knowledge and practice, rather than its immediate, unambiguous impact on established practices of medicine. In contrast to the idea that X-ray images instantly provided a new, visual way of rendering the world, Pasveer demonstrates how the images became progressively significant, their use and diagnostic significance evolving over some time. What could be argued to be 'inside' the images from the

beginning, ready to be assimilated by radiology and the physicians, actually had to be shaped by the X-ray workers.

Timmermans (1998) also explores the role of technologies in health care; he examines the practices and functions of resuscitation technology in sudden death in emergency departments. He argues that the 'potential and power of a technological device to shape an interaction is not pre-given but is realised in practice' (Timmermans, 1998:148). Timmermans describes the ways in which the routine organisational arrangements force the members of resuscitation teams to proceed through resuscitation protocols even though chances of revival are minimal, but that the ways practitioners realise the protocols demands will vary according to the individual circumstances. As such, resuscitation efforts can sustain a period of liminality providing an opportunity for relatives to prepare for the impending death. Timmermans, then, articulates how the interpretations to be drawn from a set of practices are not fixed or predetermined but dependent upon the situation in which they occur.

Hirshauer (1991) presents a constructivist interpretation of operating theatre practices. Although concentrating primarily on the ritual aspects of operating theatre practice that accomplish a compliant operative object, Hirshauer does discuss the relationship between the anaesthetised patient and the anaesthetist. Hirshauer acknowledges how the patient's body is technologically extended and whose 'signs of life' are 'externalised' (1991:291) in the form of digital signs and readings, audible and visual alarms, and clinical signals.

> To the anaesthetists, the signs of life indicate a patient's state, which has to be continually controlled to maintain the delicate equilibrium of the various circulations. Compared with the evidence of verbal exchanges, which may begin with, say, 'how are you feeling?', the body's dumbness presents a problem. The evidence of machine-produced values takes their place, supported by the evidence of clinical signs. (Hirshauer, 1991:291)

Hirshauer identifies how machine-produced values coupled with clinical signs replaces verbal communication, an observation that resonates with the argument in the previous chapter. He goes on to suggest that:

> One must read all these values to *see* how the patient is 'feeling', what s/he needs. (Hirshauer, 1991:291, original italics)

Here, however, Hirshauer concentrates on the visualisation of these signs. He comments that regular blood analyses are *presented* on computer print outs, the monitor *shows* the pulse rate, the ECG trace, respiratory rate, tidal volume, airway pressures, oxygen concentration and so on. This implies that the meaning of these 'signs of life' are readily transposed from the patient to the monitor, the meaning being offered up to the anaesthetist as stable, transparent and inherent within the readings.

Again, Hirshauer misses the work involved in assessing the salience of the signs of life when he discusses the relevance of the alarms. He observes that when machine produced values fall outside preset limits the monitor will alarm and he offers two common interpretations for the particular example he documents.

> The (ventilator) alarm signal indicates not only a threat to a vital function but also the fading of narcosis. It alerts the vigilant anaesthetist to restore the intermediate state of narcosis. (Hirshauer, 1991:292)

However, this fails to convey the sheer contingency of these alarms and signals, and how, as Timmermans' and Pasveer's work suggests, they rely on other situational and communicative resources for the meaning. It seems to indicate that a given clinical sign comes complete with a corresponding interpretation, somehow contained within them rather than the meaning being accomplished. Hirshauer hints at this aspect when he states that clinical signs 'complement the machine produced values' and are assessed in the 'light of anamnestic data collected before the operation' (1991:292). Hirshauer lists some of these clinical signs – listening with a stethoscope, registering a tear, checking the pupils but does not elaborate on the processes through which they are allied to the 'signs of life' and how, of the multiple possibilities, the legitimacy of an eventuality is accomplished. It is this work that interests me in this chapter, how the anaesthetist works to establish the salience of the cyborg's signs and signals and in doing so legitimates one possibility over another.

The production of medical knowledge has also been the subject of many studies in medical anthropology. Often the focus has been on the means through which 'scientific' knowledge is attained, for instance through RCTs (see Lowy, 2000 for an example). In this chapter, however, I want to concentrate on the workplace practices that generate the ongoing, situated knowledge that serves to inform practice. Keating and Cambrosio (2000) straddle this micro/macro divide in their study of the

development of a classificatory system for leukaemias and lymphomas. They propose that:

> Medical classifications are less a finished product than an active, ongoing intervention on patients or body parts. ... In medicine, classification is coincident with diagnosis and the constitution and transformation of both diagnosis and classification follow from and lead to changes in the knowledge of the entities that are diagnosed/classified. (Keating and Cambrosio, 2000:105-6)

Keating and Cambrosio, however, do identify 'an uneasy relationship between the laboratory and the clinic' (2000:118) that stems from the 'unrivalled aura of scientific certainty' (Keating and Cambrosio, 2000:118) that the pathologists are granted. In spite of the physicians already having a 'working' diagnosis, the definitive diagnostic word rests with the pathologist. A question that follows from this study, then, is how clinicians actually produce and legitimate a 'working' diagnosis, a question I am interested to pursue in this chapter.

Dumit (2000) investigates the role that brain imaging plays in establishing the legitimacy of diagnoses such as Attention Deficit Disorder, Chronic Fatigue Syndrome, Gulf War Syndrome and Multiple Chemical Sensitivity by analysing the controversies that surround these disorders and the various social, political and economic arguments that are invoked in these controversies. He argues that brain scans and other biological evidence may offer some adjudicative function in establishing the existence of disorders, but are rarely the *final* word on these disorders, rather they function *locally* as *temporary* resting places for explanations. (Dumit,

2000:210) Brain imaging, Dumit suggests, plays a key role in resisting the easy assignment of blame, stigma and causation to the individual, but not by settling the matter once and for all in biology. As Dumit puts it:

> Rather, the continual jostling for competing social, political and moral notions of nature and personhood that underpin our notions of biology and disease imply that these socio-medical disorders might only be 'explained' temporarily and locally. (Dumit, 2000:227-8)

However, by remaining outside Dumit's remit, the ways in which brain imaging features in the daily practice of establishing a medical diagnosis escapes analysis.

Analysing the work of anaesthetists: theoretical resources

All these insights indicate the level of work that goes into forging an account which both explains the current signs and symptoms the patient exhibits and proposes an appropriate course of action. It also suggests that medical technologies and devices play a key role in this work. How then should one examine the ways in which these accounts are developed? What theoretical resources exist that will enable the analyst to hold in focus the practical performances of humans and technologies in anaesthetic work?

One such resource is Law's (1987) 'heterogeneous engineering'; in its original form the term was conceived to describe the enrolment and stabilisation of disparate elements, of varying degrees of malleability, into a network. The negotiations, tactics

and relationships that hold a network together give the product of the network its resultant characteristics:

> the stability and form of artifacts should be seen as a function of the interaction of heterogeneous elements as these are shaped and assimilated into a network. (Law, 1987:113)

Law uses the concept of 'heterogeneous engineering' to elucidate the development process of a large-scale technological artefacts, in this case Portuguese ship building. In this Law acknowledges that:

> successful large-scale heterogeneous engineering is difficult. Elements in the network prove difficult to tame or difficult to hold in place. Vigilance and surveillance have to be maintained, or else the elements will fall out of line and the network will start to crumble. (1987:114)

Therefore, 'heterogeneous engineering' refers to the activity of drawing together elements of the natural, physical, social, and technological and tethering those elements in a stable network so as to produce an artefact, outcome, or effect.

I propose to view the activities of the anaesthetist as 'heterogeneous engineering'; drawing together elements into an account that lends a present situation some intelligibility. There are, however, some difficulties in using this term, the first is to do with the notion of stability. As Law points out, heterogeneous elements do not cohere naturally of their own accord, they must be stabilised or 'the network will start

to crumble' (1987:114). Consequently, a fundamental problem faced by those involved in 'heterogeneous engineering' is:

> how to juxtapose and relate heterogeneous elements together such that they stay in place and are not dissociated by other actors in the environment in the course of the inevitable struggles (Law, 1987:117).

It is clear to see why in ship building stability is essential, but as Singleton (1998) argues, sometimes it is the instability and ambivalence of a network that is essential in ensuring the network's durability. In the case of the Cervical Screening Programme (CSP), Singleton suggests that only by allowing and accommodating instability at the level of practice does the laboratory manage to maintain stability at the level of the CSP. One of the examples of intractable instability Singleton describes concerns the analysis and reporting of cervical cells. The laboratory follows guidelines for recommendations, fitting diagnoses into the categories on the report cards. However, detecting the degree of abnormality present is not as straightforward as presented by the government and the public CSP. The changes in the cells vary beyond the classifications presented on the report cards and the significance of the changes can also have a variety of meanings. The laboratory workers accept this uncertainty as part of their role and ambivalently state that 'it is influential' but that 'in reality it does not make a lot of difference', the difficulty generally being in charting the difference between 'mild' and 'moderate' changes (Singleton, 1998:94).

In his analysis of medical decision making Berg (1992) also indicates why stability need not necessarily be a criteria for the success of 'heterogeneous engineering'; he

argues that a problem is solvable when a doctor is able to propose a 'disposal', meaning a limited set of actions sufficient to answer a specific patient problem. This does not mean, however, that the patient's problem is relieved, according to Berg, what matters is that the physician knows what to do next. This implies that the accounts anaesthetists produce need not hold indefinitely, only long enough to direct the next action, after which further elements may be incorporated that will reconfigure again the account and suggested actions.

Berg empirically demonstrates how historical information and examination results, organisational practices, time, and disposal options all mutually interact and are reconstructed in the light of one another. He argues that no single element is more fundamental than the others, that the elements reciprocally shape one another and are themselves moulded in the process. As Berg tells it, accounts are continually realigned to match an evolving clinical picture, an account only has to endure as far as it directs the next action. Consequently, stability may not be the most suitable criteria on which to judge the success of heterogeneous engineering in anaesthesia.

A second problem is that in describing the work of anaesthetists as 'heterogeneous engineering' one centres the anaesthetist as the 'heterogeneous engineer', the pivotal actor, the planner, the grand designer; incongruous perhaps when approaching decision making as a distributed activity. Timmermans and Berg (1997) note this tendency of actor-network studies to centre the perspective of scientists or engineers, and the 'managerialist' overtones of the 'heterogeneous engineer' are noted by de Laet and Mol (2000). To criticisms such as these Law (2002) responds that:

> we need to hold on to the idea that the agent – the 'actor' of the 'actor-netowrk' – is an agent, a centre, a planner, a designer, only to the extent that matters are also decentred, unplanned, undesigned. (Law, 2002:136)

and he revisits 'heterogeneity' to delineate its various forms. Doing so, he proposes, recovers the ontological heterogeneity of the term; it avoids, he suggests, 'the flattening effect of imagining that there is on the one hand a great designer, a heterogeneous engineer, and on the other a set of materially heterogeneous bits and pieces' (Law, 2002:136). So, I use the term 'heterogeneous engineering' cautiously, wary of its propensity to centre the anaesthetist as *the* decision maker, and to invoke notions of stability and endurance. Consequently, I will use the term in the sense of an activity that anaesthetists as well as many other participants of anaesthesia may engage in, and by balancing this chapter alongside the others I endeavour to illustrate how it is not only the anaesthetist that shapes the course of anaesthetic practice, many other elements also contribute to this.

Emphasising the fluidity, ambivalence and contingency, rather than the stability, of medical diagnosis and treatment Mol (2000) argues that it is not always possible to make diverse elements align and converge, to achieve a singular coherent narrative. Sometimes, explanations of a clinical situation will be divergent, some may take priority over others, but the others still exist:

> Where in textbooks the various versions of a disease tend to be neatly *aligned* to form a coherent overall picture, in practice there are gaps, fissures and frictions between different performances of any 'one' disease. It must be easier to coordinate images and stories of a textbook into singularity, than it is to do this

> with the materialities of the body and the hospital. For in practice links between various performances are sometimes hard to craft and if they are crafted, even if they go under the same name, the 'diseases' diagnosed in different sites, do not necessarily coincide. Instead of being aligned into coherence, in practice reality is *multiple*. (Mol, 2000:96)

This resonates with my experience of anaesthesia in which, on occasions, different explanations of a clinical situation can be devised in retrospect and sometimes even made to cohere but what matters at the time is the clinically situated understanding that suggests a further set of actions. Perhaps, then, the validity of an interpretation rests in some part on the ability of an account, safely, to inform the next set of practical actions.

For Mol, 'performance' is a move away from 'construction', a term used in the social sciences to stress the historicity and contingency of the 'constructed' entities (Haraway, 1991b). The difficulty Mol (2000) has with 'construction' is that it tends to invoke notions of endurance, and in Mol's studies of the body and diseases such as atherosclerosis, articulations of atherosclerosis will not endure unless revitalised time and again. Drawing together the pain a person with atherosclerosis experiences and the thickened vessels creates a narrative that will disappear unless it is re-enacted. So there is a parallel here between the heterogeneous engineer and stability, and constructivism invoking notions of endurance. Mol addresses this difficulty by using the 'performance' metaphor:

> It is this requirement of repetitive re-enactment that the theater metaphor *performance* gets across quite well. ... The instruments and skills involved in

> this performance are not invented from scratch every morning: there are scripts available. These may be followed meticulously or fairly freely; they may be modified and changed. (Mol, 2000:86, original italics)

Therefore, performativity suggests that the work of assimilating a narrative does not begin from the outset over and over, rather it is that once made, those links must be re-enacted unless they begin to decay. In the case of anaesthesia an explanatory account, or narrative of a clinical situation, will hold for as long as it is being performed. Mol (1998) adds that such links are only performed insofar as they suggest an action, something practical. So like Berg, Mol argues that the purpose of making these links, assembling these heterogeneous elements to tell a particular story and generate a situated interpretation of events, is to suggest a set of practical actions.

Engineering in action: untidy and uncertain

As I discuss below heterogeneous engineering in anaesthesia is an activity that anaesthetists engage in to try to determine what is happening to the patient and what their next set of actions should be. However, the image of an anaesthetist engineering an account of a clinical situation in which all the elements fall neatly into alignment producing an explanation that clearly points to the appropriate course of action is an idealised model of practice that rarely occurs. In my observation of anaesthetic practice, heterogeneous engineering was difficult, uncertain, with obstinate and contrary elements continually disrupting the emergent account. These elements had either to be discredited and dispelled from the account or simply ignored and left

unexplained. Here, though the issue hinges on how safe it was to do so, what were the risks involved in dispelling or ignoring an element? Sometimes engineering would produce parallel, multiple, or fragmented accounts, sometimes these could be taken as a lead for action and sometimes they could not. And on occasions, when the necessities of life (a clear airway, the ability to breathe, and an adequate circulation) are jeopardised, action can threaten to overtake the precarious strategy of the heterogeneous engineering. As we will see, heterogeneous engineering in practice then, is a messy, contingent and inherently uncertain affair.

Engineering a (more or less) convergent interpretation

It is a Saturday morning, an 8 year old child is having an 'Open reduction and internal fixation' of his broken arm. This involves surgically exposing the fracture, realigning the bones, placing a metal plate, secured by metal screws, so as to bridge the fracture and then closing the wound. For this procedure the child requires a general anaesthetic. The anaesthetist, Dr Steve Wilkins, is relatively new to the specialty, he has been practising anaesthesia, mostly under supervision, for just over 6 months now. This is one of the first occasions he has practised independently. The sequence begins in the operating theatre with the surgery already underway.

> The black face mask is lying on the pillow next to the patient. The pulse rate, displayed on the monitor, goes back up to 130. Dr Wilkins peels back the tape covering the patient's eyes, lifts back the eyelid and looks at the pupil, he then administers more morphine. He has given 5mls so far. Pulse 147, blood pressure 147/51.

Dr Wilkins talks to me, he says he had given 5 of morphine and his pupils were pinpoint, now the pupils are really wide again and the patient is also taking on a lot of isoflurane. *(Meaning that the patient is responding to pain as he has insufficient analgesia to counter the effects of surgery.)*

Pulse slowing to 103. Dr Wilkins is recording on the anaesthetic chart some measurements from the list on the screen. Pulse 86. Dr Wilkins stands leaning on the drip stand, watching the monitor. Blood pressure 120/44. Dr Wilkins turns the volume down on the pulse oximeter. 'High end tidal CO2' flashing on the screen, the numbers in white read '8.7'. Dr Wilkins presses some buttons on the monitor and scrolls through some screens. *(I think what he is doing is changing the limits on the end tidal carbon dioxide as one of the screens he scrolled onto was called 'Airway Gases', and following this the number stops flashing.)*

Dr Wilkins feels the patient's forehead. An ODP enters with the controlled drug book. Dr Wilkins asks the ODP for 50 mgs of voltarol *(a pain killer)*. End tidal carbon dioxide now reading 9.2 and not flashing. The ODP enters, hands Dr Wilkins a glove and a voltarol suppository.

10.24

Dr Wilkins administers the voltarol suppository. He then looks at the pupils again and gives more morphine (about 8 mls given in total).

I ask about the end tidal carbon dioxide readings, he says he did change the limits. He says 'its probably because he is hypoventilating, it's quite high but it's all right'.

10.30

End tidal CO2 now flashing again and reading 10, pulse 80, blood pressure 108/48. Dr Wilkins watching the surgery.[9]

Demonstrated here are a number of the resources the anaesthetist can draw on in producing an intelligible account of the clinical situation. When the pulse rate goes up to 130 the anaesthetist looks at the patient's pupils and then administers some morphine. The anaesthetist takes the raised pulse rate as a signal that the patient is experiencing pain, the appearance of the patient's pupils, going from pinpoint to wide, confirms this interpretation. The raised blood pressure (147/51 is high for an 8 year old) adds weight to this account. In this way aggregated patient 'norms' are another element drawn into an account that might explain the signs and symptoms the patient displays. This account is again affirmed by the amount of isoflurane, an anaesthetic vapour, the patient inhales. The patient, in this example, is not paralysed and so still regulates his own breathing, he can, therefore, 'take on' more isoflurane by increasing the depth and rate of inhalation. Increasing the amount of anaesthetic inhaled, in turn, deepens the level of anaesthesia and thus counters the painful effects of the surgery. Assembling these communicative signals from the cyborg and coupling them with situational resources such as the activities of the surgeon (when the surgeon manipulates the fracture this will be more painful than when s/he closes the wound) creates a coherent narrative. This narrative suggests to the anaesthetist that the patient is in pain and in doing so proposes a course of action to the anaesthetist: the anaesthetist should give some analgesia, morphine for immediate effect and volterol to cover the next few hours. Subsequent signals from the cyborg, the pulse slowing to 86 and the blood pressure reading falling to 120/44, implies that the anaesthetist's explanatory account and accompanying course of action has had the desired effect of counteracting the pain of surgery.

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[9] DG Obs 190800

This is not quite the end of the story, some of the signals have not been incorporated into this interpretation. The carbon dioxide readings, for instance, tell a slightly divergent story. Exhaled carbon dioxide (end tidal CO2) is primarily measured as an indication of the adequacy of ventilation. However, given that one characteristic of morphine is to act as a respiratory depressant, if the anaesthetist overestimates the amount of morphine required this will result in insufficient patient ventilation and a corresponding rise in the amount of exhaled carbon dioxide. Therefore, the end tidal carbon dioxide reading can also serve as an indirect measure of the efficacy of analgesia. Maybe, the anaesthetist's actions have not only relieved the pain but also depressed the patient's respiratory ability.

The question the anaesthetist now seeks to answer is whether he has given insufficient, sufficient or more than sufficient analgesia? The anaesthetist searches for elements to confirm the interpretation, suggested by the carbon dioxide readings, of more than sufficient analgesia. What he finds, however, does not corroborate this account. He feels the patient's forehead, a clammy or sweaty forehead serves as another indication that the patient is experiencing pain. This contradicts the possibility of an over-analgesed patient and suggests further analgesia is required. The anaesthetist administers a voltarol suppository and, on checking the pupils again, some more morphine.

I ask the anaesthetist about what the carbon dioxide readings indicate to him. He replies that the carbon dioxide is indeed quite high, most probably because the patient was 'hypoventilating' (not breathing at a sufficient rate or depth) but that this was not at such a level as to cause concern. So the anaesthetist, in his heterogeneous

engineering, draws on a range of resources to interpret the situation. Some of these emanate from the cyborg: readings such as blood pressure and pulse measurements, respiration rate, the measurement of inspired and expired gases, the size of pupils, the feel of the patient's skin, and as glimpsed at the end of the excerpt the anaesthetist can watch the surgery and make a judgement of the level of pain it will incur. So the intelligibility of the situation is engineered in producing a coherent narrative. All the signs do not, of themselves, cohere; producing a coherent account, therefore, necessitates the exclusion of one of these elements, in this case the carbon dioxide readings. Producing an explanatory account, then, is about balance, in this the majority of the elements converge to suggest that the patient is responding to pain, and by marginalising the discrepant details the anaesthetist can act on this basis. Coherence, rather than divergence, is taken as the basis for action.

Accounting for multiplicity

In the following scene, again the carbon dioxide reading is problematic, and again it seems as though the anaesthetist (Dr Tom Hughes) is unwilling to act on the basis of one rogue reading apparently unconvinced by the possibilities it invokes. The action begins in the anaesthetic room before the anaesthetist arrives and continues when the patient has been anaesthetised, has been transferred to the operating theatre, wherein the surgeons are 'scrubbing up' prior to beginning the surgery.

> As the ODP, Ben Pearson, is connecting up the monitoring I ask him how he finds the new machines.
>
> Ben "Alright, I can't remember the old ones." He tells me about a difficulty he had with the machine in theatre this morning. When changing the soda lime *(a large canister of pink granules that absorbs carbon dioxide)* the old machines

just used to clip back in but with these machines you have to get it exactly right or you don't get a seal around the canister and end up with quite a big leak in the circuit.

(The anaesthetist arrives, the patient is anaesthetised and transferred to the operating theatre)

09.16

Two surgeons are 'scrubbing up'. The anaesthetist, Dr Hughes, looks at the anaesthetic machine and mentions the carbon dioxide.

Ben "What are you thinking? MH?" *(Malignant Hyperthermia, a rare inherited disorder triggered by anaesthetic agents, characterized by climbing temperature and a high carbon dioxide.)*

Dr Hughes "I'm not really thinking MH, he's had too many anaesthetics, but he shouldn't have a CO2 of that either." He turns to the surgeon "Is there really a laparotomy? *(A conversation ensues between the anaesthetist and the surgeon about the condition of another patient)*

Patient now prepped and draped. Carbon dioxide 7.2, blood pressure 88/65.

The ODP brings in a temperature probe and Dr Hughes inserts it into the patient's nose and feeds it down to the level of the stomach.

(Another conversation, this time between the anaesthetist and the junior surgeon about some of the patients on the intensive care unit)

Dr Hughes and the ODP talk about the anaesthetic machine.

Dr Hughes "... CO2 trace..."

Ben "... leak... soda lime..."

Dr Hughes takes his gloves off, kneels, looking and feeling round the canister of soda lime.

The surgeon asks for "Heparin 3500"

Dr Hughes "Heparin 3500, can you get that?" (to Ben) Dr Hughes feels the patient's forehead with the back of his hand. He has one hand on the vapouriser which is on 1.5%. Dr Hughes presses something on the screen.

(Approximately 15 minutes later)

Dr Hughes turns the vapouriser up to 1% and looks at the monitor. He lays the antibiotic down on the pillow and exchanges it for a new bag of fluid. Carbon dioxide 6.1, temperature 36.7, blood pressure 99/55, pulse 71 and oxygen saturation 99%.

(Another 10 minutes later)

09.48

Dr Hughes writing on anaesthetic chart. He runs the back of his hand over the patient's forehead and then stands looking at the monitoring.

(Another 15 minutes later)

10.04

Dr Hughes "This guys getting steadily cooler, he's now 36.3."

Ben "Do you want a gamgee hat?" He brings in some cotton wool covered in gauze and drapes it over the patient's head.

Dr Hughes talks to the surgeon "We will do your lady *(patient requiring a laparotomy, mentioned above)* but I wouldn't be surprised if she needs ICU post op."

Carbon dioxide 5.7, pulse 68, oxygen saturation 99%, blood pressure 99/59.

In a quiet moment I ask the anaesthetist whether he was worried about the carbon dioxide readings earlier.

Dr Hughes "Yes because the trace didn't drop to the baseline which means that he will have inspiratory CO2 which you shouldn't have at all. It *(the soda lime)* should wipe it out. So that means either a leak in the circuit or MH, it's unlikely to be MH as he has had too many previous operations. It seems to have resolved now and it didn't clinically cause any problems, also the falling

temperature is comforting. In the anaesthetic room his CO2 was 11 on 8 litres and if I ran at my normal low flows of 1 litre I was worried his CO2 would have just climbed. I was also worried that the isoflurane reading was not correct, but again that did not cause a problem clinically."[10]

The carbon dioxide reading is higher than anticipated for which Dr Hughes is unable to find a suitable explanation. 'Malignant hyperthermia' was one possibility as indicated by a raised and climbing carbon dioxide. However, malignant hyperthermia is a genetic condition and would have shown in the patient's previous anaesthetics. So this explanation doesn't correspond with the patient's medical history, but this detail alone is insufficient to discredit an interpretation of malignant hyperthermia, other elements must be found to support this account. With malignant hyperthermia the patient would also exhibit a climbing temperature, consequently a communication pathway is established to ascertain this information – a temperature probe is inserted, via the nasal passageways, into the stomach and connected to the anaesthetic machine where the readings are displayed. Dr Hughes and the ODP discuss another possibility, that the carbon dioxide readings are incorrect, perhaps due to a leak in the anaesthetic circuit. The ODP had already indicated to me earlier that it can be difficult to achieve a good seal after changing the soda lime. Work in pursuit of this explanation ensues, Dr Hughes checks the fit of the soda lime canister, feeling for any leaks in the circuit. Unsuccessful, Dr Hughes turns his attention back to the patient, feeling the temperature of the patient's skin. As time goes on the patient's temperature falls rather than rises and the anaesthetist and the ODP take steps to prevent further heat loss.

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[10] DG Obs 280900

At this point I ask about the carbon dioxide readings. The anaesthetist's response suggests that he only considered two possibilities and neither adequately accounted for the situation. First, it seemed that the patient was inspiring carbon dioxide that should have been absorbed by the soda lime. Perhaps there may be a leak in the circuit, but on examining the circuit no leak could be found. Furthermore, the patient's carbon dioxide readings in the anaesthetic room were also high and it would be unlikely for there to be a leak in both circuits. Secondly, a high carbon dioxide reading could indicate the onset of malignant hyperthermia but the patient has had numerous anaesthetics in the past and no prior indication of malignant hyperthermia. Moreover, the patient's temperature fell during surgery rather than rose, again discrediting an explanation of malignant hyperthermia.

What is interesting here is the anaesthetist's reasoning: 'It seems to have resolved now and it didn't *clinically* cause any problems'. The anaesthetist couldn't engineer a singular account of the clinical situation, convergence of the signs and resources couldn't be achieved, explanations remained multiple. Multiplicity, in this case, does not provide a sound basis for action. The question then turns on where the balance lies, in favour of which explanation. However, it was impossible to assign more credibility to one than the other, both possibilities seemed equally unlikely, therefore, the anaesthetist could use neither of these accounts as the basis for further action. Instead action was premised on the assumption that *clinically* there were no problems. Here the anaesthetist makes an interesting distinction, 'clinically' appears to refer to the organic components of the cyborg. The readings are produced, these are problematic, but they are not problematically manifested in the patient's body, the

problem seems to exist only in the machine part of the cyborg. If then the problem is not organically present it remains a potential or theoretical problem, not a 'clinical' problem requiring an intervention. Having reached this position, and in the continuing absence of a 'clinical' problem regarding the carbon dioxide levels, achieving a singular coherent account of the anomalous carbon dioxide readings becomes unnecessary. The multiple accounts are simply left separate and divergent whilst anaesthetic practice continues. This much is evident when the operation is finished and care of the patient is handed over to the recovery nurse.

> The recovery sister enters with the trolley and positions it next to the operating table. She connects the portable oxygen to the laryngeal mask.
> Dr Hughes "... this gents got renal failure... graft right arm... axillary block..."
> Someone enters and tells Dr Hughes that there is a phone call for him. He goes to answer the phone. The recovery sister takes the patient to Recovery.

The anaesthetist makes no mention of anomalous carbon dioxide readings infering that crafting a link between anomalous carbon dioxide readings and the 'clinical' condition of the patient was no longer necessary. Where work goes into engineering an account to explain the carbon dioxide readings a link is partially performed. Unable to ally the carbon dioxide readings to any other informative element or situational resource, those possibilities cease to be performed and simply dissipate. On delegating the care of the patient to the recovery nurse, the anomalous carbon dioxide readings, which have not been problematically manifested in the patient, remain a potential or theoretical problem for the anaesthetist. It then becomes unnecessary to continue to perform these unsatisfactory and partial links. An intelligible account of the carbon dioxide readings simply cannot be achieved. The only sensible account to be crafted is one

that excludes the carbon dioxide readings; so divergent and contradictory resources are again expelled from the dominant interpretation. As the situation evolves it becomes unimportant to even try to assimilate them into a singular coherent story. Multiple possibilities exist, but no longer being performed, they decay.

Multiple performances and fragmented ontologies

Below is a description of an incident in the intensive care unit during a morning ward round in which a team of health professionals (in this case a consultant anaesthetist, two junior doctors and several nurses) review all the patients. It is a long excerpt that spans a period of approximately two hours, so some editing was necessary and is indicated in italics, as are the explanations I have added. The account describes a critical period of one patient's care. The doctors and nurses are aware that the patient's condition is deteriorating but are unable to identify precisely the problem. This situation, therefore, illustrates some of the work entailed in engineering an account that both explains the symptoms the patient displays and suggests a set of consequent actions. After intense work to isolate and address the problems, and stabilise the patient's condition, the consultant conveys the course of events to the family. A different type of data, a debriefing interview in which the consultant uses the transcript as a tool to aid reflection, then follows. Thus, I present three versions of this event, my description of the episode, my recording of the anaesthetist's description to the family, and the anaesthetist's commentary on my description. Here, then, the health professionals: nurses, student nurses, two junior doctors (a surgical and an anaesthetic SHO) and a consultant anaesthetist, are all scrutinising the patient's chest X-ray before reviewing the patient himself. They are discussing whether the patient might have a pneumothorax, a term used to describe a leak in the

lungs through which air escapes but remains trapped within the chest cavity. This then compresses the lung preventing proper inhalation.

Dr George Williams, consultant anaesthetist, and Dr Prasad Chatterji, an anaesthetic SHO, head over to the X-ray viewing box, by the nurses' station, Dr Charlie Davis, a surgical SHO, and I follow. Dr Williams puts some 'chest films' up and discusses with the two SHOs whether it shows a pneumothorax – they conclude it does. Dr Davis hands them another X-ray that they look at. By now 2 nurses and 1 student nurse are also gathered round the Xrays. Dr Williams questions the nurses: 'If you saw this what would you think?' One of the nurses mentions that the 'trachy' *(tracheostomy – a surgical opening in the throat through which the patient is intubated and ventilated)* tube is pointing the wrong way.

Dr Williams "The trachy looks like it is in the wrong place.... And either fluid or atelectesis or an artefact... Is there anything we need to do in a rush because of this Xray?"

Dr Chatterji "No"

We all follow Dr Williams back to the second patient, the curtains are drawn around us.

Dr Williams briefly recaps the patient's history of care in the ICU "... attempted tracheostomy... bleeding ... Charlie saved the day..."

The nurse who answered the question about the trachy now approaches holding a coffee, she begins to give a history of the last day's care. I see from her name badge she is called Lucy.

Lucy "... CO2 keeps going up and up, it doesn't seem to matter what you do to the ventilator..."

This patient is lying still in the bed, covered neatly with a sheet, attached to the ventilator via the tracheostomy.

Lucy "...tachycardic..."

Dr Williams "Why?"

Lucy "he's struggling"

The nurse carries on with the history mentioning the patient's urine output, potassium, on TPN feeds *(liquid nutrition administered intravenously)*, no bowel sounds...

Dr Williams "... taking a while... anyone examined him?"

Dr Davis "Very quiet breath sounds, CO2 retaining. I don't think he's getting rid of...(he turns to the ventilator and points to a tiny notch on the trace)... little notch there"

Another person enters distracting Dr Williams momentarily

Dr Williams "Why is he... quick listen to his chest." As he puts the stethoscope to the patient's chest he lifts one of the eyelids. He then disconnects the ventilator.

Lucy "Did you mean to do that?"

Dr Williams "Yes, what can you hear? (He listens by the tracheostomy.) ... big wheeze... basically his chest is full of gas... chest is so full can't get... (he feels the patient's tummy)... distended but... (there is a dressing on the patient's tummy, a white plaster with 10AM written on it)... don't want any air trapping *(in which the expiratory phase of respiration is not completed before the ventilator delivers another breath)*... 200 mls plus... chest getting bigger and bigger no matter what pressures... expiratory wheeze...blood cultures..."

Dr Williams and the other doctors discuss various aspects of the patient's condition and decide they need to change the ventilation.

Dr Willliams interrupts "I wouldn't get him to breathe himself... air trapping..."

Dr Chatterji "you mean paralyse him?"

Dr Williams "Yes. Give some tracrium now, just see if it works..."

Dr Williams alters something on the ventilator. Someone else enters, and tells Dr Williams to page another anaesthetist when he's finished the ward round.

Lucy returns with some ampoules of atracurium.

Lucy "50 George?"

Dr Williams "... if paralysed, well sedated, I think he's well sedated... infected element, don't know what it is... paralyse and ventilate... air trapping like buggery, don't write that down (to me). Why is that going up and down? (he points to the screen)"

Lucy "Not a smooth expiration"

Dr Williams "His heart... just bag him" He disconnects the ventilator and connects the water circuit *(a manual ventilation circuit)*. The ventilator still going, making a loud noise now it is not connected, Dr Davis attaches a reservoir bag to the end, this makes it quieter.

Dr Williams "Suction catheter"

Lucy feeds a catheter down the tracheostomy. Dr Williams is stood on the patient's left by the head, next to him is Dr Davis, then one male (possibly a student nurse), then Dr Chatterji, then me at the bottom. On the right is Lucy then the ICU Sister. Dr Williams disconnects the water circuit and listens, head down by the patient's throat. He presses with both hands on the patient's chest.

Dr Williams "What can you hear?"

Lucy "Nothing" she listens, head by patient's throat.

Dr Williams "He's still exhaling." He reconnects the ventilator. "Are we ventilating?"

Dr Chatterji "No"

Dr Williams switches back to the water circuit, Dr Davis ventilates. Dr Williams moves round to the head of the patient and removes a pillow. He lifts the patient's chin up and holds the tracheostomy tube and takes over ventilating.

Dr Williams "Quite high pressure... do about 6 a minute" he hands the bag back to Dr Davis. Dr Davis turns the valve on the water circuit and squeezes the bag with both hands.

Dr Williams "Air entry very quiet... give a nebuliser now."

Lucy "Salbutamol" *(a drug inhaled to dilate the airways)*

Dr Williams "10 mls of 1 in 10 000 adrenaline"

Lucy "Press top left" Dr Davis presses something on the monitor.

Dr Williams "Bronchoscope.... Lets have another look at the X-ray, check we are not missing anything." We all go back to the viewing box.

Dr Williams "Is there a pneumothorax there?" He takes his glasses off and peers very closely at the X-ray, he follows lines on the X-ray with his finger.

Dr Davis "You can see a line superimposed... I can't see a pneumothorax." he points to the X-ray.

Dr Williams "If we can't ventilate him we are going to have to stick drains in... this looks suspicious..." He compares today's X-ray to yesterday's. (At one point Dr Williams gets todays and yesterdays X-rays the wrong way round, Dr Davis corrects him.)

Dr Williams "lung is much more hyperinflated today"

We all follow Dr Williams back to the patient. Dr Williams tapping the patient's chest. Dr Williams asks for a stethoscope and someone hands him one, he listens to patient's chest.

Dr Williams "100% oxygen please... adrenaline, that's the concentrated stuff"

The intensive care sister has just handed him a syringe, he hands it back.

Sister "What did you ask for?"

Dr Williams "1: 10 000"

The ICU Sister returns with the prepacked syringe of adrenaline and hands it to Dr Williams. He opens the blue plastic packet and squirts about 1 ml down the tracheostomy tube. Dr Williams watches the patient.

Lucy "What is that for?"

Dr Williams "Severe bronchospasm... it acts directly to break bronchospasm..."

Lucy "He was quite stable until George came along"

Dr Williams looks round at Lucy and smiles. He listens again to the patient's chest. He feeds the suction catheter down and back again. "Why is the machine not delivering breaths? Is it a machine problem or a patient problem?"

Dr Williams now ventilating using the water circuit, squeezing hard to empty the whole of the bag.

Dr Davis brings in a foil tray containing some cannulae. (I think I heard Dr Williams mention cannulae earlier) Dr Davis puts a pair of gloves on.

Dr Williams "Hyperinflated lungs... no chance to exhale... if in doubt do it."

Dr Davis inserts a brown cannula into the upper right side of the patient's chest. He removes the needle.

Dr Williams "Lovely hiss"

Lucy "Setting up for a chest drain..."

Under the supervision of Dr Williams, Dr Davis and Dr Chatterji put a chest drain in each side. Following this the bronchoscope arrives, it had been asked for earlier but was being sterilised in theatre.

Dr Williams feeds the bronchoscope down the tracheostomy. "No obstruction in the right main bronchus... end of tube stuck up against the wall... try ventilating now... any easier?"

Lucy "No"

Dr Williams offers the eyepiece of the bronchoscope to Lucy, she looks down it.

Dr Williams "You're ventilating against that .... Having a bit of a problem... get a tube handy..."

Dr Davis leaves. Dr Edward Hargreaves, another consultant anaesthetist, enters.

Lucy "Crash trolley please" she says this loudly, directed outside curtains.

('Crash trolley' contains resuscitation equipment)

Dr Williams briefs Dr Hargreaves on their actions this morning regarding this patient.

Crash trolley wheeled in.

Dr Williams "Take the trachy right out..."

Dr Hargreaves "When the bronchoscope was down what did you see... pointing..." Dr Hargreaves continues questioning Dr Williams.

Dr Williams "Ventilation very, very difficult... bronchoscope... against the anterior wall..."

Lucy ventilating. Dr Chatterji stitching the chest drain in.

Dr Hargreaves "Would a tube be easier?"

Dr Williams "You would know the tube would be pointing straight down... basically disconnect from the ventilator... long, long expiratory... chest hasn't been a major problem..."

Dr Hargreaves "Not paralysed..."

Dr Williams "We paralysed about 40 minutes ago... I think change the tube ... just see..."

Dr Hargreaves "I'd be surprised if it makes a difference..."

Dr Williams at the head, looking down at the patient's chest, frowning. He stands holding the patient's chin up.

After some further discussion with Dr Hargreaves, Dr Williams decides to change the tracheostomy tube for an endotracheal tube. Before they can do so the X-ray team arrives and take a chest X-ray of the patient.

11.55

We all move back over to the bedside. Dr Chatterji is listening to the patient's chest with a stethoscope. Dr Williams moves up to the head and takes over ventilating, he lays the patient flat.

Dr Williams "Lets just put down a normal tube first of all."

Dr Davis "Do you want sux going in now?" *(suxamethonium – a paralysing drug to allow intubation)*

Dr Williams "Yes please." He inserts the laryngoscope, then the tube into the mouth but does not yet advance the tube down to the trachea.

Dr Williams "Ready to take the trachy out in a minute?"

Sister "Tell me when to deflate."

Dr Williams "Is it stitched in?"

Sister "Shit"

Dr Williams "Stitch cutter" (loudly, directed outside the curtains)

There is now another cannula sticking out of the left side of patient's chest (I didn't notice this going in). The sister cuts the stitches holding the tracheostomy tube in place.

Dr Hargreaves "His belly's blowing up" I look at the patient's abdomen, it is visibly inflated.

Dr Williams "Why is that?"

I look at the monitor – oxygen saturation reading 75%.

Dr Williams intubates then connects the water circuit and ventilates. "That feels better."

Sister "Sleek" *(a type of adhesive dressing)*

Dr Wiliams "Aspirate on the NG" *(nasogastric tube)*

Dr Hargreaves "Saturation coming up nicely." Oxygen saturation is now 86%.

The sister directs Dr Chatterji on how to tape the chest drain down. (Patient looks pink again now)

Dr Hargreaves "89%... belly's going down now too..." (Abdomen almost back to normal)

Dr Williams "Charlie try and ventilate"

Dr Hargreaves "Everything under control from the monitor." He is stood next to me at the bottom end of the bed.

Dr Williams "See what the Xray shows..."

Dr Hargreaves "I'll go down and have a look."

Dr Williams bronchoscopes again, down the tube this time. He connects the suction to the bronchoscope. 3 nurses working at securing everything – the endotracheal tube, chest drains etc.

Dr Williams and Dr Davis are stood at the head, Dr Chatterji on patient's left. (The atmosphere is calmer now, around the time of intubation I felt it was quite tense).

Whilst this securing work continues Dr Hargreaves returns from checking the X-ray and reports that the X-ray shows "2 pneumothoraces" requiring a further two chest drains. They set up and insert two more chest drains, Dr Williams supervises. Dr Williams says that he needs to talk to the patient's family and asks Lucy to accompany him.

Dr Williams, Lucy and I leave the unit and walk a short distance down the corridor to the relative's room. It is a smallish room with a kitchen area and sitting area. The family, a young man, mid-late twenties (son) and an older woman (wife), are seated drinking tea.

Dr Williams sits in the far corner of the room facing them both, Lucy sits on the sofa next to the son and I stand behind Lucy. Dr Williams introduces us all, he tells them the patient is stable now but earlier on they had had some difficulties. He begins by going back to the previous day when the tracheostomy was inserted then talks them through today's events when they had difficulty ventilating. He explains that this may have been for two reasons, firstly the

tracheostomy was pressed against the wall of the trachea, so they have changed from the tracheostomy back to a tube going in the mouth and down into the throat. The other reason was a pneumothorax. Dr Williams explains that a pneumothorax is where there is a small hole in the lung that leaks out a pocket of air that then compresses the lung. He said at one point the patient's oxygen saturation, which they like to keep at around 100, went down to about 75% for a period of about 4 or 5 minutes, during this period Dr Williams said they were really struggling. He continues that they changed to the endotracheal tube, which goes into the mouth and down the throat, and put chest drains in each side, and the patient's oxygen saturation is now back up to 98%.

The relatives express some relief, exhale slowly, 'thank you doctor'.

Dr Williams goes on 'I have to be honest with you, at one point it was touch and go and I thought we were going to lose him'. The wife looks shocked.

Dr Williams describes what the patient now looks like – he has 4 drains in (gestures where they are) and a tube down his throat.

Following a short discussion about other members of the family Dr Williams asks if they will just wait a few minutes longer whilst they go and clear up the equipment and then they can go in and see him. Dr Williams, Lucy and I go back to ICU.[11]

At the outset of this episode, when first appraising the X-rays, the two hypotheses that might best explain the patient's condition are discussed: is the tracheostomy tube positioned wrongly, and are there pneumothoraces present? Crucially, however, they decide that whilst the X-ray hints at these possibilities, the X-ray is not decisive enough to warrant immediate action. The X-ray alone, as a singular source, is not sufficient to impose an explanatory narrative on the patient's condition. The account it

suggests cannot, at this stage, be tightly coupled with the symptoms the patient exhibits. For this account to hold more work must be done to strengthen the link. Attention, therefore, turns from the X-ray to the patient himself.

The team move to the patient's bedside, the nurse gives a brief summary of care and the surgical SHO reports on his physical examination of the patient. They quickly focus on a problem with the ventilation: high and climbing levels of carbon dioxide is the first element mentioned in the history given by the nurse and the first aspect reported in the doctor's physical examination "very quiet breath sounds, CO2 retaining". However, neither the nurse nor the junior doctor incorporate in their performances an explanation for this and consequently practical responses to this situation are not proposed. Both the nurse and the junior doctor restate the patient's signals, they do not interpret them. Dr Williams, the consultant anaesthetist, works on creating an account that will explain these readings and thereby suggest a response. He listens to the patient's chest, disconnects the ventilator and listens again, he mentions an 'expiratory wheeze' and 'air trapping'. So he begins to craft an explanation that will justify both the patient's high levels of carbon dioxide and expanded chest: the ventilator's settings may not give the patient sufficient opportunity to exhale before the next breath is delivered, consequently air is 'trapped' within the patient's lungs. Dr Williams' performance, therefore, links together a summary of the current situation with an explanatory account, and inherent in this account is a suggested line of action – to change the ventilation pattern. It is as Berg (1992) and Mol (1998) suggest, that explanations encompass a 'disposal' and that these justifications are performed only insofar as they direct practical actions. Dr

[11] DG Obs 240101

Williams' engineering work is successful at linking together the patient's condition with an explanation and subsequent practical activity. They decide to change the pattern of ventilation.

The consultant anaesthetist continues working to refine this account thereby reducing the range of possible responses. The ventilation pattern doesn't suit the patient? Why? Is it 'a machine problem or a patient problem?' Again, then, in isolating the problem with ventilation the anaesthetist seeks to disaggregate the cyborg into patient and machine components. They decide to paralyse the patient, simplifying the situation by bringing the patient's breathing completely under mechanical control, but still exhalation is problematic, the wave form displayed by the monitor is atypical, it's 'not a smooth exhalation'. If this is not due to the patient, is it then a technical difficulty? If so, is the technical difficulty located at the patient end or the machine end? They change the circuit and ventilate manually, thereby excluding the machine from the equation, but still the pressure to transfer oxygen from the reservoir bag to the patient's lungs is high suggesting that the difficulty is to be located within the patient. Disconnecting the circuit, Dr Williams and Lucy listen. Dr Williams suggests the patient is 'still exhaling', therefore, Dr Williams again performs a link between prolonged and difficult expiration and high carbon dioxide levels. That Lucy, an intensive care nurse, does not identify that the patient is still exhaling suggests it is not a self-evident element, its presence and meaning obvious and transparent, rather its presence is somewhat ambiguous and has to be crafted and legitimated. Consequently, engineering work is about assembling heterogeneous elements into a coherent account but it is also about disaggregating the elements and actively dissociating or excluding elements superfluous to the account. This serves to refine and further limit

prospective actions. Dr Williams, therefore, discerns a technical difficulty with the ventilation located somewhere within the patient.

The team returns to the X-ray to reconsider the possibility of a pneumothorax. The X-ray suggests, but cannot definitively confirm, a pneumothorax. They are still, at this stage, unable to tightly couple the X-ray and the symptoms the patient exhibits together in an explanation. However, ventilation is now so difficult that some action is necessary, 'if we can't ventilate him we are going to have to stick drains in'. Comparing the X-rays does indicate that 'the lung is much more hyperinflated today' but at this stage the mispositioned tracheostomy tube, the pneumothoraces, and the hyperinflated lungs remain separate, dissociated and isolated possibilities.

Another explanatory narrative, bronchospasm, is briefly considered. If the lungs are in spasm and cannot contract so as to exhale, adrenaline administered down the tracheostomy tube will act directly to break this spasm. Surprisingly, the proposal of bronchospasm is countered almost immediately with the administration of adrenaline. Little or no work has been expended upon legitimating this possibility and yet it is performed without reservation. The use of adrenaline in this situation is unlikely to worsen the situation and might just improve it. It is an intervention easily performed and with little risk, implying that the level of work expended in legitimating an account and the actions recommended within it is related to the ease and degree of risk associated with the intervention.

Unfortunately, this course of action proves fruitless, it does not change the situation, and Dr Williams comes back to question the method and pattern of ventilation: 'is it a

machine problem or a patient problem?' He ventilates manually, having to squeeze the bag hard to transfer oxygen to the patient's lungs. Events at this stage are beginning to overtake the anaesthetist: there is still considerable ambiguity as to the meaning to be crafted from all these heterogeneous sources but action is beginning to be premised less by engineering a strategic explanation for the patient's condition and more by the practical necessity to deliver oxygen. Assembling and dissociating the signs and signals from the patient, other informative and situational resources (X-rays, laboratory results, and medical records) to produce a strategic account that both renders the situation intelligible and proposes a set of appropriate actions may be the preferred mode of working for the anaesthetist but it is not the only way of organising action; urgency in delivering such necessities of life as oxygen can take priority over heterogeneous engineering in guiding action.

Dr Davis inserts a cannula into the patient's chest to act as a temporary chest drain. This will deflate a pocket of air between the pleura and the lung that might have been compressing the lung. After placing two chest drains the bronchoscope arrives – a device that allows internal visualisation of the lungs. By inserting the bronchoscope into the tracheostomy tube Dr Williams sees that the end of the tracheostomy tube is pressed against the wall of the trachea. Finally, an ally for the X-ray appears, visual affirmation that the tracheostomy tube is indeed mispositioned. But again, the practical necessities threaten to outstrip strategic engineering, they are 'having a bit of a problem ventilating' and need to 'get a tube handy'. Lucy calls for the 'crash trolley' that contains all such emergency resuscitation equipment.

Coupling the X-ray, which indicates a mispositioned tracheostomy tube, with the visual confirmation, enabled by the bronchoscope, that the tube is pressed against the wall of the trachea, alters the balance of elements and resources legitimating an account that problematises the placement of the tracheostomy tube. This then suggests a course of action: the tracheostomy tube should be changed to an endotracheal tube, thereby ensuring that the tube would be 'pointing straight down' rather than pressed against the wall of the trachea. After a further X-ray the tracheostomy tube is changed for an endotracheal tube. Following intubation Dr Williams manually ventilates, it 'feels better' and the oxygen saturation rises from 75% to 86%. Dr Hargreaves reports that 'everything's under control from the monitor', indicating that the critical situation has begun to resolve.

The anaesthetist must assemble a coherent narrative to justify the patient's condition. This work involves carefully sorting the heterogeneous elements, incorporating, disaggregating, isolating, identifying, crafting, and dissociating the elements to produce a meaningful account. Additionally, however, this cannot be a restatement of the situation such as 'the carbon dioxide levels are high' they must incorporate an explanation if they are to suggest a set of actions. Furthermore, it seems that the degree to which elements must be aligned is relative to the degree to which the proposed actions may be easily and safely performed: the more extreme the proposed measures, the tighter the elements should be woven together in an explanatory account. This can be seen above, where the administration of adrenaline down the tracheostomy tube is an intervention unlikely to cause significant difficulties and might potentially improve the situation. A great deal of work does not then go in to enrolling elements to support this proposition but this course of action is performed

anyway. Conversely, changing the endotracheal tube or inserting chest drains is far more interventionist, therefore, this line of action must be more rigorously legitimated, the elements supporting these activities must be tightly woven together. As Mol suggests, engineering these 'links' is difficult, the elements don't always naturally cohere or fall into alignment, or even present themselves, and these links are performed only insofar as they suggest practical actions. Engineering necessitates not only assimilation of disparate elements but also the active dissociation of other disparate elements. This works to clarify, simplify, and refine the account. An account, therefore, need not be watertight, incorporating and explaining every element but enough elements should be enrolled so as to weight the balance in favour of one or other account. Moreover, the degree of work necessary to legitimate an account appears to map directly onto the degree of risk incurred by the proposed actions. And finally, it seems as though the actions aren't always organised by heterogeneous engineering but sometimes by practical necessities, sometimes the strategy is missing but activities continue on a practical basis.

A further performance sees the possible ontologies limited to two. When the consultant anaesthetist talks with the patient's family he conveys only the mispositioned tracheostomy tube and the pneumothoraces as explanations for this situation. Air trapping from an unsuitable ventilation pattern, and the possible bronchospasm, are no longer being performed as sensible interpretations of the patient's condition. Whilst this account is necessarily simplified so as not to overload the family with superfluous medical details, this performance reifies the two favoured accounts leaving the other possibilities to degrade. Interestingly, the anaesthetist presents the two explanations as separate and distinct. The problem with the

tracheostomy tube is linked to the activity of oral intubation and the pneumothoraces are linked to the insertion of chest drains, but these two rationales are not coupled together into a singular ontology, they exist in tandem. An overall, coherent narrative, with all the heterogeneous elements consistently explaining a single possibility appears to be unnecessary. As Mol suggests, links are only performed insofar as they serve a practical purpose. Action was justified on the basis of a fragmented ontology, therefore, converging these two ontologies is unwarranted.

Following the event I gave Dr Williams a copy of my transcript which he talks me through in a 'debrief'. He begins at the point where the team were reviewing the patient's chest X-ray prior to examining the patient himself.

> So we looked at it and decided it was a pneumothorax. And we had a bit of confusion there because I think one x-ray was done that night and another the night before before that, and I think we looked at the two X-rays the opposite way round. But we definitely thought there was a pneumothorax there ... Another thing that we said here that's important later on is that one of the nurses mentions that the trachy is pointing the wrong way. I said the trachy looks like it is in the wrong place ... a trachy in the wrong, pointing the wrong way, which was actually again critical later on

He summarises:

> ... in those ten lines the nurses say the pneumothorax and trachy doesn't look quite right and clinically that was actually crucial later on.

Dr Williams confirms then that the two favoured interpretations emerge early in the episode but again they are unrelated, each justifying an aspect of the patient's condition. On moving to the patient's bedside Dr Williams then recounts his engineering efforts, running through the numerous possibilities: is it a problem with the ventilation, 'air trapping', is it a problem with the patient? Paralysing the patient, relocating the responsibility for delivering ventilation to the machine, and being programmed by the anaesthetist, simplifies the equation. They then change from mechanical to manual ventilation to try to isolate the location of the difficulty. Dr Williams concludes:

> This is the thing where I felt something wasn't right, and this is going through the process of what is wrong. Is it that there's air trapping, is it that the ventilator is not working properly, what is going on here? I'm not 100% sure what is going on here. I think that were not ventilating very well because there is just air trapping, but actually it probably wasn't that, we were air trapping, *but we were air trapping because he had a pneumothorax and we couldn't ventilate him properly.*

Dr Williams describes a period of confusion wherein the possible ontologies proliferate. In retrospect, however, Dr Williams limits those possibilities to two. He affirms that they were air trapping but rather than it being a problem with the ventilation pattern (not allowing enough time for the expiratory phase before the machine delivers another breath) he links the air trapping to the pneumothoraces and the mispositioned tracheostomy tube, '*we were air trapping because he had a pneumothorax and we couldn't ventilate him properly*'.

Dr Williams describes the work of legitimating this account, it is difficult, ambiguity persists and the rationales for action threaten to shift from the strategic engineering to practical necessities.

> I want to have a look down the trachy to see if the tracheostomy is working ok. And I'm going through all my checks here: patient, ventilator, bronchoscope, X-ray and you see things going through my mind here, what the hell is going on? Except I can't, I can't put my finger on what is going on here. So he's air trapping, got a pneumothorax there, and this is the chest X-ray where we thought there was a pneumothorax before. Is there, isn't there a pneumothorax? And you can just sense the doubt in my mind at this point. Charlie says I can't see a pneumothorax. Erm but if we can't ventilate him then we are going to have to presume that there is a pneumothorax. ... We think it might be a pneumothorax or is it just bronchospasm, machine's not working, is it a machine problem or patient problem. You can just sense things are getting out of control here.

This then is a difficult time for the heterogeneous engineer, crafting a singular narrative to incorporate all these disparate elements looks impossible. Future actions are likely to be premised not on an explanation of the clinical situation but on the bare necessities of keeping the patient alive.

In this situation the legitimation for the possibility of a mispositioned tracheostomy tube is provided by the bronchoscope. Dr Williams describes what he sees:

> The tube is basically abutting against the trachea, so basically instead of going in, imagine the trachea here, instead of going in nicely like that it was basically

> stuck up against the anterior wall. I think what was actually, what was actually making it worse was we were getting gas in but we weren't able to get it out.

So air trapping is aligned as a consequence of the mispositioned tracheostomy tube. This explanation sets in train a course of action which involves changing the tracheostomy tube for an endotracheal tube.

> Anyway I stuck the tube down and someone says 'feels better', we aspirate on the nasogastric tube, and the saturation is coming up nicely. Everything looks, this is suddenly, as soon as we put the tube down everything improves... 'Everything under control from the monitor', see what the X-rays shows, 'Dr Williams bronchs again down the tube this time', so I had a look to see if the tube was in the right place, it was, everything looked good. Everyone was trying to stick everything in now. It all got a bit calm at this stage as soon as I changed the tube it got better ... Anyway the chest X-ray had been done at this stage er and there was still two pneumothoraces there and again we have to put two bigger drains in.[12]

Dr Williams explanation and justification for action rests on a fragmented ontology each fragment accounting for an aspect of the patient's condition. There appears to be no imperative to tie this into a singular ontology as there is no reason to suppose that patients can only have one problem at a time. Furthermore, when explanatory narratives prove difficult to compose and rationales are missing, this does not mean that action can be suspended pending a more definitive account; actions, in some

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cases, must continue but on the basis of practicalities. What then does this mean for the anaesthetist's heterogeneous engineering endeavours and its relation to action?

Engineering as skilful contrivance

In the previous chapter I argued that anaesthetised patients were not blank slates on which anaesthetists' could impose their descriptions of behaviour, anaesthesia might verbally silence patients but this does not leave them entirely at the mercy of the anaesthetist's articulations. I argued that the technological reconfiguration of the patient's body provided the conditions for the cyborg to demonstrate a form of agency and contribute to informing the unfolding action of anaesthetic practice. The anaesthetist cannot then fabricate just any account – their accounts are constrained by signs and signals that the cyborg offers. Hence this chapter set out to examine the anaesthetist's part in organising the work of anaesthesia.

In looking for theoretical resources that might elucidate this process I enlisted Law's notion of 'heterogeneous engineering' and I discussed some of the difficulties in using this resource. Chiefly, these difficulties concern how the term tends to cast the anaesthetist as a grand planner or architect who can single-handedly arrange the elements and determine action, precisely the version I want to disrupt. Law revisits the notion of heterogeneity to delineate some of its forms and restore its complexity. For my purposes, however, it is the 'engineering' part of the term that requires elaboration. Rather than using 'engineering' in the sense of system building and controlling, it is the 'skilfully contrive to bring about' (OED, 1999) sense that I think is a more apt description of 'heterogeneous engineering' in anaesthesia although this

still does not capture the precariousness of the activity. I use the term then not to describe the anaesthetist, but to describe an activity anaesthetists engage in, to skilfully contrive an intelligible account of a clinical situation in an attempt to inform and organise their activities.

Berg's work adds to this process of skilful contrivance in insisting that no one resource is essentially more fundamental than another and that it is possible to rearticulate any given resource in the light of another. This introduces the idea that the stability of accounts is not necessarily the best criteria on which to judge the success of heterogeneous engineering. Berg goes on to argue that action does not follow decision making in a linear process. It is altogether a more symbiotic relationship. The work of generating an explanatory narrative of the patient's condition also creates a set of actions that address the account. This process of engineering an intelligible coherent account out of the cyborg's communicative resources can be seen in the first section of data. Although there are some discrepant clinical details the overall balance of communication are made to favour one particular account which then provides a basis for action.

Mol, on the other hand, argues that this work is not quite as straightforward as it may seem. As the first scenario illustrates, it is not always possible to engineer a singular account, to assimilate *all* the informative resources into one all encompassing account. Sometimes making links between the stories and the elements is difficult to achieve, sometimes stories, or accounts of a disease, are multiple and remain so. In which case, the question that follows is not which account is more 'real' but 'which should be taken as a lead for further action?' (Mol, 1998:151). That possibilities are multiple,

can resist convergence, and remain so, is clearly demonstrated in the second scenario. However, the question that Mol poses: not which ontology is more real but which can be taken as the lead for action, causes some difficulty. Being unable to mobilise allies in favour of an account that would explain the anomalous carbon dioxide readings, the situation remains unintelligible. Ontological multiplicity, in this case, does not offer a lead for action, a problem, then, because an explanation must suggest an action. The only sensible account is one that *excludes* the carbon dioxide readings demonstrating how the work of the heterogeneous engineering is not only about tying elements *into* a favoured explanation but also to actively *dispel* from the explanation those elements that serve to confuse the situation. Consequently, it becomes unimportant to continue to perform partial and unsatisfactory accounts if they cannot suggest practical actions. Action, therefore, is premised on an assumption of 'no *clinical* problem', meaning that the patient does not exhibit signs of a problem, the carbon dioxide readings displayed on the monitor remain a potential or theoretical problem. Multiple possibilities may exist, but no longer being performed, they decay.

The third scenario is complex. There are multiple performances and multiple possible ontologies. Engineering work here results in a fragmented account, each fragment suggesting a corresponding action. Both fragments are acted upon and so doing performs the ontology. The anaesthetist does not require a singular, coherent account that tethers all the elements neatly together. It is enough that both fragments are legitimated, in that they correspond with other elements to produce an intelligible account, and suggest a set of practical activities to address the situation. Consequently, it seems as though it is the legitimation work that proposes a lead for action. But also suggested here is that the work involved in aligning the elements to

legitimate an account is proportionate to the degree to which the suggested course of action can be safely and easily carried out. The more radical and interventionist the proposed action, the greater the need to legitimate the account, to aligning the elements into a tightly coherent narrative. Accounts, therefore, do not have to be watertight, there may well be discrepant elements that can safely be excluded from the account, it is a question of balance: where does the balance lie, which story has more allies? The process of heterogeneous engineering for the anaesthetist is inherently precarious. The kind of account that is assembled: convergent, multiple or fragmented, is heavily contingent on the particular elements of the situation, as are the corresponding leads for action. Perhaps this suggests that a criterion for success of heterogeneous engineering is not so much the stability of their explanation of a clinical situation as the extent to which the account leads to a safe set of practical actions.

Heterogeneous engineering, for the anaesthetist, is a 'mode of ordering' (Law, 1994), a means of organising the elements of a clinical situation so as to render it intelligible, with the aim of informing subsequent actions. But is does not come in just one form, as can be seen from the discussion here, it comes in at least three forms of strategically shaping action. This may be a preferred means of organising anaesthetic activities but it is not the only means, events can sometimes overtake the process of heterogeneous engineering; the lack of strategy, however, does not necessarily correspond to a suspension of action, in critical periods, when strategy is absent, action must continue, if necessary, on the essential activities that sustain life. In this case, performances rely, for their justification, not on a skilfully contrived account but on basic, practical necessities.

Chapter 5

Governing participation: access, boundaries and their effects

'Given that anaesthetic practice is not accomplished by the anaesthetist alone, but by anaesthetic teams in collaboration with the patient, it would seem particularly important to understand the ways in which anaesthetic work is interactionally produced, and how the patients themselves participate in the production of this work.'

(Pilnick and Hindmarsh, 1999)

I have, so far, examined the involvement of the patient in anaesthetic practice, and I have looked at the work of the anaesthetist, but what of the other members of an anaesthetic team to which Pilnick and Hindmarsh refer? What constitutes their role and how is it defined? What scope do these practitioners have to inform an anaesthetic trajectory? In this chapter I explore these questions, I am interested to elucidate how access to anaesthetic practice is governed, how boundaries between the participants are performed, transgressed and reified and the effects this has on the opportunities the participants have to develop knowledge of anaesthetic practice. I look at different forms of knowledge participants access and use in their work, and how this shapes the potential participants have to guide the course of an anaesthetic.

Shifting centres: attending to the 'others'

Anspach (1987) analyses the distribution of work and knowledge amongst doctors and nurses. She proposes that the reason for differentiation between medical and nursing knowledge lies in the character of work each group experiences. Each occupational group, she argues, engages in different sets of daily experiences which then define the character of knowledge available to the respective groups. On studying the prognostic decision-making process in a neonatal intensive care unit Anspach found that physicians 'because of limited contact with patients' (1987:219) would be more likely to rely on diagnostic technology, placing little confidence in their intuitive judgements. Nurses, on the other hand, relied upon cues they gleaned from continuous interactions with infants, characterising them as 'gut feelings'. She goes on to argue that the knowledge mobilised by the physicians, based on diagnostic technology occupies a superior epistemological status to the intuitive judgements offered by the nurses.

For Anspach, then, the organisation of the neonatal intensive care unit functions as an 'ecology of knowledge' allocating different types of work, experiences, and knowledge to those who work within it. She argues that:

> each set of participants approaches the life-and-death decision from a very partial knowledge base. Moreover, the types of prognostic knowledge used in life-and-death decisions are not valued equally. As the data indicate, technological cues and interactive cues do not carry equal weight within the realm of medical discourse. Despite the fact that nurses have access to certain

> aspects of an infant's behaviour which is not available to the other participants, the interactive cues noted by the nurses are *devalued data*. (Anspach, 1987:229, original emphasis)

Anspach, therefore, concludes that physicians become structurally disengaged from the infants and their families, and being distanced they rely on technological diagnostic data in their prognostic decision-making. Nurses, however, are frequently more pessimistic in their prognostic judgements than the physician as a result of continuous contact with the babies. In the interests of more informed and equitable decision making Anspach argues for a social structure that facilitates greater interaction among physicians, parents and patients, and for a more inclusive 'criteria of certainty' (1987:229) to include not only technological data but also the interactive cues that tend to be characterised as 'intuitive judgements'.

In Svensson's (1996) study of 'the interplay between doctors and nurses' he concurs with Anspach's characterisation of the nature of knowledge which doctors and nurses generate and employ:

> nurses get to know and observe the patient in an entirely different way from doctors. The nurse knows what the patient can manage to do alone or will need help with; she can see deterioration or improvement that the doctor cannot register. She learns how the patient looks upon his or her illness and situation in life. She becomes aware of the patient's social network, home conditions and work. She makes contact with relatives, and with people who are important for rehabilitation or care outside the ward. (Svensson, 1996:384-5)

However, in contrast to Anspach, Svensson argues that this does not disadvantage nurses. On the contrary, he suggests that as a result of changes in the healthcare context over the last decade, doctors have come to depend on this knowledge. Svensson refers to changes such as the increasing profile of 'the social' prompted by the prevalence of chronic illness and, most importantly for Svensson, the reorganisation of nursing work from task allocation to a form of team nursing. Svensson suggests this new configuration of nursing work engenders a more comprehensive knowledge of the patient, and rather than the ward sister acting as an intermediary, nurses and doctors now communicate directly. Consequently, Svensson argues:

> nurses, through their nearness to the patients and their relatives, and through the new arenas created for cooperation with the doctors, have come to be the dominating actors in the negotiation of norms for interaction with patients. (Svensson, 1996:392)

Although Anspach and Svensson describe similar characteristics of the knowledge nurses develop, they reach different conclusions about the effects of such knowledge. For Anspach, nurses' knowledge is 'devalued' in terms of prognostic decision-making, whereas Svensson proposes that nurses are uniquely positioned with knowledge on which 'The doctor is in a state of dependence' (1996:387). Perhaps both these positions are a little polarised, Anspach's analysis hints at a technological determinist perspective in which technology is a driving autonomous force. According to Anspach, the knowledge neonatal physicians employ is prioritised by virtue of it being

technologically generated and processed. 'Intuitive cues', on which Anspach suggests nurses rely, have a more nebulous quality, their worth not only uncertain but for Anspach actively *devalued.* Svensson, in contrast, takes a rather optimistic view highlighlighting the opportunities for nurses involvement in decision making and emphasising the dependence of medical staff on nurse's knowledge of patients. As a consequence the contours of medicine and nursing are flattened, obscuring how the hierarchical relationship may be achieved and invoked in decision making.

Svensson does, however, acknowledge that boundaries between medical and nursing knowledge have not dissolved and that nurses are still wary of breaching that boundary:

> Most of the nurses in our study maintain that they seldom feel hindered from presenting their opinions and thoughts to the doctors regarding medical treatment; but at the same time, many emphasise that they are somewhat careful when it comes to the 'purely medical'. This is viewed as intruding upon another's area of competence, and as calling for some caution against presenting oneself in a way that appears challenging. (Svensson, 1996:388)

So the boundary between medicine and nursing knowledge may have shifted, allowing nurses more opportunity for negotiation and intervention in decision-making, however, treatment decisions still remain in the province of medicine which nurses may at best influence which raises the question of how equitable are these negotiations.

In responding to Svensson, Allen (1997) addresses the issue of equity within negotiations. Allen argues that when interviewed nurses frequently recounted episodes in which the boundaries of their practice were contested, however, when observing the nurses at work Allen noted that all health care professionals practiced with 'minimal inter-occupational negotiation and little explicit conflict' (Allen, 1997:505). Allen interprets this discrepancy as a reflection of the nurses' efforts to demonstrate control over their work boundaries. She suggests that the nurses attempted to establish their autonomy, emphasised in contemporary nursing ideology, by insisting they could choose whether to accept 'doctor-devolved work'. Although, when operating within the constraints of the ward situation, Allen observed that accepting additional activities appeared to be the most feasible and practicable option:

> given the informal influence they wielded over treatment decisions, it was only a small step to take this further and do the work themselves than it was to try and get the doctor to do it. (Allen, 1997: 513)

Allen does, however, point out that the lack of overt interoccupational negotiation or conflict did not correspond to a blanket acceptance of doctor's devolved activities, on the contrary, nurses acquiesced only when doctors were unavailable.

> Nurses, however, had not simply incorporated this work into their everyday practice; rather, they undertook informal boundary-blurring work when the doctor was unavailable. When doctors were physically present on the ward, nursing staff adhered to hospital policy and asked the doctor to carry out these tasks. (Allen, 1997: 511-2)

Allen's study indicates the complex multidimensional nature of the distribution of work and knowledge across a nursing-medical boundary; where it was possible to avoid additional responsibilities, nurses did so, but when pressed nurses routinely undertook a range of duties that fell outside their jurisdiction. However, rather than doctors actively delegating responsibilities and nurses accepting them, the shift is more insidious. Shaping this adoption of additional duties are organisational difficulties such as the problems nurses experienced in actually getting doctors to the ward, coupled with the acknowledgement of the heavy workload doctors faced.

Also influencing the redistribution of work between doctors and nurses is the degree of confidence a nurse has of his or her knowledge and abilities and of their relationships with doctors, as Allen comments:

> It was also more common for experienced nurses to blur occupational boundaries than junior staff. Indeed I observed junior nurses asking more senior staff to do their boundary-blurring work for them. Moreover, nurses were more likely to break the rules for doctors they trusted. (Allen, 1997: 512)

Touching on the role of trust Allen points to the local, flexible, and contingent nature of a medical-nursing boundary. She also comments that boundary-blurring work often means 'breaking the rules'; that when undertaking additional duties nurses remain unsupported by organisational policies and consequently vulnerable to disciplinary action.

Tjora (2000) examines interprofessional relationships between doctors and nurses in Norwegian emergency communication centres (AMK centres) in which nurses handle requests for medical assistance both in emergency cases (when an ambulance or helicopter may be needed) and in routine cases (where a visit from a primary care doctor is requested). Tjora identifies three 'boundary-spanning' activities that nurses perform, firstly they make decisions using doctors tools, secondly, they co-ordinate the movement and activities of doctors making home visits, and finally, after engaging in activity that resembles medical 'diagnosis' they offer advice to callers.

In prioritising doctors' calls, nurses are required to use the 'Norwegian Index for Medical Emergency Assistance (NI) which provides a framework for such evaluative or 'diagnostic' work. However many nurses are uncomfortable with this inflexible mandate because it binds them to rigid rules for categorising patients. Tjora observes how the NI seeks to pre-programme nursing work according to an idealised model of individual decision-making, whereas in practice decision-making is frequently socially accomplished in collaboration between two or more nurses, using their own knowledge and experience, and reserving the use of the NI for a post-decision quality control check to verify their decisions.

Paradoxically, in prioritising emergency visits nurses are placed in a central position to manage and exert control over doctors' work. Tjora posits that the emergency communication centre is the central node of an information network in which everyone relies on the nurse for the supply of information. He proposes that nurses construct descriptions of patients in particular terms so as to communicate suggestions

for action to the doctor. In this way nurses present their impressions of how serious cases are and in what sequence the doctor should handle them.

Finally, Tjora examines the diagnostic work that nurses perform when doctors are unavailable.

> Where doctors were not available, nurses in larger centres would regularly draw on professional experience and pooled knowledge of colleagues to try to diagnose patient's conditions over the phone. (Tjora, 2000:733)

Concurring with Allen, Tjora specifies this 'boundary-spanning' activity only occurs when there is no medical assistance available. Furthermore, Tjora asserts that he only observed boundary spanning diagnostic work in the larger centres where nurses had peer support. He found nurses would regularly work collaboratively in this activity.

> two nurses pool their knowledge, to use 'joint competence' as a basis for action. Joint-competence feels safer than one's own competence, even when all team members possess similar expertise. (Tjora, 2000:733)

Tjora's choice of words 'feels safer' alludes to a sense in which this boundary spanning activity is similarly unsupported by organisational policies and that in performing this diagnostic work nurses are exposed to the possibility of disciplinary action.

Tjora suggests that the value of this boundary-spanning activity is lies in the economic and optimal use of doctors' time, hinting at the integral nature of this boundary

spanning work for the smooth running of a system. That Allen and Tjora acknowledge how this kind of activity generally occurs in the absence of doctors suggests a breach in the system that nurses feel obliged to bridge. A parallel can be drawn here with Berg (1997) and Timmermans and Berg's (1997:291) paper on protocols in which they argue that the 'tinkering' with the protocol that nurses employed was actually essential for the functioning of the tool, it was a *'sine qua non'*.

However, Tjora notes such knowledge and practices may escape the label of 'diagnosis' in respect of political sensibilities.

> my observations have shown that nurses in the AMK centres perform many tasks without doctors' involvement to solve people's problems. That they do not define these tasks as 'diagnosis' may reflect a political need to keep a low profile, but underestimates the complexity of the judgements they make. (Tjora, 2000:736)

The above discussion gives an indication of how the distribution of work amongst health care practitioners is often organised around flexible and tacit arrangements, the character of the work may change subtly depending on the practitioner who undertakes it, and the work may be labelled differently. As such the delicate ordering of work amongst practitioners can prove to be elusive and resist analysis. Hindmarsh and Pilnick suggest that the 'interactional coordination work' (2002:141) is a subject rarely scrutinised in the literature concerned with health care teams. Instead they note that 'the focus on team constitution and power relations tends to gloss the tacit practices of in situ collaboration and teamwork' (Hindmarsh and Pilnick, 2002:141). Thus, they

examine the accomplishment of teamwork in anaesthesia focusing on the organising practices and skills required of participants.

Analysing video recordings of work in anaesthetic rooms they suggest that anaesthetists and ODPs, whilst engaged in seemingly individual tasks, are simultaneously attentive to one another's actions and respond accordingly; anaesthetists and ODPs will read the implications of a collegues' activities for their own work demonstrating 'an initimate sensitivity to the trajectory of colleagues' actions' (Hindmarsh and Pilnick, 2002:149).

> Part of learning to be an anaesthetist or an ODP is about developing expertise in reading the embodied conduct of colleagues. The uninitiated do not have an intimate understanding of the potential or likely trajectories of action that will emerge when a colleague has picked up a gas mask, lifts a mask from the face of the patient or approaches with a syringe at particular moments within the anaesthetic room activities. (Hindmarsh and Pilnick, 2002: 152)

Furthermore, they observe how talk, ostensibly directed at the patient, may also serve to camouflage collaboration with their colleagues, it being closely coupled with a response on the part of a colleague. Consequently, an ODP witnessing an anaesthetist beginning to engage in a particular activity can project a trajectory of actions that routinely follow:

> Such an orientation to, and use of, the organisation of embodied conduct in anaesthetic work contributes to the impression of a well-drilled team, even

when that team may have met only moments before the patient was wheeled into the room. (2002:152)

Teamwork differentiated: theoretical resources

Hindmarsh and Pilnick, then, direct one's attention towards the day-to-day, even moment-to-moment, working practices that order and accomplish anaesthetic practice. This focus complements the foregoing discussion that outlines how the knowledge and practices of such practitioners as nurses and ODPs are shaped and defined by disputes and constraints on practice, and tacit arrangements as to the boundaries of their responsibilities. This does, however, raise the question of which analytical tools assist the articulation of the details of the daily work but without losing the focus on the processes through which the boundaries of one's practice are achieved and maintained.

Lave and Wenger's (1991) concept of 'legitimate peripheral participation' in 'communities of practice' provides a theoretical resource with which to address this undertaking. Their aim is to conceptualise learning in terms which are intentionally decoupled from teaching. For Lave and Wenger, the 'learner' is transformed into a practitioner, a newcomer whose evolving knowledge, skill and discourse are part of a developing identity, a member of a community of practice. They state 'learning and a sense of identity are inseparable: They are aspects of the same phenomenon' (Lave and Wenger, 1991:115). A community of practice is:

> a set of relations among persons, activity, and world, over time and in relation with other tangential and overlapping communities of practice. A community of practice is an intrinsic condition for the existence of knowledge, not least because it provides the interpretive support necessary for making sense of its heritage. Thus, participation in the cultural practice in which any knowledge exists is an epistemological principle of learning. The social structure of this practice, its power relations, and its conditions for legitimacy define possibilities for learning (ie for legitimate peripheral participation). (Lave and Wenger, 1991:98)

A community of practice, then, provides the newcomer with the resources with which to interpret and make sense of members' work practices. It is only by participating in practice that newcomers can access these learning resources and opportunities. Moreover, the characteristics and potential of such learning opportunities and resources are provided by the structure of the community. As such, knowledge, for Lave and Wenger is located within the community, rather than within individuals. 'Mastery', they state, resides not in the master but in the organization of the community of practice of which the master is part. Therefore, Lave and Wenger suggest that learning occurs through 'centripetal participation' in the 'learning curriculum' of the community. For Lave and Wenger, a 'learning curriculum' is not a set of dictates outlining the skills or competencies inherent in proper practice, rather, a learning curriculum unfolds in opportunities for engagement in practice. 'Centripetal participation' refers to the process whereby individuals move through varying levels of participation, their identity evolving as they do so. Increasing levels of participation furnishes them with different perspectives from which to interpret practice.

> Viewpoints from which to understand the practice evolve through changing participation in the division of labor, changing relations to ongoing community practices, and changing social relations in the community. (Lave and Wenger, 1991:56)

Although Lave and Wenger concentrate on apprentices as they develop into experts, hence the term 'centripetal', meaning movement towards the centre or a central identity, this concept is also useful in analysing the contributions of different types of practitioners that make up a community of practice. Although not necessarily 'centripetal', scrub nurses, recovery nurses, anaesthetic nurses, ODPs, and surgeons all occupy varying levels of participation in the production of anaesthesia. Such levels of participation may be structurally limited and it will not be possible, or desirable, for all practitioners to become expert anaesthetists, as is the aim in apprenticeship. It is the 'peripheral' in 'legitimate peripheral participation' that underscores the multiple decentred perspectives and lends its suitability to the analysis of the various identities within a community of practice. Also enhancing its suitability for my analytical purposes is that Lave and Wenger emphasise the dispersed nature of an activity and identify how the structure of distributed tasks incurs many constraints on the learning environment.

> The way a task is partitioned across a set of task performers has consequences for both the efficiency of task performance and for the efficiency of knowledge acquisition. (Lave and Wenger, 1991:75)

Focussing on the distribution of a task, and the constraints and opportunities this offers to different practitioners, facilitates inquiry into the structural reproduction of identities, and how this functions to cap some potentialities while promoting others. Lave and Wenger direct attention towards this structuring of resources for learning in practice.

> a decentered view of the master as pedagogue moves the focus of analysis away from teaching and onto the intricate structuring of a community's learning resources. (Lave and Wenger, 1991:94)

One of the most important learning resources they identify is the attribution of legitimacy of participation on the learner in preference to formal pedagogical instruction.

> It should be clear that, in shaping the relation of masters to apprentices, the issue of conferring legitimacy is more important than the issue of providing teaching. (Lave and Wenger, 1991:92)

Conferring legitimacy, then, provides access to the learning curriculum. In the operating theatres and anaesthesia, 'legitimacy' acts as a kind of security clearance, providing access to certain areas, opportunities and experiences. Newcomers need an introduction, a sponsor, to legitimate their presence. But like security clearance, legitimacy is *stratified*, the role to which a newcomer aspires correlates with the level of legitimacy, and rights to practice, they are granted.

> In short, the form in which such legitimate access is secured for apprentices depends on the characteristics of the division of labor in the social milieu in which the community of practice is located. (Lave and Wenger, 1991:92)

Consequently, this suggests that the level of legitimate access conferred is strongly related to the degree to which the different identities are forged. Moreover, it draws attention to the fundamental problem of access.

> For newcomers, their shifting location as they move centripetally through a complex form of practice creates possibilities for understanding the world as experienced. Denying access and limiting the centripetal movement of newcomers and other practitioners changes the learning curriculum. (Lave and Wenger, 1991:122-3)

In this way Lave and Wenger attend to both the structural element and the contingent nature of the reproduction of identities. Access and the centripetal movement of learners may be regulated and limited but this still allows for individual and experiential contingencies.

Whilst making it clear that the problem of access goes beyond the use of artefacts and technologies, Lave and Wenger suggest that focussing on these provides a good arena in which to discuss the issue of access to understanding.

> Becoming a full participant certainly includes engaging with the technologies of everyday practice, as well as participating in the social relations, production processes, and other activities of communities of practice. But the

> understanding to be gained from engagement with technology can be extremely varied depending on the form of participation enabled by its use. (Lave and Wenger, 1991:101)

For example, the type of participation enabled by an endotracheal tube is different for an ODP or nurse as for an anaesthetist. The nurse or ODP will check and prepare the tube whereas the anaesthetist will insert it, and for the patient it is an essential adjunct to their breathing apparatus. They continue:

> Participation involving technology is especially significant because the artefacts used within a cultural practice carry a substantial portion of that practice's heritage. For example, the alidade used by the quartermasters for taking bearings has developed as a navigational instrument over hundreds of years, and embodies calculations invented long ago (Hutchins in press). Thus, understanding the technology of practice is more than learning to use tools: it is a way to connect with the history of the practice and to participate more directly in its cultural life. (Lave and Wenger, 1991:101)

The development of technologies and artefacts incorporates knowledge, understandings, and values from the current communities of practice. These technologies then remain as a historical trace in the reproduction cycles of the communities of practice, in which newcomers become masters and are eventually replaced. This resonates with Haraway's suggestion that objects are:

> a knot of knowledge-making practices, industry and commerce, popular culture, social struggles, psychoanalytic formations, bodily histories, human

> and non-human actions, local and global flows, inherited narratives, new stories, syncretic technical/cultural processes, and more. (Haraway, 1997:129)

Learning to operate the technoscientific objects of a community of practice, then, is tacitly to engage with its knowledge, culture and history.

In attending to the histories and developmental cycles inherent in communities of practice, and to the structuring of access to learning resources, Lave and Wenger direct analytical attention to the tension created by changing knowledge, practices and practitioners.

> The different ways in which old-timers and newcomers establish and maintain identities conflict and generate competing viewpoints on the practice and its development. Newcomers are caught in a dilemma. On the one hand, they need to engage in the existing practice, which has developed over time: to understand it, to participate in it, and to become full members of the community in which it exists. On the other hand, they have a stake in its development as they begin to establish their own identity in its future. (Lave and Wenger, 1991:115)

As such, conflict is addressed as an integral element of practice.

> Conflict is experienced and worked out through a shared everyday practice in which differing viewpoints and common stakes are in interplay. (Lave and Wenger, 1991:116)

Therefore, attending to the performance of differing viewpoints and common stakes, points to the making of boundaries and the crafting of potentialities of different staff groups.

Access, boundaries and their effects

Below I follow some of the conflicts and struggles that occurred when the boundaries of a nurse's or ODP's practice were called into question. These boundary disputes bring to light some of the issues Lave and Wenger highlight as integral to the process of learning as they are enacted in the anaesthetic community of practice: the fickle rights of access, the varying levels of legitimate participation, the effects of limited participation on knowledge resources and the ensuing potential to inform anaesthetic practice.

Regulating access: preserving practices

The anaesthetic room, a small room adjoining the operating theatre is the location in which the intricate work of inducing anaesthesia occurs. Access to this room and the practice therein is usually limited to those participants who have a practical function to perform. Below a routine paediatric operating list is taking place. There are two anaesthetists, one consultant, Dr Graham Hesketh, and one specialist registrar, Dr Fatima Mani, who is approaching the end of the 7 year anaesthetic training, and a senior ODP, Steve Didsbury. The first patient's procedure is very quick to perform, literally only involving the extraction of two teeth, as such the surgeon deems it unnecessary to transfer the patient to the operating theatre and would prefer to remove the teeth in the anaesthetic room. The consultant anaesthetist does not object but the

ODP does. As we join the scenario the child has only just been anaesthetised. For young children induction is usually performed with the parent sat on a stool by the anaesthetic machine holding the child. Once unconscious, the child is lifted onto the trolley and the parent leaves.

The stool is moved and the trolley wheeled towards the anaesthetic machine, Mum and ward nurse leave. The surgeon enters and goes round to the right hand side of the patient (between the patient and the counter). The theatre sister enters and shows Dr Hesketh a slip from the operating list, he nods, and the theatre sister leaves. *(This slip contains the next patient's details, by showing it to Dr Hesketh the theatre sister obtains his agreement to send for this next patient.)*

The surgeon pulls the teeth out.

There is an exchange between the surgeon and the ODP that I don't catch.

"Put the monitoring on" (not sure who said this – either Dr Hesketh or the ODP)

08.47

Dr Hesketh "Done?"

Surgeon "Yes, better find a specimen bottle for these". He goes through the doors to theatre.

Dr Hesketh "Pop her on her side." The patient is turned onto her side and the sides of the trolley are raised. "I'll ask him not to come in the anaesthetic room for the next one." (looking at the ODP)

Dr Hesketh is assembling the oxygen mask. The black face mask is lifted off and replaced with the oxygen mask. The surgeon returns and places the specimen bottle, containing the teeth, under the pillow. He turns to the ODP

Surgeon "Sorry Steve, it was just..."

The ODP interjects "No, my objection was right."

Patient wheeled to Recovery by the ODP and Dr Mani[13].

The anaesthetic room is the domain of those involved in providing anaesthetic care, namely ODPs, anaesthetic nurses and anaesthetists. It is routine practice to apply pulse oximetry, blood pressure and electrocardiogram monitoring before beginning general anaesthesia. Sometimes this practice is waved for young children in an attempt to limit their apprehension, and the monitoring is applied as soon as possible after induction. However, in this instance the surgeon does not observe this norm and proceeds to remove the teeth before the ODP could attach the monitoring. There follows an exchange between the surgeon and ODP in which the ODP objects to this violation of routine practice. Dr Hesketh (the consultant anaesthetist) appears to concur with the ODP saying he will ask the surgeon not to enter the anaesthetic room for the next case. Interestingly, rather than explaining and affirming the need for monitoring, the anaesthetist opts to exclude the surgeon from the anaesthetic room. By protecting the boundaries of their territory he safeguards the anaesthetic team's routine practices. The surgeon was permitted to transgress territorial boundaries to perform his procedure in the anaesthetic room, which is not uncommon for very quick, minimal procedures, however, he also impinged on customary anaesthetic practice by overriding the ODP's attempt to apply the monitoring. The surgeon is henceforth denied access to this domain, his legitimacy to practice in the anaesthetic room is revoked and likewise his experience of anaesthetic practice limited.

[13] DG Obs 020800.

Here, for the second patient that morning, the surgeon's exclusion from the anaesthetic room is again accomplished.

> The ODP and I go into the anaesthetic room. The surgeon follows and as he tries to enter the ODP locks the door. The patient has already arrived.
> ODP "Can I just borrow this hand" he attaches the tourniquet, then releases it and asks the patient to take her cardigan off, reattaches the tourniquet.
> Dr Hesketh enters.

In a bold gesture the ODP positively, and abruptly, excludes the surgeon from the anaesthetic room. The ODP patrols the boundaries of the anaesthetic room and adjudicates on the legitimacy of requests for entry. This is not an isolated incident but is repeated throughout the morning:

> Patient wheeled to Recovery. I enter the anaesthetic room via the entrance on the main corridor as I hear the connecting doors to theatre being locked.
> ODP is putting the monitoring on and then checking the name band.

It is noteworthy that this objection originates from the ODP rather than the anaesthetist. The following elaborates this theme; Dr Hesketh catches up with Dr Mani, the ODP and I as we take a patient to Recovery. Dr Hesketh addresses me:

> Dr Hesketh ".... I have no problem with you being there but Steve has already complained about four times this morning that there are too many people in the anaesthetic room .... he's got a point actually, we should have put the monitoring on first.... (he turns to Dr Mani) no point putting a cannula in, that's the beauty of Sevo...."

We go back into the anaesthetic room.

Dr Hesketh "Fentanyl please."

ODP "That's what I was saying, you can't keep him *(the surgeon)* out."

(whilst opening the controlled drug cupboard).

Dr Hesketh "You're right, we should have put the monitoring on first."

ODP "Do you want fentanyl for all the kids?"

The ODP complains to the anaesthetist that there are too many people encroaching on the anaesthetic room that morning, suggesting that there is a limit to the number of people who have a legitimate right to access to this environment and the practices therein. In effect the ODP polices the boundaries of the anaesthetic territory and by restricting access he also restricts the opportunities to engage in anaesthetic practices. Without such participation an individual's experiences are limited thereby structurally restricting the potential identity that can develop. Obviously it is not the intention of the surgeon to participate in anaesthesia to such a degree that he would become an anaesthetist, rather the point is that by being excluded from this domain and the practices therein the surgeon is denied access to the knowledge suspended within these practices. Consequently, his ability to understand anaesthetic priorities remains capped by his lack of exposure to those priorities.

Legitimacy disputed

Where this aspect of legitimate access to the 'learning curriculum' becomes more contentious is where nurses, ODPs and trainee anaesthetists are concerned. This issue is played out between the ODP and the trainee anaesthetist during the anaesthetic process for a subsequent patient.

As I enter the anaesthetic room Dr Mani and the ODP are already there and the patient is anaesthetised. Dr Mani is stood at the head and the ODP in between the anaesthetic machine and the patient. Dr Mani removes the laryngeal mask (LM – *a device that holds open the airway of an unconscious patient*). ODP takes a new black mask out of a packet. I look at the oxygen saturation monitor, it is reading 100%, the patient looks pink, normal colour. Dr Mani tries to turn the Sevoflurane on, struggles. Dr Hesketh turns off the Isoflurane *(anaesthetic machines are configured so as only one anaesthetic vapour can be turned on at once).*

Dr Hesketh "Is it just a poorly fitting LM?"

Dr Mani "Umm"

ODP "Not down far enough" *(seems to answer for her)*

Dr Mani tries to reinsert it, she is unsuccessful.

ODP "Come round this side..." (gesturing to the right hand side of the patient)

Dr Mani "I will try it my own way, please, if you don't mind."

Dr Mani reinserts the laryngeal mask.

Dr Hesketh "It's turned, you can tell it's not in right because the black line is twisted." *(There is a black line that runs the length of a reinforced laryngeal mask, it should always be uppermost).*

Dr Mani removes the laryngeal mask.

ODP "Come round this side..."

Dr Mani follows the ODPs instructions and successfully inserts the laryngeal mask.

Dr Hesketh "You've just made Steve a very happy man."

ODP tapes in the laryngeal mask.

Dr Hesketh "You happy?" to Dr Mani, she nods.

From this it appears that the ODP is trying to instruct a trainee anaesthetist, who has repeatedly failed, how to insert a reinforced laryngeal mask. The reinforced laryngeal masks are slightly more difficult to insert than the standard laryngeal masks as they are flexible, designed to be bent and angled away from the field of surgery, but still to provide a patent pathway. However, it is still a relatively simple technique that is usually mastered early in an anaesthetist's career, this anaesthetist is nearing completion of her 7 years training. Dr Mani is somewhat resistant to this attempt to instruct her, stating that she would prefer to 'do it her own way'. When this further attempt fails she successfully follows the ODP's directions. This raises the question of the ODP's expertise: has he developed this by watching anaesthetists at work or is he himself skilled at performing this technique? And how has he become so if the insertion of laryngeal masks is an anaesthetist's role? Other than anaesthetists, which individuals have legitimate access to the 'learning curriculum' and how are these opportunities allocated? Moreover, by instructing Dr Mani the ODP is contesting her expertise. There is a perceptible tension that Dr Hesketh recognises and his light-hearted observation about making Steve a 'happy man' is designed to dissolve.

On this occasion I have the opportunity to sit down with the consultant anaesthetist immediately following the end of the operating list, I ask him about the incident with the laryngeal mask.

> It was the anaesthetist-ODP dynamics. It was obvious as soon as we walked in the room the LM wasn't in the right place and I think they had removed it by that time. What had happened was Steve had put the cannula in and then put the LM in, and it wasn't in right, now it doesn't matter to me who puts it in.... Fatima removed it and was trying to reinsert it, and Steve was trying to

tell her how to do it, she said she wanted to do it her way. I think that was good but then it wasn't in right, and you can tell straight away because either they are a long way out or the black line isn't laying straight, and this time the black line was twisted. The important thing was that she took it out and tried from the side, the way Steve had suggested and it went in. The main thing is that the patient doesn't desaturate and doesn't wake up. I have no problem with Steve telling people how to do things, it doesn't matter to me who it is – it's your get out of jail free card. There are several things you can do: with the normal LMs you can try putting them in the wrong way round and then turning them, with the reinforced LMs you can reposition the head, or take away the pillow, or move yourself round to the side. The reason ODPs do it from the side is that is where they learn to do it from. I've always done it from the head so if I was to take over I would have done it the same way as Fatima but if I'd had trouble I would have tried it Steve's way.

The consultant anaesthetist immediately locates the source of the problem in a particular combination of the embodied features of the ODP and anaesthetist, rather than in the breaching of formal boundaries of practice; here elements such as the ODP's and the anaesthetist's respective levels of experience and expertise, their assertiveness, and the way tasks were being divided between them, all come into play. From Dr Hesketh's description it seems as though the ODP had been monopolising the learning curriculum, appropriating the experiences from which an anaesthetist's developing identity follows. Only in this case the ODP hadn't positioned the larygneal mask correctly. Dr Mani then removed the LM and this was the point at

which Dr Hesketh and I entered[14]. What followed was a brief, and somewhat muted, struggle for dominance; the anaesthetist trying to exercise her right and legitimacy to perform the tasks that define an anaesthetist's identity, namely airway management, and the ODP trying to assert his expertise in this area by answering the consultant's question and instructing Dr Mani on the technique. Dr Hesketh describes the ODP's technique not as *the* way to insert a reinforced laryngeal mask but one of a range of techniques that comprise an anaesthetist's 'trouble-shooting' repertoire. He makes the insightful observation that ODPs learn a different LM insertion technique because their spatial position during the course of induction is different to the anaesthetist's, the anaesthetist routinely stands at the head whilst the ODP is generally positioned at the side, demonstrating how the micro-geography of the anaesthetic room engenders varying experiences, techniques, and consequently, knowledge.

The overt display of knowledge by the ODP in the above sequence is not typical of the politics of knowledge in anaesthesia, however, I use it in the same way that ethnomethodology shows how the breaching of rules exposes the rule-based operations that produce a 'normal' situation (Gherardi, 2000). So by breaching the customs of anaesthesia the ODP exposes to scrutiny the norms and politics of knowledge.

Performing knowledge claims

The following sequence is also about the appropriation of the 'learning curricula' but in this it is the anaesthetist laying claim to an activity. The setting is a routine minor general surgical list, the sequence begins in the anaesthetic room as the patient is

[14] There is a methodological point to note here. On the basis of my observation alone I assumed that

being induced. Present are an anaesthetist, Dr Trevor Rhodes, an ODP, Ian Jackson, the patient and I.

Dr Rhodes "Bit of oxygen to breathe as you go off now."

After a few moments the ODP lifts the patient's gown to wrap up his arms in it *(this secures them out of the surgical field for the duration of the operation)*. The ODP points to a pulsating area in the patient's abdomen, its rather large *(roughly half the area of Ian's hand span)*, the ODP lays his hand on it. The ODP and Dr Rhodes talk about whether there was any mention of an aneurysm in his notes – there wasn't. Dr Rhodes tells me that it is not often you get to diagnose anything in anaesthesia.

Dr Rhodes lifts the mask off, the ODP opens the patient's mouth, pulling down the lower jaw, and Dr Rhodes inserts the laryngeal mask with a slight twist. The ODP inflates the laryngeal mask. Dr Rhodes connects the breathing circuit. One of the pumps beeps and Dr Rhodes replaces the remifentanyl syringe, one had already been prepared and was lying next to the pump. The ODP tapes the laryngeal mask in position and then tapes the patient's eyes shut. Dr Rhodes ventilating. The ODP rewraps the patient's arms in his gown. The patient's hands are moving.

ODP "Happy?"

Dr Rhodes "Just get him a little bit more settled." He presses buttons on the pump. Pause. "Yep." Dr Rhodes and the ODP disconnect the monitoring and breathing circuit, the ODP takes the brakes off, opens the doors and they wheel the patient through to theatre. The ODP also wheels the trolley with the pumps on.

Dr Mani had inserted the LM. Only on later questioning did it arise that the ODP had attempted the first failed LM insertion. This underscores the importance triangulating different sources of data.

ODP "Ready, brace, lift." Patient is transferred onto the table. ODP connects the breathing circuit. Circulating nurse inserts the arm supports.

Dr Rhodes "We were just wondering about his abdomen..."

The surgeon looks at the patient's abdomen, lays his hand on the area that is visibly pulsating.

Scrub nurse "Oh, you can see it..."

Circ nurse "You're not doing anything to him here!"

Surgeon "He should have an ultrasound scan..."

ODP "Legs up" he puts the patient's legs up in the stirrups.

Dr Rhodes turns to me and tells me this type of anaesthetic technique (continuous infusion of Remifentanyl and Propofol rather than using anaesthetic gases) is very good for this type of patient. I am about to ask him to explain why when the surgeon begins talking to Dr Rhodes.

Surgeon "We need to arrange a scan... it's a big one as well..."

Dr Rhodes turns the gases on – oxygen to 1 litre, air to 4 litres.

Dr Rhodes "Don't get to diagnose many things in anaesthesia..."

Another nurse enters "You wanting to do this*(the scan)* today?"

Surgeon "No, all I need is a form."

Blood pressure 83/56, pulse 51, oxygen saturation 98%.

Surgeon "He's kicking still."

Dr Rhodes "OK" he stands and presses some buttons on the pump, he holds down one of the buttons on the remifentanyl pump *(giving an additional amount)*. He writes on the anaesthetic chart.

The other nurse re-enters and talks to the surgeon about the scan – it will be next month.

Dr Rhodes goes into the anaesthetic room.

Nurse leaves and re-enters moments later.

Nurse "They can do it today whilst he's in hospital."

Surgeon "Who will see the scan... Mr Roberts *(a vascular consultant surgeon)...*"[15]

It is the ODP who initially draws attention to the pulsating area of the patient's abdomen, pointing to it and then laying his hand on it. With no diagnostic tests or procedures and a negligible amount of ceremony, this pulsating area has now become an 'aneurysm', a serious condition in which a weakness in the vessel wall herniates and may potentially rupture with the consequent blood loss being life threatening. However, it is the anaesthetist who claims the discovery of the aneurysm by using the word 'diagnosis'. This resonates with Tjora (2000), as discussed above, who identified that nurses often stop short of using the word 'diagnosis' even when the processes involved are inseparable from those used in medical diagnosis. The ODP, in this scenario, makes no display as to the authorship of the 'diagnosis'. On transferring him to the operating theatre the anaesthetist is quick to draw the surgeon's attention to the patient's abdomen, and in a gesture identical to that performed by the ODP, the surgeon lays his hand on the pulsating region. Again, without the flourish of a naming ceremony the two nurses indicate that they appreciate its significance with their comments 'oh you can see it' and 'you're not doing anything to him here!' suggesting that this particular theatre is not an appropriate setting in which to undertake a surgical repair of an abdominal aortic aneurysm, the nearest intensive care unit being 25 miles away. Dr Rhodes repeats his comment about the scarcity of diagnostic opportunities in anaesthesia thereby reiterating his claim to authorship of this discovery. The legitimacy of the claims to knowledge and the experiences and opportunities that produce it, are *stratified* in line with the professional identity to which an individual

[15] DG Obs 150201

aspires. Nurses and ODPs may recognise an aneurysm but it is a doctor who can claim to diagnose one.

Fortifying professional boundaries

'Stratified legitimacy' of participation and the effort exerted to reinforce these boundaries are clearly exhibited below. In this interview the consultant anaesthetist (Dr Harry Rogers) describes an incident in which a very ill elderly patient with many chronic conditions and an acute bowel obstruction had a cardiac arrest on induction. Unusually, with only a brief spell of cardiac massage and adrenaline the patient's heart rhythm was restored.

> I gave her, something like 50 mcgs of fentanyl and 4 mgs of etomidate and some sux *(a combination of drugs to induce anaesthesia and paralyse the patient)*, and she went very pale and we lost her peripheral pulse. We all looked at each other for a couple of seconds and we were all saying the same thing: shall we, shan't we? It took maybe 10 seconds to establish she hadn't got a carotid pulse either and I felt that we probably had to do cardiac massage. The reason I felt that was that it was very unlikely to work, but at least we were doing something. I mean I knew the pathology; someone with aortic stenosis does that to you and you're very unlikely to succeed. ... I gave her some ephedrine initially and some methoxamine *(both used to increase the heart rate and blood pressure)* and then when it was clear that she had arrested, I gave her 0.5 mgs of adrenalin. This is all through peripheral vein of course, but the amazing thing was that after the second brief episode of cardiac massage ... she just suddenly restored an output and then under the influence of the adrenalin she had, she had a heart rate of 100 and a blood pressure 200/100 and she very, very quickly pinked up. ...

> I said 'well lets get on and put the lines in' at which stage I think John (ODP) and Priya (SHO) found it a bit too much because they just said 'I don't think you should be going on any further'. That's where I think they had a valid point. You could question what on earth they are doing saying that in an anaesthetic room in that circumstance, and I found that quite challenging actually, particularly from John. I think with Priya it's ok because Priya is in a position of training to make those decisions, so Priya has a right to know why I'm doing that. John doesn't in those circumstances, John has to do what, under those circumstances, you know in the heat of the moment, John has to do what you ask. I mean he can take you aside afterwards, talk to the principal ODP or whatever, but I wasn't pleased and I said 'no I'm sorry I have a contract with this patient ... no, we'll put the central line in and we go ahead as we were'.

Following the restoration of the patient's heart rhythm Dr Rogers suggestion that they continue with the anaesthetic preparation of the patient for surgery was questioned by both the trainee anaesthetist (Dr Priya Chatterji) and the senior ODP (John Smith). The consultant felt that Dr Chatterji had a valid right to question; she has a right to an explanation as to his decision to continue. For Dr Rogers, the ODP, quite categorically, doesn't. His questioning was received as challenging and was met with the blunt response to continue as planned, no explanation given or seen as necessary. The ODP's participation, therefore, cannot be described as 'centripetal' as its legitimacy is structurally capped and the boundaries amongst the participants of anaesthesia are fortified. Dr Rogers returns to the stratification of legitimate peripheral participation later in the interview.

> I was actually very angry that he challenged me in the middle of that but in a sense he was right, he was playing it by the book. If we were going to resuscitate this woman we should do it properly get a few more people along, you know give X mgs of adrenalin, according to a protocol, defibrillate at X joules. But I'm stood there thinking, hang on, you know this is my patient only I know what her medical history is, and only I know how difficult it is to resuscitate somebody with aortic stenosis, therefore, only I am competent to make the decision as to whether or not we progress. I don't need 6 theatre nurses who have all been on an ALS course telling me what drugs to use; she either responds to what I give her or she doesn't, and nobody's going to change my opinion.

Here the consultant alights on an important point; in spite of nurses and doctors learning alongside one another on Advanced Life Support courses, and having to demonstrate the same competencies and theoretical understandings to successfully complete the course, back in the workplace doctors are able to practice their newly acquired theoretical understandings whereas nurses are prohibited from making treatment decisions, their involvement being limited to carrying out practical tasks, such as defibrillation, on instruction.

The effects of stratified legitimacy on knowledge resources

Having seen how legitimate peripheral participation is stratified according to the identity to which one aspires, it is now necessary to inquire as to how this is manifested in the resources a participant has to guide the trajectory of anaesthesia. Here a consultant anaesthetist (Dr Georgina Phillips), an anaesthetic SHO (Dr Peter

Frank), a medical student (Helen) and the senior ODP (Steve Didsbury) are working together on an Ear, Nose and Throat operating list.

The induction is underway as Dr Phillips, the medical student and I enter the anaesthetic room.

Dr Frank is standing at the head of the patient, inserting a guedel airway into the patient's mouth. The ODP is on the patient's left.

Dr Phillips puts a pair of gloves on and pulls out the patient's nose pack.

ODP is holding the laryngeal mask.

Dr Frank "I'll just give her a bit more..." he connects the propofol syringe to the cannula and injects. He ventilates then lifts the mask off.

ODP holds the laryngeal mask hovering over the patient's face.

Dr Frank "No, not yet. (He repositions the guedel) Is she biting her tongue? No." (quietly) He continues ventilating, repositions the black mask and then resumes ventilating. The anaesthetic machine beeps. He lifts jaw and holds the mask on with both hands, he looks at the reservoir bag, it moves but is not clearly inflating and deflating. Patient makes muffled groaning noise. The reservoir bag had been resting on the pillow, it falls to the floor. Dr Frank turns the Sevoflurane *(anaesthetic gas)* down to 5% (it had been on 8%). The bag is now clearly inflating and deflating.

Dr Phillips "So you can see what Peter is doing, getting her deep and settled so she will accept the LM..."

Dr Frank lifts the mask off and suctions, he hesitates but the ODP inserts the laryngeal mask, it stays in position.

Dr Frank "That's good". Moments later patient coughs. "Oh mama mia"

Dr Phillips "This is where 20 a day doesn't help... airway irritable. She looks like she's trying to cough the airway out. She is breathing down the anaesthetic so she might actually settle..." (to the medical student)
Dr Phillips hands the ODP a roll of tape[16].

In this episode the trainee anaesthetist Dr Frank is slowly deepening the level of anaesthesia until he judges that the patient will accept the laryngeal mask. The reason for this more cautious induction strategy becomes apparent as the action progresses – the patient is a smoker, and smokers are notorious for having 'irritable' airways, necessitating a deeper level of anaesthesia for the insertion of a laryngeal mask. The anaesthetist will have been aware of this information from the preoperative assessment. The ODP, not privy to this aspect of anaesthesia, does not take this into account. Soon after beginning the induction the ODP is prompting Dr Frank to insert the laryngeal mask holding it hovering over the patient's mouth and requiring the anaesthetist to say 'no, not yet'. When he then lifts off the mask to suction and hesitates, the ODP takes this opportunity to insert the laryngeal mask. The patient begins to cough and the consultant, Dr Phillips, explains to the medical student that as the patient is breathing the anaesthetic she will probably settle and the laryngeal mask will not need to be resited. Without access to the information garnered at a preoperative assessment the ODP has fewer resources with which to evaluate the patient's condition. The ODP judges the patient to be deep enough to accept the laryngeal mask. However, the anaesthetists, suspecting an irritable airway, opt to wait to achieve a deeper level of anaesthesia. It follows then that the structural limitation of the nurses' and ODPs' participation in anaesthesia has a subsequent detrimental effect

[16] DG Obs 051200

on their evaluation of the patient's status; they are disadvantaged in terms of interpretative resources.

Significantly this episode brings to light the difference between performing a task and being accountable for it; by working under the direct supervision of the anaesthetists the ODP may insert a laryngeal mask without actually accepting responsibility it, airway management is the anaesthetist's domain and being present retains this responsibility. This departs from the literature reviewed above in which nurses undertook doctors' duties, and would be held accountable, only when doctors were not available. This latter scenario is more frequently seen in the recovery room where the anaesthetist 'hands over' the care of the patient to a nurse, or more recently an ODP. Doctors may often be present in the department but they are frequently unavailable, being involved in activities from which they cannot be separated.

The persuasive potential of knowledge resources

I have discussed how the stratification of legitimacy limits the resources with which a nurse or ODP may use to assess a clinical situation. I now turn to the resources ODPs and nurses do have, and the potential of these resources to facilitate the practitioner's contribution to the unfolding course of anaesthesia. In this interview a recovery nurse (Wendy Hughes) reads to me her account of an event she recorded for the purpose of 'critical incident analysis'. She describes a situation in which she received, and assumed responsibility for, a patient following a routine laparoscopic cholecystectomy which is 'keyhole' surgery for the removal of the gall bladder. The account shows that on admission to the recovery room the patient was sleepy but rousable, and measurements such as blood pressure and pulse were within normal limits. However,

during the course of her stay in Recovery her condition deteriorated: she became pale, her temperature fell, her blood pressure fell, her level of consciousness diminished and she became difficult to rouse, and her wound drain contained a significant amount of blood.

> At this point I was sufficiently concerned and spoke directly to the consultant surgeon who had performed the operation. He carried out a brief examination and advised me to exchange the medinorm drain and monitor her closely. I asked if he wanted me to arrange a blood transfusion in view of Kate's low blood pressure and pallor but this request was denied. Following the conversation with the surgeon I spoke to the anaesthetist in charge of Kate's care, he reviewed Kate in recovery and asked me to arrange for four units of blood to be collected from the Haematology Department. On contacting the laboratory it became apparent that Kate had not been cross-matched for blood and indeed there was no pre-operative blood results available. I relayed this information to the anaesthetist who arranged for a full blood count, cross-match, urea and electrolites.
>
> ... ...
>
> At this point I remembered feeling uneasy and suspected there was a possibility that Kate was bleeding internally. However, I knew the only option available to me was to monitor Kate's condition closely and continue to raise my concerns with the surgeon and anaesthetist, this was the course of action that I took.

Kate continued to slowly deteriorate over the course of the morning and at 12.20 I was extremely concerned, agitated and frustrated, having continuously raised my concerns strongly to all involved parties I felt unsupported and

ignored. Kate by this time appeared pale and clammy, her blood pressure was being maintained with colloid infusion but her conscious level was deteriorating and it was becoming difficult to rouse her.

... ...

Again I voiced my concerns this time with the surgical senior registrar as the consultant had left the theatre complex on completion of his list. During my conversation with the senior registrar Kate's blood results returned from the laboratory. Kate's haemoglobin was recorded at 6.8. It was now obvious that Kate was haemorrhaging internally but by now she was visibly and physiologically shocked. Despite Kate's critical condition the senior registrar remained reluctant to take Kate back to theatre without first discussing it with the consultant surgeon. At this point I summonsed the consultant anaesthetist in charge of the critical care directorate due to the lack of support afforded to me by the anaesthetist in Kate's care. He quickly assessed the situation and began to make immediate arrangements for 6 units of blood to be transfused as a matter of urgency and for Kate to return to theatre. Kate returned to theatre at 2 o'clock where upon following an emergency laparotomy it was discovered that she had been haemorrhaging from a small incision to her liver. This was easily rectified but due to the critical condition and considerable blood loss she was transferred to the High Dependency Unit where she remained for two days before being relocated to the ward[17].

In this situation the recovery nurse took sole responsibility for the care of this patient; she draws on the resources available to her to engineer an intelligible account of the situation, however, this does not lead directly to action, the interventions required to prevent deterioration of the patient's condition lay outside her remit. The nurse could

[17] DG Int 301100

not prescribe a blood transfusion, or perform the surgery, for this she had to enrol a number of doctors. And all but her final, somewhat desperate, attempt to do so, failed. The nurse is unable to initiate action based on her evaluation of the situation, instead she has to persuade doctors of the veracity of her account and her lack of success incurs a considerable degree of anxiety.

The recovery nurse goes on to recount uneasiness, uncertainty and a lack of confidence in her assessment of the patient's condition. As the patient's condition further deteriorated this ambiguity resolved and the nurse began to feel more justified in her concerns. The nurse reports an 'enormous sense of relief' when the clinical director supports her interpretation and forcefully initiates the interventions the nurse was unable to. As the interview continues I ask Wendy to elaborate on this uncertainty.

> I doubted myself ... I suspected that she was haemorrhaging from a fairly early stage ... but it's very difficult to actually look at a patient and know 100% that she is pale and clammy *because* she is shocked *because* she is losing blood internally. Plus the fact that in this particular case the reason why the surgeon was so reluctant to do anything was because she didn't display the typical textbook signs of haemorrhage ... The senior registrar argued with me over the patient, that she couldn't possibly haemorrhaging because her blood pressure was still 90 over 40, and I said 'yes but she's had 6 units of gelofusion so I'm maintaining the blood pressure with the gelofusion and that's the only reason that her blood pressure is as it is'. If I'd stopped giving that, it would drop considerably. I can remember saying to him 'you need to look at this patient as a whole, look at her holistically, don't look at

her vital signs look at *her*, she has deteriorated'. He said 'Well how's she deteriorated, her blood pressure hasn't got any lower?', 'Look at *her*, she was conscious before, she was easily rouseable, she was warm, alright she was pale, but now she's pale, clammy, hypothermic, and I'm having to put a warming blanket on her, and she's not easily rousable. She's shocked, she has the classic symptoms of shock. Look at the patient, don't look at the monitors, look at *her*!' And he argued with me for a long time, and it was while we were having this discussion that the senior consultant anaesthetist *(Clinical Director)* came through. He just took over completely and said 'this woman is clinically shocked, she's going to need resuscitation before she goes back to theatre I want 6 units banging into her straight away, so you get onto that. I don't care whether the consultant wants to take her back, this lady needs to go back to theatre now' and that was that. You know he almost shouted, it was not up for discussion, she was going back and I just remember feeling 'oh thank god for that', you know, 'thank god he has taken over' because I was just not getting anywhere.

And yet quite possibly if I'm honest all the way through there was that minute shadow of doubt, in my own ability or my own knowledge base ... Even the junior anaesthetist, not junior but the anaesthetist in charge of the case, felt out of his depth, so he had gone across to the intensive care unit and said 'you're going to have to help me here'. But I had felt unsupported from him all the way along in terms of, I was saying 'you need to do something you know, this lady is, you know, I think she's bleeding what do you think?', 'Well I do as well but that's the surgeons problem'. In other words, 'that's your problem to alert the surgeon', which I had already had done and I'd actually spoken to the consultant surgeon three times...

Wendy attributes the persistence of doubt and her difficulty in persuading the surgeons to the lack of 'textbook' signs of haemorrhage. She entreats the surgeon to look beyond the numbers displayed on the monitor and to take account of the less tangible signs – that the patient was increasingly difficult to rouse, that she was becoming paler, clammy, and her temperature falling. All of these signs are not uncommon in the immediate post-operative period but the particular configuration and direction of trends are significant and suggest to Wendy that the patient was bleeding and that this would require surgical intervention. Wendy's experiences as a recovery nurse enable her to recognise when a particular configuration of signs are indicative of significant deterioration in the patient's condition. Through working with patients in the immediate few hours following surgery she has gained an intimate knowledge of the expected trajectories, not only in terms of 'textbook' indicators but also in less tangible terms. Corresponding with Anspach's 'ecology of knowledge', the surgeons are distanced from this period and, without access to these experiences, are unable to appreciate the indications of the less tangible resources. Instead, they rely on explicit and observable measures, in the case of post-operative haemorrhage, a low blood pressure and an observably swollen abdomen. Consequently, the lack of 'textbook' indicators strips the recovery nurse of the resources with which to persuade the surgeons of her evaluation, and invokes feelings of doubt and uncertainty.

The junior anaesthetist was apparently convinced but was unable to act, demurring on the grounds that it was the surgeons' decision. The diagnosis of 'haemorrhage' following surgery is commonly constructed as a surgical decision and both Wendy (although she did repeatedly attempt to coax the surgeons towards this conclusion) and the junior anaesthetist were reluctant or unable to transgress these territorial

boundaries and encroach on the surgeons' area of expertise. As Wendy puts it they felt 'out of their depth'. It required the director of the critical care directorate, to intervene. He quickly reached the same conclusions as the recovery nurse and cuts across professional boundaries to instigate a course of action.

How was the recovery nurse able to persuade the clinical director of her account so easily, and to act on this basis, and not the surgeons? One reason for this may be the degree to which the boundaries of practice of a surgeon, anaesthetist and recovery nurse merge. Anaesthetists are present throughout surgery, and practiced at adjusting their care to the effects of the surgical intervention, they work to alleviate the effects of surgery and will then hand the care of the patient over to the recovery nurse. The nurse then continues to alleviate the ongoing effects of surgery as the patient regains consciousness. Nurses and anaesthetists share a common objective, they look for the same signs and indicators, and confer on the resolution of problems. Whilst the temporal boundaries of their work are distinct, the anaesthetists' during the surgery and the nurses' following, they strive towards the same ends and come to appreciate the common post-operative trajectories and the significance of deviations from this. Persuasion, then, is more likely to be achieved if both participants can share a common outlook, attend to the same signs, and appreciate their significance. Moreover, the anaesthetist can legitimately set in train a course of action, ordering and prescribing blood, arranging for an operating theatre to be made available, and can endeavour to persuade the surgeon.

Regulating participation: processes and effects

Hindmarsh and Pilnick (2002:158) describe teamwork as 'a practical accomplishment that emerges despite the fact that team members often have unequal power or status'. In my analysis I have focussed on the ways in which status, as a position and an identity, is developed and achieved through the stratification of legitimate participation in anaesthetic practice, and I have elaborated how a differential in power develops, and the effects this has for the nurses and ODPs of an anaesthetic team in terms of the available resources with which to engineer an account of a clinical situation, and to initiate action.

I looked first at *access*, as there is a limit to the number of actors that can be tolerated in the anaesthetic room admission tends only to be granted to those with a practical purpose to perform. Moreover, as with access, involvement is also regulated; it must follow anaesthetic norms and conventions. For those who disregard these conventions access is revoked. Patrolling the boundaries of the anaesthetic room, therefore, has the concatenated effect of governing the way individuals participate in practice, if they veer from the accustomed manner of participation their rights to access are denied. This preserves anaesthetic routines, knowledge and safety by protecting the routines from the disruption, thereby reinforcing the endorsed manner of participation. This means firstly, that membership in a community of practice is far from stable, it can be awarded and revoked capriciously depending on the depending on the demands of the situation, and secondly, that *legitimacy*, both to access certain areas and the knowledge and practices contained within, and to participate in those practices in an accepted manner, is *stratified*.

So access to the anaesthetic room does not ensure unfettered participation in its practices. When an actor participates in ways that stray outside accepted boundaries of their practice this may impinge on the opportunities of another to develop the skills, practices, knowledge and identity to which he or she aspires. Tensions develop, and legitimacy is disputed, when a participant's developing identity is jeopardised by another's appropriation of the 'learning curricula'. In attempting to avert this situation the boundaries between the different groups are in need of continual reinforcement. The *stratification of legitimate participation*, which individuals have the right to act and to question, in which circumstances, are constantly reaffirmed. Such stratification prevents the 'centripetal' development of participants and results in a range of practitioner identities. Capping the extent of participation within the 'learning curriculum' correspondingly limits the resources with which an actor can understand anaesthetic practices and the patient's condition. This, in turn, restricts the extent to which those participants may influence the care of the patient. Furthermore, the resources nurses and ODPs do have at their disposal may lack some of the persuasive potential of 'hardened' medical criteria. The account of a patient's condition engineered by a nurse, for example, may fail to persuade a surgeon to act. Nurses and ODPs, then, are disadvantaged in terms of initiating action. However, an account cannot simply be allowed to decay, the consequences being portentous, a nurse or ODP must find a participant with whom they share a common outlook, who will appreciate the significance of the subtle, intangible signs as well as the explicit measurements, and whose role legitimises the initiation of action.

Chapter 6

Agency of artefacts?

Of tools and techniques

"there still remains, however, relatively little research concerned with the ways in which material resources and artefacts feature in the day-to-day delivery of healthcare."

(Heath, Luff and Svensson, 2003:87)

I have looked, thus far, at the ways in which the patients, the anaesthetic machines, anaesthetists, nurses and ODPs, contribute to the way anaesthetic practice unfolds, the particular course an anaesthetic takes, an anaesthetic trajectory. In this chapter I am concerned to explore the role of tools and devices, the way they feature in everyday situations. This is an area that remains relatively unexplored according to Heath, Luff, and Svensson (2003). They suggest that the role of health technologies *is* studied, but that the emphasis of the studies, on the construction of meaning, frames of reference and perceptual schema, diverts attention away from how the devices are used in interaction. For Heath et al, this disregards opportunities to understand the ways in which tools, devices and artefacts feature in everyday medical practice. Button (1993) has made a similar criticism of Science and Technology Studies (STS); he argues that strangely, for a field which purports to study technology, the technology *itself* tends to 'vanish', being displaced in the studies by the mechanisms

that have shaped the technology. Consequently, as Heath et al (2003) point out, little is known about the ways in which people use mundane artefacts in day-to-day situations. In this chapter, therefore, I attend to the particular and specific ways in which tools and devices are used in the routine delivery of anaesthesia in order to elucidate how the tools support and inform the course of an anaesthetic trajectory.

Operating the tools of health care

Taking up this question of the potential for technologies to support and enhance workplace activities Webster observes that:

> technologies are only really successful when they make sense within the existing social relations within which they are to function, suggesting the crucial role played by the *translation* and even *reinvention* of technologies into everyday contexts of use. (2002:44, original emphasis)

Emphasising 'translation' and 'reinvention' Webster indicates that technologies, tools and devices do not just fit into practice, their purpose and utility obvious and transparent. Rather, achieving a fruitful outcome from a tool requires creativity, skill and knowledge from the operator.

Webster's proposition takes account of studies such as Pope's (1991) who describes how the implementation of a computer system for the management of waiting lists failed to assist the process. Pope's observation of the admissions clerks' work brought to light the actual practices that comprised the day-to-day management of

waiting lists. She revealed that the clerks' worked a dual approach to waiting list management: a computerised system that was essentially only used to produce official, and largely inaccurate, statistics, and a manual card index system that was the 'living data system', the 'everyday source of information'. She explains why the clerks strenuously resisted managerial attempts to discontinue the manual system:

> The manual waiting list consists of coloured index cards which are typed, annotated, and often flagged with stickers; the list being kept in a rather ancient cabinet. The cards provide a visual, and crucially *tactile* representation of the patient. It is immediately apparent that a tattered, heavily amended card has been there a long time. Opening one of the cabinet drawers reveals far more to the senses than obtaining a standardised computer print out. (Pope, 1991:206)

Pope goes on that the computerised system limits the amount of additional information that can be attached to a patient's file, the clerks consequently have to choose between recording such details as the patient's work telephone numbers or dates when the patient will be unavailable. In contrast, the reverse of the card, in the manual system, provides space to pencil in these details, thereby building more flexibility into the system.

When seeking to understand the management of waiting lists with a view to introducing a new technology or to 'update' or 'improve' the efficacy of the system, Pope demonstrates the importance of attending to the actual working practices that accomplish management of the waiting lists rather than relying on analytical models or common-sense notions:

> Our common-sense ideas about queues are not directly applicable to waiting lists. This is both because of the role of medically defined need and priorities, and perhaps more importantly because the actions of hospital personnel and the patients mitigate against a rational queue. The ability of some patients to work the system and the use of discretion and personal preference by clerks and clinicians, as well as the influence of events outside the admissions office all serve to disrupt any notion of the waiting list as an orderly queue. (Pope, 1991:205)

Elaborating this theme of the need to manipulate technologies in the workplace to realise their utility, Mort et al (2003) examine the practice of teledermatology. They identify how the conception of teledermatology clinics developed from 'simply a site organized around captured images' to 'a multiskilled and complex process whereby the images became supplemented by a patchwork of other kinds of activities and materials, such as reassurance, explanation, history taking, intuitive investigation, skin and blood samples and of course the online pro forma histories which accompanied the images' (2003:285). Furthermore, they suggest that the way nurses were able to touch the patients, to palpate skin lesions if necessary, to appreciate the patient's emotional response to the effects of dermatological conditions, to search for different sites to photograph in certain ways, and to judge when to take samples of blood and tissue 'generated types of knowledge, information, and subtle data that challenged the formalised structure of the pro forma histories' (Mort et al, 2003:289). Consequently, it was the 'impulse of the clinic nurses to compensate for the deficiencies in the software and more importantly for what they perceived to be the limitations of image-based diagnosis' that 'ended up creating a different kind of

service, one in which their role and skills were (could have been) considerably enhanced' (Mort et al, 2003:289).

Specifically, one of the most important changes to develop within and around the technology was the increasing significance of the pro forma histories in relation to the image, and within this, the 'free text' box:

> Image quality was found to be disappointing; it failed to match up to the expectations raised at the clinical trial, operating as it did in 'real' and different environments. The information contained in the pro forma histories therefore increased in significance in relation to the images, but in particular the status of the free text box, which was acknowledged to be insufficient to reflect some of the more qualitative aspects of the nurse consultation. ... The consultant dermatologists admitted that when they had doubts or uncertainties about an image, they turned to the fee text part of the pro forma history for guidance. (Mort et al, 2003:18)

Hence, Mort et al's study confirms what Pope alluded to: that the working practices which surround a technology, be it a protocol or a system for managing waiting lists, are not necessarily intended to subvert the system or technology but are fundamental to its continuation and success.

In Hogle's (1999) study of the practice of organ transplantation in Germany she too considers the daily activities of practitioners and finds that their adjustments and compensatory practices are necessary for guidelines and computer systems to 'work'. Hogle reports:

> During my research I saw how day-to-day decisions and activities reflect local accommodations, resistances and reinterpretations of supposedly universal, standardized medicine. Surgeons make the ultimate decision about accepting offered organs and giving away or keeping organs they have procured themselves, but coordinators play a key role in mediating information and establishing practices at each transplant centre. (1999:129)

The systems for allocating donated organs are highly complex, intricately specified, and categorically state that if a perfect match exists the organ must go to that recipient regardless of other contingencies. However, a 'perfect match' is rare whereas partial matches proliferate and Hogle identifies that it is the ambiguity of the 'in-between matches' that allows for variability in practices.

Illustrating the variability and contingency involved in transplant coordination, Hogle recalls the extent of the negotiations a transplant coordinator had to undertake in order to find recipients for the organs of a donor. These negotiations entailed multiple telephone calls to numerous specialist centres (heart, liver, pancreas) offering the available organs. These centres variously accepted, rejected or made conditional requests – they will have the heart if they can also have the lungs, or they can take the pancreas but also need a kidney. This negotiation is complicated further by the loyalty a coordinator extends to his or her own centre; in one case Hogle describes, the coordinator chose to keep the kidneys for his own centre and donated the pancreas to research. Hogle concludes:

> the coordinator worked at making the process more efficient and reducing the waste of valuable resources. So much for the myth that the Eurotransplant computer makes all decisions without human intervention. The role of coordinator in mediating choices, interpreting data, and facilitating the procedure cannot be underestimated. (1999:134)

Hartland (1993) also illustrates the role of the human actor when analysing the practices that surround and support the use of interpretative electrocardiogram (ECG) machines. ECG machines will record a 'trace' of the electrical activity of the heart from 12 different positions or 'leads', an 'interpretative' ECG machine will also give an explanation, or 'diagnosis'. Hartland attends to the different ways that humans and machines interpret an ECG; for the human the meaning of 'normal' and the position of 'normal' boundaries may be negotiated, thus, when human analysts disagree, considered discussion can take place leading to a consensus interpretation. In contrast, the machines will diagnose 'abnormal' on the basis of just one element of the recording. She suggests that humans can have a raised awareness to the possibility of error, as a skilled human would appraise all the components of the recording looking for consistency.

Hartland describes how, if unhappy with the interpretation of an ECG the machine offers, the users of interpretative ECG machines would obtain repeated traces, adjusting the leads to improve the quality of the trace, until they judge the machine to have produced the correct interpretation. Thus, Hartland describes how users 'repair' the faulty outputs of the machine. The machine's interpretations, therefore, are not routinely relied upon but regularly checked by humans in their daily practice.

Hartland concludes that the 'machine's performance is dependent on the charity of the humans who operate it' (1993:78). The practical relevance of Hartland's research becomes apparent when she contends: 'It must be recognised that the presence of an expert human interpreter is always necessary' (1993:80) and that 'The machine needs supervision' (1993:80).

Exploring the effects of tools and artefacts: theoretical resources

Heath et al (2003) argue that of those studies that examine health technologies often little detail is provided about the actual ways in which the technologies feature in everyday work practices. Instead the papers focus on such aspects as how the technology's output is made meaningful, as Pasveer (1989) concentrates on how X-ray images come to 'represent' parts of the body. Similarly, Button (1993) argues, of studies undertaken in the field of STS, that they are:

> less concerned with questions about the constitution and organisation of technology than ... with using technology as a platform from which to observe the constitution and organisation of the structural arrangements of society. (1993:10)

He takes the example of MacKenzie and Wajcman's volume on the 'social shaping of technology' that emphasises the role of economics and gender in the development of technology. Whilst he acknowledges that these topics are worthy of study, he cautions:

> There is, though, a fine line to tread between developing an interest in the shaping mechanisms and an interest in the phenomenon that is said to be shaped. In emphasising what might seem to be generally operative forces such as economic and gender forces, there is a danger that the argument that technology is socially constrained and shaped may run the risk of losing the very 'content' of technology it wishes to address. (Button, 1993:10)

For example, Button sees Cockburn's study of compositors as a 'description of gender relations and hierarchy at work' (1993:16). Again, he accepts it is a worthy topic to study but the effect is that the technology becomes one of the many arenas in which to view the manifestation of gender relationships in society. Therefore, Button contends:

> If studies done in terms of this announced interest in the content of technology are examined, it seems that the content of technology, far from being visible, has mysteriously vanished in the course of the investigation. (1993:15).

Button does not, however, let his critique rest here; he also examines studies carried out under the rubric of Actor-Network Theory. Still, he finds the details of the actual work involved in the production of technology missing. He says 'the actual assembly, the details and processes of, to use their terminology 'association' is, curiously, never addressed' (1993:23). Taking Law's study of Portuguese ship building as an example he argues:

> what is missing in his description is an account of *the details of the associating,* an account of the interactional work, the particular embodied practices of the galley builders, even though it is in those details that the galley as an artefact emerges, or is produced. The galley, as Law recognises, did not just emerge from the elements, it emerged from the association of the elements. But in Law's actor-network argument, although we have a description of all the things that went into the galley's production, including the fact of their association, we are given no understanding of what that association consists of in the production of the particular object 'the galley'. (1993:24, original emphasis)

For Button, the actions, the working practices and interactions that associate the elements and thereby *produce* the galley are the key to analysing the role of technology; it is the activities and working practices that are of prime sociological importance, and by studying these practices one can better attend to how technologies might then support the workplace.

Button (2000) suggests drawing on ethnomethodology to guide the analysis of practices that constitute the use of the technology. Principally, this involves the explication of 'members' knowledge'. Here he argues:

> Analytical explications must reference what Garfinkel terms *members' knowledge*: what people have to know, and how that knowledge is deployed in the ordering and organisation of their work. (Button, 2000:9)

According to Button attending to these practices, and the knowledge and rationales that inform them, preserves the technology, and how it features in day-to-day work, at

the forefront of the analysis. Arguably, however, the activities and working practices are not the 'content' of technology either. These practices are what humans do with, to, in and around the technology, not what the technology 'itself' does.

Button's proposal, for Berg (1998), incurs a serious flaw. Berg identifies how the kind of analysis to which Button refers emphasizes the difference between the logics of technology and the logics of human work:

> it uncovers the intricate feats that technology cannot accomplish and humans can and must. Concurrently, it stresses (and makes visible) the irreducible, central role that human work plays or should play in most socially relevant and complexly structured work tasks. (Berg, 1998:468)

The problem with this scenario, for Berg, is that the underlying dichotomy between humans and machines, technologies and devices remains unquestioned: technologies perform mechanical, predictable functions, and humans interpret, are flexible, and articulate the breaches that continually spring up. Consequently, Berg argues that a form of both humanist and technological determinism is reinstalled in the analysis by prespecifying the realms in which humans and technologies act. In contrast, recent work in STS has stressed how each merger of humans, artefacts, and technologies creates a new entity, whose capacities cannot be fully foreseen (Berg, 1998:475). This means that:

> Contrary to both technological and humanist determinist's views, technologies are not the propellers of ideologies (whether sympathetic or not); they inevitably alter, twist and transform what they 'carry'. (1998:478)

Here Berg recapitulates a key insight in STS: that in the production and use of a technology no single ideal will survive unscathed, the contingencies of production, and of the users and their environment, will make their mark on the technology, changing it into a tool the precise shape of which no-one had predicted. This is the feature to which Webster refers when he stresses how technologies are *translated* and *reinvented*, an insight that may be lost if the realms in which humans and technologies can act are rigidly, and *a priori*, defined. In this way, technologies 'are not merely 'tools' that humans 'use': they participate in the performance of the work tasks' (Berg, 1998:481). Berg advocates an analytical position from which one does not contain the technology's modes of participation within the limited, predictable and 'rational' realm but a position from which the analyst is open to the unpredictable outcomes of alliances between humans and machines.

One study that exemplifies the analytical position Berg advocates is de Laet and Mol's exposition of the Zimbabwe bush pump (2000). In this, the authors investigate the specificities of the water pump; how the components, both visible and hidden, function, how they connect, are replaced, can be improvised, and how the pump is installed and maintained. In their analysis de Laet and Mol discuss the workings of the pump, and its components in intricate detail. The authors conclude that what makes this particular pump so successful is its 'fluidity'; that it is not too rigidly defined, that the pump continues to function even with missing parts, that some components can be substituted for locally available materials, and that the pump is tolerant or 'forgiving', in that it continues to work, of local, and ingenious adaptation. De Laet and Mol explain how the design has evolved to allow easier repair and

replacement of its hydraulic components, and how some of the components, the steel bolts, may be substituted for steel bars. So de Laet and Mol demonstrate how an analytical position that emphasises the association of elements in an evolving device need not be incompatible with maintaining the specificities of the technology 'itself' in the forefront of the analysis.

MacKenzie and Spinardi (1995) approach the study of science and technology from a different perspective to de Laet and Mol, but in their discussion of the development and spread of nuclear weapons they also keep the details of the science and technology in the forefront of the analysis. They record such details as how the scientists' work suffered from being too formal and mathematical with their model's failing to accurately predict the outcome of their experiments, and the difficulties the scientists and engineers encountered in handling the materials: the differences in metallurgy of plutonium to uranium, learning how to mould high explosives into the required shapes without cracks or bubbles appearing. So whilst MacKenzie and Spinardi's focus concerns the development and spread of knowledge of nuclear weapons design and production, this is grounded in the specificities of the technologies.

Again, however, Suchman's observation (discussed in chapter three) is relevant here: in abandoning the fixed positions that allocate different capabilities to humans and technologies or machines, many studies in STS extend human characteristics to machines. Suchman proposes that whilst machines may exert a form of agency it is not necessarily the same form of agency that humans demonstrate. So studies

drawing on the analytical repertoire of STS must also be aware of certain potential flaws; namely the conflation of human and machine forms of agency.

Hence, ethnomethodology, as an analytical resource, offers the opportunity to concentrate on the ways technologies, tools and devices work in the day-to-day practices of health care. It does, however, run the risk of prespecifying the ways in which technologies can 'act'. Nevertheless, I think it is worth using ethnomethodology here as one of a number of complementary perspectives which I have endeavoured to bring together in this study. Here, by using ethnomethodology, I hope to bring to light a different aspect of anaesthesia's tools than if I should employ another resource from the theoretical repertoire of STS. In Chapter Three, using the imagery of the cyborg and drawing on Haraway and Latour brought about questions of how agency may be redistributed amongst human and machine; in this chapter my focus is more mundane, it is about what the tools do, what possibilities they enable, and how the tools contribute to the way an anaesthetic trajectory unfolds – an emphasis suited to an ethnomethodological perspective.

Tools and Techniques

The discussion in the previous chapter touched upon how artefacts contribute to the generation of anaesthetic knowledge. To recapitulate: in the scenario involving the misplacement of a reinforced laryngeal mask, the black line that runs the length of the upper side of the tube was twisted, showing the practitioners its misplacement. The consultant, Dr Graham Hesketh, recounts:

> it wasn't in right and you can tell straight away because either they are a long way out or the black line isn't laying straight and this time the black line was twisted. The important thing was that she took it out and tried from the side, the way Steve had suggested, and it went in. ...

Dr Hesketh's comments point to how a practitioner develops an understanding of the utility of a tool's characteristics, and learns how to manipulate and 'read' them so as to realise their contribution to anaesthetic knowledge. He discusses the various methods of re-siting the airway and improving the likelihood of a correct placement. He suggests:

> There are several things you can do, with the normal LMs you can try putting them in the wrong way round and then turning them, with the reinforced LMs you can reposition the head, take away the pillow, or move yourself round to the side.

He lists a variety of strategies that may overcome difficulty when inserting a laryngeal mask. These strategies imply an intimate knowledge of using a specific device, they amount to a trouble-shooting repertoire and are an example of what Garfinkel termed 'members' knowledge': what a practitioner needs to know to be able to do a particular job, perform a task, or operate a certain instrument, in this case, to insert a laryngeal mask. After running through this repertoire, he comments:

> The reason ODPs do it from the side is because that is where they learn to do it from. I've always done it from the head so if I was to take over I would

have done it the same way as Fatima (the SpR) but if I'd had trouble I would have tried it Steve's (the ODP) way.

This illuminates how ODPs and anaesthetists learn varying LM insertion techniques because of their different spatial position during the course of induction; the anaesthetist routinely stands behind the head whilst the ODP is generally positioned to the side of the patient. Crucially then, the spaces occupied by participants engender a certain set of possibilities: the opportunity to develop particular techniques, experiences, and consequently knowledge, specific to that position. This indicates how the production of anaesthetic knowledge of a patient is dependent upon the ability to achieve a particular view of the patient. Below I develop these three themes:

i) How a practitioner learns to read and manipulate a tool's characteristics so as to realise its contribution to anaesthetic knowledge.

ii) How an intimate and tool-specific knowledge is an integral element of an anaesthetist's 'members' knowledge'

iii) How the production of anaesthetic knowledge depends on the practices and positionings that achieve a particular view of the patient.

'Nice airways' and 'perfect views'

Here, the consultant anaesthetist (Dr Georgina Phillips) works with an SHO (Dr Frank) and a medical student (Helen) on an Ear, Nose and Throat operating list. The ODP is Steve Didsbury.

Dr Frank waits, holding syringes and looking at Dr Phillips.

Dr Phillips "I can ventilate"

Dr Frank "35 or 40?" *(mgs of atracurium – a muscle relaxant)*

Dr Phillips "25"

Dr Frank "She is 60 kilos"

Dr Phillips "... they might do this operation very quickly... nice airway (the medical student takes over ventilating).. hold the mask... pull the face up into the mask..."

The medical student holds the mask with one hand and squeezes the bag with the other, Dr Frank comments on two handed technique – it is good, Dr Phillips agrees – advanced for her second day in anaesthesia.

Dr Phillips "We need to do that for 2 minutes...You've got a leak around the mask somewhere..." she holds the mask on as well. The medical student then holds the mask on with both hands and Dr Phillips ventilates.

Dr Phillips "Some people you can ventilate really nicely without an airway *(meaning airway 'adjuncts')*...(pressing buttons on the monitoring)... that's a minute..."

The ODP tucks the patient's arms down by her sides with the sheet.

Dr Phillips turns the nitrous oxide off, lifts off the mask and inserts the laryngoscope. "Have you had a look at her tonsils? They're huge (to a student nurse who peers into patient's mouth). Helen, if this is a good view I'm going to let you do the laryngoscopy... absolutely perfect view..." Dr Phillips removes the laryngoscope, replaces the face mask, ventilates two or three times and lifts the mask off again.

ODP "use this hand" (to the medical student)

The medical student inserts the laryngoscope "... got the epiglottis..."

Dr Phillips "... slide down a bit further..."

ODP "lift away from you... you've gone a touch too far" (looking at patient's neck)

Dr Phillips talking her through the technique 'come back a bit...'

Medical student "Got the cords" She intubates using a RAE tube *(this is a n-shaped tube which bends down from the mouth towards the chin, it is commonly used in ENT as the tube and its connections are directed down away from the surgeon's access).*

ODP "Yes"

Dr Phillips "You saw it go through the cords?"

Helen "Yes" she looks up as she is speaking whilst still feeding the tube down further.

Dr Phillips "Wo, wo!"

Helen has pushed the tube in so the end of the tube is almost at the patient's mouth, Dr Phillips pulls it back so the bend in the tube is at the patient's lips and the end of the tube is down by the patient's chin. Dr Phillips turns and looks around at the anaesthetic machine. "Now if I had a stethoscope...(she does not finish sentence)". Dr Frank passes his stethoscope to the medical student.

The ODP is holding the tube in place, pressing it to the patient's chin.

The medical student listens to the patient's chest placing the end of the stethoscope to the side of each breast as Dr Phillips ventilates.

Medical student "Yes"

ODP places a length of tape across the tube and onto the patient's chin.[18]

Dr Frank waits for confirmation that Dr Phillips can ventilate before injecting atracurium, the muscle-relaxant drug. He suggests a dose – 35 or 40 mgs – on the basis of the patient's weight, however, Dr Phillips opts to give 25 mgs anticipating that *these* surgeons might do *this* operation very quickly. This demonstrates how the manipulation of drugs, as tools, relies on an understanding of the specific situation in

which they feature. Dr Phillips then attends to teaching the medical student a rudimentary skill of anaesthesia: ventilating a patient using only basic apparatus. The anatomical structure of some people's faces means that they do not easily fit the mask exactly making it difficult to achieve a seal. Furthermore, the internal structures of a patient's airway (the pathway from the patient's nose and mouth to their lungs) can necessitate the use of airway 'adjuncts'; specific devices that fortify this pathway. As this patient has a 'nice airway' that can be easily managed without using additional 'airway adjuncts' she provides the ideal opportunity for the medical student to achieve this technique. The medical student is successful at holding the mask on with one hand and squeezing the reservoir bag with the other hand only momentarily before Dr Phillips identifies a 'leak' where the seal of the mask on the patient's face is not complete and gases escape. The difficulty the medical student encounters illustrates the body of practices ('pull the face up into the mask', and achieve a seal) that must be accomplished to utilise even such a mundane artefact as a facemask.

Again, as the patient's anatomy offers a 'perfect view' the medical student has the opportunity to perform a laryngoscopy and intubation. With advice from Dr Phillips and the ODP on how to manipulate the laryngoscope so as to yield a view of the vocal cords the medical student successfully passes the endotracheal tube through the vocal cords. However, without an understanding of the specificity of the tube, and an awareness of the purpose of the tube's shape she still misplaces the tube, passing it too far, an error corrected by Dr Phillips.

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[18] Obs 05/12/00

Achieving a view: members' knowledge and the specificity of tools

On a separate occasion a consultant anaesthetist discusses with me a 'difficult intubation' and elaborates on the value of tool-specific knowledge.

> This lady, who was going for basically a pelvic floor type repair, was quite obese and we decided that we were going to intubate for safety of anaesthesia. She had a couple of crowns, caps at the front, but I wasn't anticipating a difficult intubation. I assessed her pre-op and she had a good mouth opening, no problems with previous anaesthetics although she hadn't been intubated with the previous anaesthetic, she had had a laryngeal mask. I wasn't anticipating problem at all. We put her to sleep, pre-oxygenated, waited, paralysed with atracurium, waited for the atracurium to work and then Robert *(an SHO)*, who can intubate, attempted the intubation and he suddenly realised that she was difficult to intubate. He had to be careful of the caps, so we were careful about her teeth and careful about her lips too, but all he could see on laryngoscopy was just the tip of the epiglottis, which makes her a grade 3 intubation. So then he tried with cricoid pressure *(where the ODP applies pressure to the front of the neck)* to just try and bring the cords into a better view, because he couldn't see the cords at all. He tried with the bougie *(a thin rubber tube angled at the tip)* going down to where we thought that the cords might be but the tube went into the oesophagus so we took it out.
>
> I then took over and I bagged, and then I had a look, and my view was exactly the same as his, I couldn't make the view any better and it was still a grade 3 intubation. And I had a go with the blind bougie, putting the bougie down blindly, and again the tube went into the oesophagus, so we took it out. I

bagged her again and we kept her asleep with the volatile, she was easy to ventilate by bag and mask, so we were in a controlled situation.

We then questioned, well, what do we do next? Well there are a number of options as to what we could of done: One was to just do it under a laryngeal mask but she was big and if we had problems ventilating with the laryngeal mask then we'd have aspiration *(where stomach contents enter the lungs – only an ET tube effectively 'seals' the lungs)* problems. We knew that she would be difficult to intubate, and then with being a couple of steps behind, it could have been a potentially dangerous situation, but we would of probably been OK. The other option was to use the McCoy laryngoscope, where you basically put it in and there's a lever there basically to pull the tip of the epiglottis up and try and improve your view. But because it was so difficult to do because of her teeth and everything and her lips, we'd cut her lip already, I though that we'd just go straight for the fibre optic intubation *(passing a flexible fibre optic scope into the patient's mouth and down the patient's airways allows direct visualisation of the structures of the airways and enables the tube to be passed down over the scope and through the trachea)*. So the anaesthetic nurse basically just brought the scope in and we jut put the tube over the scope. We lifted the jaw up after pre-oxygenation and then making sure she was well anaesthetised, straight in, it went in after about 2 minutes. Basically it went in very slickly, very easily, it was an easy intubation with a fibre optic scope, which is very satisfying.[19]

Unlike the patient described above, the patient discussed here was a 'difficult intubation' because Dr Hesketh was unable to achieve a view of the vocal cords using

[19] Int 23/11/00

standard equipment. Taking over from the SHO, he states that he was unable to improve the view. Later in the interview I asked him to elaborate on what he meant and he ran through his trouble-shooting repertoire to ensure the optimal view of the vocal cords, this included checking the patient is fully paralysed to as to allow full mouth opening, adjusting the pillows to obtain the 'classical sniffing the morning air position', and adjusting the cricoid pressure backwards and upwards himself and then asking the nurse to do so. This further demonstrates the body of practices that inform the successful use of a standard device. Dr Hesketh then discusses his options and in choosing not to use a laryngeal mask he hints at the importance of prediction in avoiding uncontrolled situations. He explains his reasons for not using the McCoy laryngoscope and in doing so he displays an intimate knowledge of the effects using this piece of equipment might have – they might further damage the patient's lips and in being careful of the patient's crowns he might still be unable to achieve the necessary view for intubation. He opts instead to use the fibre-optic scope and in obtaining a view of the vocal cords intubation was straightforward.

Interrupted views and hindered positionings

Here a registrar at the end of his training (Dr Fielding) is working with an SHO who has just begun hers (Dr Ann James), she is only just beginning to acquire the skills, knowledge and techniques necessary to anaesthetise a person. The patient is lying on a table specifically designed for shoulder operations on which the anaesthetised patient can be secured and sat upright to allow the surgeons greater access to the shoulder. However, limited access to the airway means that the anaesthetists choose to intubate, the most secure form of airway maintenance, using a flexible tube that can be bent away from the site of surgery.

Dr James is at the head holding the black mask over the patient's face. Dr Fielding takes one of the pillows out.

Dr Fielding "Big deep breaths. (Then to the ODP) That head ring is in the way a bit, can we take it out before we intubate?"

ODP "No, it's fixed." Speaking as he opens the controlled drug cupboard.

Dr Fielding is standing on the right hand side of the patient *(where ODP usually stands at induction)*, he has already injected some propofol and now turns on the gases. He turns to the SHO "Happy you can ventilate?"

Dr James "Going to lose that arm." The patient's left arm slips, she reaches for it. The ODP tucks the sheet under the patient's left arm.

Dr Fielding "Yep, ventilating OK?" I can't hear Dr James reply but Dr Fielding injects from a 5 ml syringe with blue label (atracurium) then some more propofol.

Dr James seems to be struggling to reach the patient and hold the mask on adequately. She is small and this table is big and cumbersome. Dr Fielding moves from the patient's right, round the bottom of the table and up to the head, he repositions the patient's head and holds on the mask. Dr James lets go of the mask and hands Dr Fielding the reservoir bag, she steps back. Dr Fielding ventilates.

Dr Fielding "That's fine. I think we are going to have to slide her down the table... Ready, brace, slide... that's the best way, OK, do you want to take over?" Dr Fielding hands the bag and mask back to Dr James.

Dr Fielding "...rapifen..." *(an analgesic)*

Dr James ventilating, eyes focussed on the patient's chest.

Dr Fielding looks at the patient's hands. "There's no pulse oximeter on, that's why there's no reading" He replaces the pulse oximeter on the patient's finger.

The consultant surgeon enters.

(Dr Fielding talks to the surgeon about the next patient and then turns back to the SHO.)

Dr Fielding "You happy Ann? Do you want to intubate."

Dr James "I'll have a go." She has to stand on the left side of the patient to reach the patient's head. She inserts the laryngoscope, it takes her about 4 or 5 seconds to intubate, then she swiftly removes the laryngoscope and connects the breathing circuit. *(She looks confident)* The ODP has removed the bougie and inflated the cuff.

Dr Fielding "Why aren't we getting CO2 back? Is the CO2 sensor not connected?"

Dr James "Can I have a wee look?" She inserts the laryngoscope. "I can't see, shall I take it out?"

Dr Fielding "OK, if in doubt take it out.... shut the valve."

Dr James now ventilating using the face mask.

Dr Fielding "Quick, frequent breaths Ann, that's fine." The patient's colour is pinker now. "When the sats are back up have another bash. What do you think the problem was?"

Dr James "I assume I wasn't in but I was in something."

Dr Fielding tapes the cannula in place (he must have been cannulating during this). There are lots of bleeps from anaesthetic machine.

Dr Fielding "We're struggling with the sats, are you having trouble ventilating?"

Dr James "Not that much, shall I turn the oxygen up, I know that..."

Dr Fielding "Can I have a bash?" Dr Fielding takes over ventilating. "We are losing that left arm." The ODP tucks the arm in again.

Dr Fielding ventilates, looking at the screen then the patient, then the screen again. "Have you used the bougie before? OK, come on Ann."

Dr James reinserts the laryngoscope. Dr Fielding positions himself behind Dr James and looks over her shoulder.

Dr Fielding "Can you see the cords? Put the bougie between them, pull the bougie down beyond the tube, Annette, get the bougie through the cords." Dr Fielding looks at the screen.

ODP "You've got CO2 back.... struggling"

Dr Fielding "She's doing fine." speaking softly "So much for alfentanil obliterating the ... Are you happy with the position?"

Dr James picks up a stethoscope.

Dr Fielding "I listened."

Dr James "Did you, this time?"

Dr Fielding "Yes"

The ODP is securing the tube using a large white sticker.[20]

In this, the anaesthetists encounter problems managing the patient's airway, not because of any intrinsic difficulty with the patient's anatomy, as in the scenario discussed above, but because of the difficulties incurred by the operating table. The table is a different table that neither the anaesthetists nor the ODP have had experience of using. The team, therefore, lack that specific knowledge of how a device performs in action. Possibly, Dr Fielding suspects difficulty, he attends to the positioning of the patient's head removing one of the pillows and requests removal of the head ring. The head ring, however, is a fixed component of the table and cannot be removed causing Dr James to struggle to reach the patient from the anaesthetist's customary position behind the head. Only by moving the patient down the table so the head ring is not in use can these difficulties be circumvented. The resultant

[20] Obs 09/11/00

configuration is not ideal either as Dr James has to abandon her position behind the head and stand to the side of the patient in order to reach. As mentioned above, the spatial position a participant occupies gives rise to particular views, experiences and knowledge, therefore, being prevented from occupying her usual position jeopardises Dr James view of the vocal cords and consequently her ability to intubate.

The improvised intubating position does not, initially, seem to cause Dr James a problem, she intubates relatively swiftly and with apparent confidence. However, Dr Fielding quickly raises doubt about the placement of the tube. Unable to visually confirm the placement of the tube on laryngoscopy Dr James removes it. On the second attempt at intubating Dr Fielding positions himself behind Dr James so as to try to obtain the same view. He talks her through the technique, urging her to get the bougie through the cords then the tube can be passed down over the bougie and into position.

Here, the spaces and positions ordinarily occupied by anaesthetists, which have received only a cursory mention in the data above, feature much more significantly. The difficulties incurred by not being able to achieve an adequate head and neck position for airway maintenance, and consequently the anaesthetists having to abdicate their customary positions, highlight the importance of the spatial distribution within the anaesthetic room. Moreover, lacking the experience of using the 'shoulder' table, the anaesthetists are unable to predict the ways in which it will affect their management of the airway, emphasising the importance of understanding the particularities of how a specific tool functions.

'Choreography'

In what follows the anaesthetist is acutely aware of the characteristics of the specialist tools he uses. The procedure being performed is a bronchoscopy, a procedure in which a camera is passed into the patient's lungs. The physician, Dr Baxter, and the anaesthetist, Dr Gates, therefore, have equal claim on the patient's airway, necessitating control of this area be distributed between them. Before the patient arrives Dr Gates discusses the anaesthetic routine with an SHO, Dr Kapoor.

> Dr Gates returns to the anaesthetic room and begins to run through the sequence of activities with Dr Kapoor "they get a blue cannula... then midazolam... we take them through to theatre... its quite a nice choreography... same way everytime... he goes down the right side first... we insufflate *(ventilate using a specific piece of equipment known as an insufflator)* using the ... we insufflate at times, when he is not looking, when he's in the trachea..."
>
> *The patient arrives, his details are checked and he is wheeled into theatre by Dr Gates and the ODP.*
>
> Dr Gates immediately puts the black mask over the patient's face, the ODP is attaching the monitoring. Dr Kapoor stood to the left of the patient's head, next to the anaesthetic machine, leans over and turns the valve by the bellows. Dr Gates "Spray" Dr Kapoor goes into the anaesthetic room. Dr Gates continues "OK young man (injecting propofol) you're going to have fantastic dreams... feel nice and warm... you're on a golden sandy beach... wake up when it's all over." He speaks in a soft, hypnotic voice. He picks up the laryngoscope and shows it to the ODP, there is no blade on it. The ODP goes

into anaesthetic room. Dr Gates injects from a 2 ml syringe, labelled Suxamethonium *(a paralysing drug)*, then injects a bit more propofol. "Don't like leaving sux in the cannula... 0.2 of a ml is enough to give a patient fasiculations *(in which all the muscles contract)*."

The ODP returns with another laryngoscope, complete with blade.

Dr Gates inserts the laryngoscope, he picks up a lignocaine spray *(this is a prefilled glass syringe with a long white nozzle and black marks about half way down)* and inserts it into the patient's mouth *(so that the black marks on the nozzle reach the patient's trachea)* and injects.

Dr Gates "Ready" he lifts the patient's head and Dr Kapoor takes out the pillows. She watches the screen.

Dr Baxter wraps up the patient's head in sterile towels.

Dr Gates now stands to the left of the patient's head. He picks up the insufflator *(this is a pipe attached to a cylinder of oxygen with a lever about a foot from the end)* "Just check" Dr Gates depresses the lever and a 'whoosh' of gas can be heard.

Dr Baxter inserts the bronchoscope.

Dr Gates shows the end of the insufflator to Dr Kapoor. "There is a zero here and a zero on here..." he attaches the insufflator to the bronchoscope. "... choreography... trick is not to insufflate too quickly ... wash out the carbon dioxide... won't breathe."

... ...

Dr Kapoor asks Dr Gates a question

Dr Gates "... black line to cords, look at these things" he shows her the lignocaine spray. "... insufflate now, no one has their head anywhere near..." *(message passed to the physician about the next patient)*

The ODP fiddles with the suction on the anaesthetic machine.

Dr Gates insufflates. "Have a feel, gently insufflate, see how easy it is" He passes the pipe to Dr Kapoor and she depresses the lever. Dr Gates continues "... tone in cords... (Dr Baxter squirts the contents of a 20 mls syringe down the bronchoscope)... that was a wash... not insufflate... then brush, like a chimney sweep..."

Theatre sister "Lights" The lights in the room are switched on.

Dr Baxter removes the bronchoscope.

Dr Gates "These patients are bound to have dirt at the back of their throats..." he suctions in the patient's mouth and throat and then places the black mask back over the patient's face and lifts the patient's head. Dr Kapoor replaces the pillows. She picks the reservoir bag up off the floor, Dr Gates drops it back down and ventilates, squeezing the bag with his foot.

Dr Gates "Its so easy this way, when you've got so many things going on, makes it easy, have a go." Dr Kapoor squeezes the bag with her foot.

Dr Gates "Move him down the trolley... 1,2,3" The patient is moved back down the trolley and the extra head attachment removed.

The recovery nurse joins Dr Gates by the head of the patient. Dr Gates still ventilating with his foot.

Dr Gates "Its a very efficient way of ventilating ... the risk is of washing the CO2 away..."

Dr Kapoor kicks the reservoir bag to the side.

Dr Gates places a clear oxygen mask on the patient and lifts his jaw. "Rock and Roll." Dr Gates and the recovery nurse wheel the patient to Recovery.[21]

Dr Gates talks to Dr Kapoor of a 'choreography', a carefully scripted routine, polished and finessed by regular practise. This choreography incorporates knowledge

[21] Obs 30/11/00

of a specific device, an insufflator, which is only used on the occasion of a 'bronchoscopy' list. Scripted in the choreography are such details as how, when, and when not to 'insufflate', to use the device so as to ventilate the patient. Furthermore, it organises the interplay between the physician and anaesthetist in which control of the patient's airway is handed back and forth and, accordingly, it specifies the positionings each participant should occupy at a given time. The choreography also includes a technique to ventilate the patient by foot during a period of intense activity. In effect, the entire routine is replete with tool-specific details, an acute awareness of how best to manipulate those particular devices in that particular setting.

Interestingly, the practised and polished nature of the performance, and within it, the regularity of the role, position and shape of tools and devices, appears to fulfil a further purpose; it is as though accustomed to seeing a completed picture, any missing pieces become immediately more apparent. On entering theatre Dr Gates can see at a glance that the requisite equipment is not in place. At the mention of 'spray' Dr Kapoor leaves the theatre to find a lignocaine spray. Dr Gates then quietly shows the laryngoscope to the ODP which is missing a blade. The ODP returns with a laryngoscope at precisely the moment it is required.

'Normal' patterns and expectations: recognising 'abnormal'

Developing this notion of how expected appearances highlight deviations from the norm a registrar nearing completion of his training talks to me about a recent critical incident he experienced where a patient had a severe allergic reaction to an antibiotic. As 'anaphylaxis' is relatively rare I ask him how he goes about preparing for it.

I suppose you prepare, you know, you don't ever prepare, but you prepare every day by doing your job. You know a friend of mine got a normal patient in her final exam, and that's a very horrible thing to do, to have a perfectly normal patient. But you have got to be able to recognise normal to recognise abnormal and this is it with her *(the patient)*. It wasn't right. That should not have happened to her at that stage, it's 'take down the drapes and go back to the room' you know. OK, sometimes people do occasionally feel a bit nauseous near the end when the anxiety levels come down, but not everything else. It shouldn't happen. So you recognise, you see normal, you know what normal is, so when things diverge from normal then you turn your brain on. Things aren't right. What's gone wrong and then you start, you're looking and your asking questions of yourself, looking around for any clues for what might be happening. You know has a litre just fallen to the floor? *(meaning blood loss)* Um, you know, that was one of the things that occurred to me, was she bleeding internally? Is this hypotension secondary to it, you know, had they ruptured something and not noticed? It could have been but it wouldn't just have responded to the adrenalin.

... But then as soon as her voice started going, that diagnosis went out the window. It didn't fit ...

You have got to recognise abnormal, so you prepare for it everyday by seeing normal. Every other caesarean section that I have done is a preparation. What happens when you are very junior is that you don't recognise abnormal, because you are not used to normal, and experience teaches you what is normal, as much as what is abnormal. So you know when things aren't going the way they should be. You know this, you know, again this is a pattern, this is normal, this is what I expect to happen. I have expectations, and what's

> going to happen during this case, and if it doesn't happen, then I have to react to it and find out why it isn't. And when you are junior, you don't know the difference between normal and abnormal and you know, you could have somebody who is a bit tachycardic. 'Oh yes I saw that yesterday, the consultant had a patient, tachycardic, that's all right.' and 'Oh yeah, so and so always had a blood pressure around seventy, so that's fine.' But you don't realise that this in combination with something else, with something else that you haven't noticed, means that something is going wrong. You don't know about the operations, you don't know the blood loss related to each operation. So when you are junior you don't have the experience to recognise that something is going wrong. And you don't see it until it's too late, and a lot of problems happen because people react too late because they haven't recognised, you don't see the problem coming until it's here, and then it's crisis management.[22]

The anaesthetist here talks of patterns, expectations, of what is usually the case for each stage of an operation. At a certain stage of the caesarean section they should have been packing away the equipment and taking the patient back to her room. There was no reason to expect a sudden drop in her blood pressure. He then describes looking round for features that didn't fit with his anticipated image, for clues as to the cause of this sudden change in the patient's condition. The anaesthetist proposes that 'experience teaches you what is normal as much as what is abnormal' and from the discussion thus far it is possible to suggest some of the elements that comprise an anaesthetist's body of normal expectations and how these expectations function in daily anaesthetic practice: familiarity with operative procedures and

[22] Int 05/10/00

anticipating the effects and likely trajectory stage by stage focuses attention on any deviations from the 'norm'; specific knowledge of a particular surgeon's techniques, habits and capabilities enables an anaesthetist to manipulate their tools and devices to suit the demands of a particular situation; and the place, position and appearance of tools and devices also feature highly in the body of expectations emphasising any missing items or non-prepared equipment in this composed picture of 'normal'.

Networks of expertise: connecting humans and devices

In responding to a question on the constitution of expertise, a consultant anaesthetist draws together the elements discussed above.

> Um it's a combination of personal experience, what you take in from all the people that surround you in anaesthesia. And that can include the entire theatre team, nurses, surgeons, ODP's have all got something to contribute to expertise in anaesthesia. Anaesthesia isn't just a case of putting a patient to sleep. There's an awful lot more that you need to take into account. There's what's wrong with the patient. What's the surgeon actually going to do? What's *this* particular surgeon going to do? Nurses can provide you with all sorts of snippets about their experience of having worked with a surgeon, and how they are likely to perform in certain situations. So there's the environment, if you like, of theatres that contributes to what you need to learn in order to be an expert. And you can be an expert in one theatre, and in the next door theatre you may not be an expert, because you are not used to working in that environment. I see that particularly, I moved from, well I moved a session *(from one hospital to another)* two or three years ago and when I got there... OK, I had been a consultant for fifteen years, but I felt like a fish out of water. And I felt unsafe because the equipment was unfamiliar to me. I mean it was

> all basic anaesthetic equipment that anyone can use, but it was equipment that I was not at that time particularly familiar with. Working with staff that I didn't know, working with surgeons that operated in a different way. And all these things, I mean you're actually degraded as an expert. And you have to start to learn again, even though you have been a consultant for fifteen years. And that applies every time you move outside of that field which you've built up your expertise in over the years.[23]

The consultant recognises that anaesthetic expertise does not come embodied in one particular human; it is an effect of the aggregation of familiar surgeons, nurses, ODPs, equipment and the environment. He suggests that expertise is about knowing the specificities, for example, how a surgeon performs a particular operation and being able to predict how he or she will react in certain circumstances, enabling an anaesthetist to anticipate their requirements. Furthermore, the anaesthetist considers the role of the equipment and devices with which he works. Even when working with 'basic anaesthetic equipment', which on the face of it, anyone *should* be able to use, Dr Williams recalls the importance of that *particular* practical knowledge of using the equipment, of knowing the idiosyncracies of a tool's performance. He describes how being faced with an unfamiliar context and working with equipment he is not practised at operating has a detrimental effect on the combined product of these elements: it *degrades* the expertise effect.

Members' knowledge: its production, constitution and utility

[23] Int 22/05/01

Inspired by ethnomethodology I have been concerned, in this chapter, to elucidate the role tools and devices play in the daily practice of anaesthesia. As suggested by proponents of ethnomethodology I have focussed on the practices and members' knowledge necessary to realise the contribution of anaesthetic tools and devices. On the basis of my analysis I propose that a significant component of an anaesthetist's 'members' knowledge' is an acute and intimate appreciation of the particularities of tools, devices, and also in this case, a surgeon's techniques and habits. An awareness of how a particular surgeon operates enables the anaesthetist to anticipate their requirements, making for a smooth and efficient anaesthetic service. Moreover, knowledge of how a specific tool performs affords the anaesthetist the opportunity to manipulate the tool, to develop practices that utilise the tool to best effect, for example, working out the most advantageous position from which to use the tool in a given situation. This resonates with Heath et al's observations of underground train drivers:

> It is widely recognised that drivers need to become 'familiar' with particular vehicles, and more importantly, they need to develop 'line knowledge'; a practical understanding of the characteristics of the particular line, the sorts of problems and difficulties which may be expected, and the ways in which the train can be driven along the line to provide a smooth safe and comfortable journey for passengers. (1999:572)

Developing this awareness of the specificities of anaesthetic practice, an anaesthetist cultivates a body of 'normal appearances' (Sacks, 1972). For anaesthesia it seems

that the form, position and configuration of both humans and devices are significant elements in constituting this body of expectations. Furthermore, the utility of this body of expectations is indicated in the analysis: in becoming accustomed to the 'normal appearance' of a given situation one can recognise more readily the 'abnormal' or missing. This serves as a resource to anticipate, identify and prepare for, or avert, problems if they should arise, again as Heath et al describe:

> General expectations and orientations concerning the character of the line and the conduct of passengers serve both as resources to view particular scenes and account for problems and difficulties, if and when they arise. (1999:563)

The value of an ethnomethodological approach in this analysis can be seen in the way it illuminates the role of tools, artefacts and devices in the production of knowledge, in the way features of the tool can elucidate a clinical situation; a black line may show that a laryngeal mask is misplaced; becoming familiar with the position and features of a device can enable a better manipulation of it; and importantly, a device's absence, or a change in the device's appearance, may be the element that warns of impending difficulties. Returning to Button's argument, however, I am left with the sense that this emphasis, on members' knowledge, does not so much preserve the tools in the forefront of the analysis, as it actually deflects attention away from the tools and onto the ways humans use and manipulate them: it directs attention to the techniques.

Ethnomethodology serves as a theoretical resource that orients the analyst towards a very practical discussion of the role and contribution of tools and devices. It is a useful perspective to employ in the context of health and medicine, when the value and utility of research must be made readily apparent to, for example, funding agencies, to its professional audience, and to ethical committees. It avoids an analysis in which a tool is animated with the agency of its operators, and when used in conjunction with the resources, insights and questions of STS it allows the analyst to concentrate on elucidating a tool's own form of agency. What, then, can be said of a tool's form of agency? How should I characterise the tools' and devices' contribution to the course of an anaesthetic trajectory? It seems as though, just as the anaesthetised patient relies on their alliance with the technology to enact a form of agency, here, the tools and devices depend on their human operator to realise their contribution.

Conclusions

Participating in anaesthesia: agency and consequences

I have presented a detailed account of how certain elements involved in anaesthetic practice 'act' and so contribute to the particular course of an anaesthetic. I do not present a *complete* model of action in anaesthesia. The elements I consider are those that interest me; motivated by my experience as a nurse and by the analytical orientation of STS, I have sought to elucidate the way patients and machines, anaesthetists, nurses and ODPs, and tools and devices inform the unfolding trajectory of an anaesthetic. The product of these labours, presented here, is a situated and partial perspective, it is one way to talk about the way action unfolds in anaesthesia. Moreover, it is located and accountable, in that I have endeavoured to make visible the threads of my developing argument. As Haraway insists, it is only through knowledge being partial and constructed, that the potential for conversation with other fields, discourses and viewpoints, can be secured. What then, is the point of these arguments? What are the implications of my arguments and how might they connect with other debates?

EBM projects an idealised form of practice in which the most effective treatment options are determined by aggregating and synthesising the findings of research.

Once this knowledge has been established, then it is simply a case of following this lead. Considerations such as the patient's wishes, financial implications, the available material resources, the skill of the practitioner and his or her preferences, and the level of nursing required, are constructed as 'other', as 'barriers' or 'obstacles' to EBM, not as legitimate elements that comprise practice. Moreover, it seems as though the more the debates about EBM acknowledge these 'other' elements, and the stronger commentators argue for their greater priority, the more evidence based anaesthesia depends on accepting the authority of 'evidence' and so it continues to marginalise the contribution of these 'other' elements. This has the effect of undermining the grounds on which action is based, when it does not concur with the recommendations of evidence. If EBM continues to develop in this way, diminishing the legitimacy of patients and situational contingencies to inform treatment 'decisions', then a situation is likely to ensue in which the expertise and knowledges that have contributed to such 'decisions', and on which safe anaesthesia depends, will be obscured and driven underground. (This is an argument analogous to that which I present in Chapter Five: to achieve optimal patient care, nurses and ODPs currently use 'persuasion' to cloak their contribution to anaesthesia when the required activities fall beyond their professional boundaries, a point to which I return below.)

In this thesis then, I wanted to connect with EBM in two ways: to produce a modest piece of research, and so join with other researchers working to expand the construction of 'evidence' EBM holds. It seems that although EBM has the potential to benefit anaesthetic care – by indicating those techniques worth investment, in terms of developing skill in their performance, and by organising the delivery of anaesthesia around the 'most effective' treatments and interventions – the construction and

selection of such interventions is problematic, rigid and restrictive. Secondly then, and relatedly, I wanted to counter the conception of the 'other' elements of practice as 'barriers' or 'obstacles' to EBM, by elaborating the intricacies and extent of their involvement, and to argue for their legitimacy to inform choices about the delivery of anaesthesia.

My belief that this legitimacy is in question is informed by my experience as a nurse, by my understanding of the rationalist perspective, as exemplified by EBM, and further as it is epitomised in models of anaesthetic practice as action planning and problem solving. In this line, Gaba (1994:217) argues that the anaesthetist must 'command and control *all* the resources' in order to translate knowledge into action. The assumption that this is even possible, that the resources do not have a will or agency of their own, that they will simply conform to the anaesthetist's command, is highly problematical. Contesting this position, then, meant expanding the conception of agency, and exploring the ways various elements contribute to, and shape, action. 'Decisions', therefore, I take to be distributed amongst many more actors than a rational framework supposes, and agency may come in forms that lack the attributes usually assigned to an 'actor': intentionality, consciousness, the ability to verbalise. These 'other' forms of agency may be quieter and more subtle, but their effects and contribution to an anaesthetic trajectory can still be traced.

My starting point was to explore the merger of patient and machine necessitated by present day anaesthesia; my aim here was to furnish the existing sociological understanding of the nature of the relationship between humans and technology with details of anaesthesia's cyborgs. According to Gray et al (1995:3) 'reconfiguring'

cyborgs create 'posthuman creatures equal to but different from humans'. A cyborg state in anaesthesia transforms methods of communication; the application of monitoring devices greatly expands the anaesthetised patient's repertoire of communicative resources. In the light of Poovey's description of anaesthesia during the Victorian period, this union of human and machine can be cast as a positive outcome of technological development, arguably equipping the patient with more resources with which to enact agency, to contribute to the course of their anaesthetic.

An effect of my analysis of the relationship between patients and anaesthetic machines has been to delineate further the forms of agency our intertwinement with technology makes possible; I have shown how agency need not be of the same form that conscious, intentional agents exhibit. To lack intentionality does not mean to be passive and considered homogenous, rather unconscious patients retain their specificity in their embodied form, in the signs and signals the body and the technology produce, in their histories as recorded in the medical records, and in the interventions their unconscious bodies require. The outline of their anaesthetic may be made to conform to an anaesthetic plan but the precise form of their anaesthetic trajectories is shaped to a large degree by the unconscious patient and their union with anaesthetic machines.

Of what possible use is this analysis for clinicians in anaesthesia? How does this analysis connect with their concerns and debates? Probably, this analysis confirms what they know, on one level, already: that patients have the ability to derail even the most straightforward of plans, and that practitioners cannot predict and control for every eventuality, a concept of practice that stands in contrast to Gaba's. But rather

than considering the patient's contribution as a barrier or obstacle to be surmounted, here the combination of elements is articulated as an event in which the situation of action develops an intrinsic momentum; here the combination of patient and machine creates a dynamic, vigorous, 'acting' entity. In this conceptualisation, it is easy to understand how the attainment, maintenance, and reversal of a cyborg state is precarious, easily disturbed, and therefore closely marshalled by a team of practitioners. So to answer Hogle: yes, cyborgism can be transient, indeed such transience is not only important for anaesthesia but a measurement of its success. Articulating the accomplishment of this transience then, introduces the idea that a guardian, marshall or facilitator is required; for an actor to accomplish transience in cyborg states is dependent on his or her connection with a network of humans and technologies.

My next position from which to examine 'action' in anaesthesia, was that of the anaesthetists. I suggested the anaesthetist's work could be considered as 'heterogeneous engineering'; but not in the managerial sense, it was more like 'skilful contrivance', to bring about an intelligible account of a clinical situation in an attempt to inform and organise their activities, but even this description is in danger of missing the precariousness of the activity. In this description of anaesthetic work the idea that action follows decision making in a linear process was thoroughly eroded; the work of generating an explanatory narrative of the patient's condition also creates a set of actions that address the account. On some occasions it is possible to engineer a coherent account, in which the overall balance of communication can be made to favour one particular account and correspondingly indicates a direction for action. Sometimes, however, accounts of a clinical situation remain multiple. Which account

should then be taken as a lead for action? In this case the anaesthetist has two options: to actively *dispel* from the explanation those elements that serve to confuse the situation and proceed on the basis of the dominant account; or the anaesthetist can work on a fragmented account, each fragment suggesting a corresponding action. A singular, coherent account that tethers all the elements neatly together is not necessary for action to proceed; it is enough that both fragments are legitimated, in that they correspond with other elements to produce an intelligible account and suggest a set of practical activities to address the situation.

Consequently, it seems as though it is the efforts to *legitimate* the account that secures a lead for action. Anaesthetists must interleave the multifarious situational resources into an account to produce 'evidence' to legitimate their actions. This is not, however, to 'command' the elements to conform to a preoperative plan; rather it is a thoroughly situated, contingent, and uncertain activity; the anaesthetist, other participants, and resources, 'acting' in response to one another, shaping the course of the anaesthetic. This analysis, therefore, emphasises the importance and prevalence of justifying and legimating a course of action in clinical practice. This then illustrates the necessity to argue for the recognition of 'other' elements in a context of EBM; if their legitimacy to inform action is denigrated, then so is the 'evidence' on which action relies for its justification.

Moreover, the work necessary to establish the legitimacy of the account is proportionate to the degree to which the proposed course of action can be safely and easily carried out. Safe practice is achieved by matching the gravity of the intervention with the volume of evidence, it is about balance. Heterogeneous

engineering for the anaesthetist is inherently precarious; the kind of account that is assembled – convergent, multiple or fragmented – is heavily contingent on the particular elements of the situation, as are the corresponding leads for action. This suggests that the success of heterogeneous engineering is not so much the stability of the explanation of a clinical situation as the extent to which the account leads to a safe set of practical actions. The value of this analysis for sociology, then, lies in the way engineering is recast as a precarious activity; heterogeneous engineering, for the anaesthetist, is a means of organising the elements of a clinical situation so as to render it intelligible, with the aim of informing subsequent actions. And it comes in at least three forms of strategically shaping action, with coherent, multiple and fragmented accounts. However, lack of strategy does not necessarily correspond to a suspension of action; in critical periods, performances rely, for their justification, not on a skilfully contrived account but on basic, practical necessities.

In examining the contributions of nurses and ODPs I argued that the *stratification* of legitimate participation in anaesthetic practice was instrumental in shaping the resources available to a nurse or ODP with which to engineer an account of a clinical situation, and initiate action. I suggested that action and involvement was regulated, participation must follow accepted norms and conventions, which function so as to limit participation at certain levels in line with the identity of the practitioner. When practitioners stray beyond these conventional boundaries, their participation may jeopardise the development of another's identity, and their legitimacy is contested. Thus, the stratification of legitimate participation is continually being reaffirmed. However, restricting participation also restricts the development of resources with which to account for the situation, and correspondingly disadvantages the ODPs or

nurses in terms of initiating action. Sometimes the consequences of allowing an account to decay are life threatening, in which case the ability to initiate action, depends on persuading other practitioners to act. Success appears to hinge on persuading actors with a shared outlook, who share an appreciation of the subtle, intangible signs as well as the explicit measurements, and on persuading a participant whose role legitimates prescription and treatment decisions.

If the potential reconfiguration of anaesthetic services follows current trends in the NHS to organise healthcare by establishing protocols and clinical practice guidelines (Timmermans and Berg, 2003a) and if it follows the patterns of work set overseas, then it seems likely that non-physician anaesthetists, should this option be further developed, will also be a protocol-guided service. This means that although the limits of a participant's practice may have advanced, the overall shape of the service, and the relationships between participants, remains much the same, with doctors retaining their diagnostic and prescriptive capacities, and nurses and ODPs implementing the prescribed care. The difficulty here is that it is probable this 'new' configuration will inherit the same problems as the 'old', in that the boundary 'blurring' or 'spanning' work Allen and Tjora discuss will still be necessary but it will remain invisible, or at least obscured, often being relabelled. When undertaking this work, then, nurses and ODPs will continue to be unsupported by organisational policies because of the location of diagnosis and prescription outside the boundaries of their practice. This may even be exacerbated if safety is coupled ever more tightly to the guidelines with which such 'new' practitioners must work.

Berg (1997) and Timmermans and Berg (1997) have suggested that 'tinkering' with protocols, in which practitioners might reorganise the protocol's demands, or skip a step, is essential in enabling a protocol to 'work'. However, whilst arguing for its importance, 'tinkering' underplays the complexity of the activity; 'tinkering' involves the simultaneous adjustment of the protocols demands, the clinical environment, the patient's clinical condition, and other participants' activities, in line with the practitioner's assessment and desired trajectory. My analysis shows how treatment may be impeded by the failure to persuade other participants to act; when reconfiguring the delivery of anaesthesia, then, instead of such work continuing 'undercover', the relocation of such traditionally 'medical' activities as diagnosis and prescription to within a non-physician anaesthetist's remit, may also potentially enhance safety and should be given serious consideration.

My final perspective from which to examine action was to focus on the practices and members' knowledge necessary to realise the contribution of anaesthetic tools and devices. I proposed that a significant component of an anaesthetist's 'members' knowledge' is an acute and intimate appreciation of the particularities of tools and devices, which makes for a smooth and efficient anaesthetic service. Developing this awareness of the specificities of anaesthetic practice, an anaesthetist cultivates a body of 'normal appearances', a body of expectations regarding the form, position and configuration of both humans and devices. Of significance here is that, in becoming accustomed to the 'normal appearance' of a given situation one can recognise more readily the 'abnormal' or missing. This serves as a resource to anticipate, identify and prepare for, or avert, impending difficulties. This perspective indicates the value of a research focus, for health and medicine, on the tools and technologies, as Heath

et al (2003) suggest, it elucidates the ways in which they feature in daily health care, rather than relying on assumptions of how they are intended to feature.

On a theoretical note, I find that in concentrating on members' knowledge my attention is deflected from the tools to the ways practitioners use them, to the techniques. However, rather than seeing this as a failure, for me, it serves to illustrate a key insight of STS: that humans and technologies are thoroughly co-dependent in demonstrating their agency. Moreover, this insight applies not only to tools, devices and their operators, but also for each of the elements I have examined. It has become increasingly clear throughout this thesis that a demonstration of each element's particular form of agency depends on their relations with other elements. In contrast to prior renderings of the unconscious patient as a passive object, and medical practitioners as the acting agents, I have argued that the technological augmentation of the patient amplifies the unconscious patient's contribution and actively shapes the course of their anaesthetic trajectory. The anaesthetist depends on this contribution, and that of the tools, devices, nurses and ODPs, to engineer the intelligibility of the situation and prescribe a course of action. Nurses and ODPs regularly seek to inform this course of action by persuading anaesthetists to read the situation in a particular way. Consequently, agency is best described as decentred or collective, and as relational.

Thus, accepting that the shape of action is essentially tied to the elements that comprise its situation means that a lead for action is distributed amongst these elements I discuss and others. However, some of the elements informing anaesthetic work elude recognition, being 'silent', unconscious, lacking intentionality, or lacking

the resources to initiate action, which causes practitioners difficulty when legitimating and accounting for their work. If elements of practice are supposed to be passive components that can be easily manipulated to conform to a plan, then the ability of these elements to 'act' and to contribute to shaping an anaesthetic trajectory leaves the practitioners without acceptable resources with which to account for their actions and its consequences. Furthermore, codes of professional conduct and organisational policies tend to tether accountability to specific human actors and discrete actions. There is a tension, therefore, in that certain practitioners are held accountable for decisions and actions that are authored by many participants, both human and nonhuman, and distributed both spatially and temporally, and consequently, over which they may only have limited control. From this position, the distribution of accountability appears inequitable and raises a further question for research: can practitioners actually be responsible for all they are held accountable for? I suggest that this calls for an examination, and possibly a reconfiguration, of professional accountability.

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