Expertise in practice: an ethnographic study exploring acquisition and use of knowledge in anaesthesia

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Background. Expert professional practice in any field is known to rely on both explicit (formal) and tacit (personal) forms of knowledge. Current anaesthetic training programmes appear to favour explicit knowledge and measurable competencies. We aimed to describe and explore the way different types of knowledge are learned and used in anaesthetic practice.

Method. Qualitative approach using non-participant observation of, and semi-structured interviews with, anaesthetic staff in two English hospitals.

Results. The development of expertise in anaesthesia rests on the ability to reconcile and interpret many sources of knowledge—clinical, social, electronic, and experiential—and formal theoretical learning. Experts have mastered technical skills but are also able to understand the dynamic and uncertain condition of the anaesthetized patient and respond to changes in it. This expertise is acquired by working with colleagues, and, importantly, by working independently, to develop personal routines. Routines mark the successful incorporation of new knowledge but also function as a defence against the inherent uncertainty of anaesthetic practice. The habits seen in experts’ routines are preferred ways of working chosen from a larger repertoire of techniques which can also be mobilized as changing circumstances demand.

Conclusions. Opportunities for developing expertise are linked to the independent development of personal routines. Evidence-based approaches to professional practice may obscure the role played by the interpretation of knowledge. We suggest that the restriction of apprenticeship-style training threatens the acquisition of anaesthetic expertise as defined in this paper.


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Anaesthetic work requires theoretical knowledge, manual dexterity, and prompt recognition and handling of threats to patient safety. Often compared with aviation, the working environment shares features with high-technology industries and is characterized by high dynamism, uncertainty, time pressure, ill-formed problems, complex human–machine interactions, and risk.1 Healthcare professionals are increasingly called to account for what they do by governmental and public bodies, but are often unable to give a good account of what they do.2 Schon3 suggests that this difficulty is a consequence of what he terms ‘technical rationality’—a model of professional activity as problem-solving which is made ‘rigorous’ by the application of scientific theory and technique. The dominance of technical rationality leaves practitioners unable to account for those aspects of practice that lie outside this model. The aims of this study were to observe, describe, and define expertise in anaesthetic practice, and to trace how it is acquired during the anaesthetist’s education.

Methods

The study was conducted principally in one English district general hospital, with shorter periods of observation at a second English hospital. Approval for this work was granted by the local Research Ethics Committees. It was clear that what we intended to study was not readily quantifiable and would depend on close engagement with anaesthetists in...
Table 1 Details of observation sessions. SHO, senior house officer; SpR, specialist registrar

| OB1  | Consultant anaesthetist, orthopaedic list |
| OB2  | Consultant anaesthetist and SHO, ‘emergency’ list |
| OB3  | Consultant anaesthetist and SpR, vascular, trauma list |
| OB4  | SHO, trauma list |
| OB5  | Consultant anaesthetist, general surgical list |
| OB6  | Tutorial: consultant and SpR with SHOs |
| OB7  | Consultant anaesthetist and SHO, orthopaedic list |
| OB8  | Consultant anaesthetist, vascular list |
| OB9  | SpR, ENT list |
| OB10 | Viva examination practice |
| OB11 | Retired consultant anaesthetist, dental clinic |
| OB12 | Recovery room |
| OB13 | Consultant anaesthetist, gynaecology list |
| OB14 | Tutorial: consultant and SpR with SHOs |
| OB15 | Consultant anaesthetist and SHO, day care general surgical list |
| OB16 | Consultant anaesthetist, urology list |
| OB17 | Consultant anaesthetist and SpR, paediatric maxillofacial list |
| OB18 | SHO, weekend on call session |
| OB19 | Consultant anaesthetist, ophthalmic day care list |
| OB20 | Consultant anaesthetist and SHO, trauma list |
| OB21 | ‘Audit’ meeting |
| OB22 | Consultant anaesthetist, orthopaedic list |
| OB23 | Consultant anaesthetist, vascular list |
| OB24 | Consultant anaesthetist and A&E SpR, orthopaedic list |
| OB25 | SpR, ‘emergency’ list |
| OB26 | Consultant anaesthetist, general surgical urgencies list |
| OB27 | Consultant anaesthetist and SHO, trauma list and cardioversion |
| OB28 | Consultant and SHO, trauma list |
| OB29 | Two SHOs, trauma list |
| OB30 | Consultant anaesthetist and SHO, bronchoscopy list |
| OB31 | Consultant anaesthetist, SHO and medical student, ENT list |
| OB32 | Consultant anaesthetist and SHO, orthopaedic list |
| OB33 | ‘Audit’ meeting |
| OB34 | Consultant anaesthetist, surgical and anaesthetic SHOs, intensive care. Also includes OSCE (objective structured clinical examination) practice |
| OB35 | Consultant anaesthetist, SpR, SHO, two medical students, intensive care |
| OB36 | Staff grade anaesthetist, general surgical list |
| OB37 | SHO, evening on call session |
|       | At comparative site: |
| OB38 | Consultant anaesthetist, orthopaedic list |
| OB39 | Consultant anaesthetist, SHO and medical student, vascular list |

Clinical practice. We therefore adopted an ethnographic approach,7 grounded in detailed observation, followed by a series of in-depth interviews. Ethnography is, typically, small-scale social research carried out in everyday settings, using a range of methods to focus on the meanings of individuals’ actions and explanations rather than their quantification.5 The aim is to build up a picture of the phenomena under study which ‘makes sense’ but which also allows, along with other qualitative approaches, for the inductive development of more general theories.7

This paper focuses on two key areas, namely how expertise is defined in anaesthesia and how the context-specific knowledge, which this expertise encompasses, is acquired in practice. We focused mainly on the operating theatre environment, using observation of, and interviews with, anaesthetists, operating department practitioners, and theatre and recovery nurses. The first anaesthetic department studied comprised 25 anaesthetists, both trainees and permanent staff. These individuals were all invited to take part in the study, and regular meetings were held to inform all staff of the progress of the study and to secure their continued co-operation. None declined to be observed although two people declined to be interviewed. For comparative purposes a shorter period of observation was undertaken at a second site, in a department that comprised 39 anaesthetists, including trainees. Patients on the operating lists were informed orally and in writing of the study and their written consent was obtained.

Observation

Operating sessions were purposively sampled to cover a range of different types of surgery and anaesthetic practice, and levels of anaesthetic expertise (Table 1). Observation was conducted principally by D.G., but seven sessions were conducted in tandem with one of the other researchers (M.M. or C.P.) to allow comparisons and internal validity checks on the data collection. Observation was performed without audio or video recording. Detailed contemporaneous notes were taken during the observation period, and transcribed immediately afterwards. Approximately three observation periods were carried out per month over 1 yr, yielding a total of 133 h. To ensure that the breadth of anaesthetic work was captured, the observations included sessions following the anaesthetist from preoperative patient visits to the operation itself; following individual patients through from ward to theatre to recovery room and back to the ward; with detailed attention to clinical areas where boundaries between different staff groups and areas of expertise were less pronounced—the theatre recovery room and intensive care unit. In addition, departmental audit meetings, and teaching sessions were observed.

Interviews

Twenty-one interviewees were sampled to include a cross-section of medical, nursing, and support staff from the anaesthetic team. Of these, seven were consultant anaesthetists with between 2 and 15 yr experience (Table 2). Interviews lasted between 30 and 120 min, averaging approximately 1 h. Discussions were guided by a topic list reflecting our interest in the learning process and knowledge and skill acquisition. Some were identified from initial analysis of observational notes. Topics included decision-making, the development and use of personal techniques, responses to emergent problems during anaesthesia, the recognition and definition of critical incidents, difficulties encountered in administering anaesthesia, roles and responsibilities (e.g. teaching), formal and informal training schedules and structures, and views on the development of expertise in everyday practice. Typically, the interviews focused on personal practice so as to elicit data on how respondents’ views have been shaped by experience and how, in turn, their views inform their daily practice. We encouraged respondents to refer to specific periods of
clinical practice (for example a recent on-call session), or critical incidents. On two occasions, a debriefing interview was conducted using the observation transcripts to focus discussion. Interviews were tape-recorded and transcribed.

Analysis

Qualitative analysis differs markedly from the quantitative approaches typically used to study anaesthesia. It focuses on establishing meaning and interpretation rather than enumeration or statistical prediction. In this study, the raw data were the transcripts of the interviews and the researchers’ notes from the observational sessions. Qualitative work develops analytical categories to describe and explain the phenomena under study.5 These categories and emerging themes are usually derived inductively, that is, from the data themselves. An important feature of qualitative work is that data collection and analysis are iterative rather than sequential, so that emerging themes inform the subsequent data collection.

Our analysis began with each researcher reading, re-reading, and annotating the transcripts to identify themes and categories within and across the transcripts/notes. This was followed by ‘data clinics’ where each member of the team talked through his/her reading of a transcript, outlining the major themes, and analytical categories. This process was repeated so that the annotations from a group of transcripts could be distilled into larger, more inclusive themes. The joint working between social scientists and anaesthetic staff was crucial to this stage of the analysis as it allowed clarification of technical aspects of anaesthetic practice for non-anaesthetists, and of the techniques of intensive qualitative analysis for those with a clinical background. Inevitably, different members of the research team tended to focus on different aspects of each transcript. This provided a breadth of perspective, and, because all the team had studied all the transcripts, it worked against any one individual being able to dominate the process and impose their personal views upon it. The next stage of the analysis entailed going back through the transcripts, comparing themes and looking for ‘negative’ or contradictory cases. The ongoing research allowed the collection of additional data to test and further explore these themes until the point of ‘data saturation’—where no further new themes arose.

To enhance the validity of the analysis, four anaesthetists were involved in respondent validation,8 participating in this first stage of analysis and responding to resulting themes. Having consolidated the main categories and the relationships between themes, the transcripts were systematically coded and stored on a database using the software programme ATLAS.ti,9 to facilitate archiving and retrieval of material.

Results

Details of the interviewees and observations are provided in Tables 1 and 2.

Defining expertise

The expert anaesthetists we studied made use of a variety of types of knowledge simultaneously, as in this extract from the observation of a routine gynaecological procedure:

The surgeon (S1) discusses patient details with the anaesthetist and asks the age of the patient. The anaesthetist (A1) reads in the notes and says ‘54’. A1 injects small syringe into the drip and disposes of the empty syringe in the sharps bucket, adjusts the volume of oxygen again, and adjusts the bed having been asked to do so by S1. A1 checks the patient’s notes. The ventilator pump is moving and making a slight sound at this point. A1 stands up and begins to write some more details in the notes. One of the green lights is pulsing on and off and is sometimes continuous. There is a pulsing noise fairly regularly but not very loud. Male 1 returns to talk quietly to the A1. I can also hear the diathermy, which is making long beeping noises while the surgeons are operating. A1 sits down watching the patient’s head and glancing at the screen on the monitors. She adjusts the oxygen dial.

(\textit{OB 13: observation of consultant anaesthetist.})

Here, the anaesthetist has available to her a number of types of knowledge. There is knowledge of the patient as a person (‘social knowledge’) derived from the preoperative visit. There is knowledge from the patient’s case notes. She is also gathering knowledge about the patient’s physiological progress during anaesthesia from direct observation and indirectly through electronic monitors. Underlying all this there is formal theoretical knowledge and the knowledge gained from experience.

The interviews gave rise to the notion that explicit ‘textbook’ knowledge, although a vital component of competent practice, was insufficient for the development of expertise. Whilst some interviewees referred to protocol-driven approaches to treatment, they appeared to find them only useful as a starting-point, or were dismissive of their use. Here a consultant anaesthetist recounted a case where a senior ODP had questioned his management of a patient with aortic stenosis whose arterial pressure decreased sharply on induction of anaesthesia:
This episode took place at the end of an operation. The patient was nearly awake and beginning to breathe again for herself. Usually, the anaesthetist would wait until the patient was well oxygenated before removing the tracheal tube. In this case, the consultant anaesthetist, finding that the patient’s oxygen saturation remained low, chose to ignore customary practice and removed the tube – to the benefit of the patient. The names are pseudonyms.

Anaesthetist: ‘She desaturates very quickly.’ (He is stood by the anaesthetic machine, ventilating.) ‘What length is the tube in at?’
ODP: ‘24, 22 at the teeth.’
Anaesthetist: ‘Hmmm. Maybe it’s just shifted.’ (Saturation now 93%). ‘Mrs M, time to wake up, operation’s finished, are you comfortable?’ (Change in tone of beeps.) ‘She’s desaturating again.’ (Saturation 91%. Anaesthetist walks back to anaesthetic machine, ventilates, oxygen saturation 89%. ODP stood by the patient’s head.)
Anaesthetist: ‘As soon as the sats drop she starts looking dark.’ (Saturation 89%.
Anaesthetist ventilates, saturation 88%). ‘Come on Mrs M.’
16.20
… equipment moved …
Anaesthetist: ‘Mrs M, operation’s finished.’ (Uses suction. Patient coughing.) ‘That’s better … Mrs M, big deep breaths, operation’s finished, open your eyes.’ (Anaesthetist ventilates, saturation 89%).
… another ODP enters and talks to Anaesthetist …
Anaesthetist changes the position of the pulse oximeter, saturation 82%, ventilates, patient coughs again, saturation 79%. Anaesthetist turns the valve by the bellows.
Anaesthetist: ‘Is there a stethoscope?’ ODP hands him a stethoscope that had been hanging on the anaesthetic machine. Anaesthetist presses the stethoscope to the patient’s chest, by her armpits and listens as he ventilates, he does the same on the other side. Patient coughing. Anaesthetist continues ventilating, saturation 87%.
16.28
Anaesthetist: ‘Sounds all right.’ (Anaesthetist asks for a suction catheter, ODP hands him one. Anaesthetist ventilating, frowning at the patient.)
Anaesthetist: ‘Mrs M, weee tickle in the back of your throat.’ (He feeds the catheter down the tube, ODP occludes the hole at the top and Anaesthetist pulls the catheter out.) ‘Nothing to speak of.’
… A nurse enters, again questions Anaesthetist about the next patient …
Anaesthetist: ‘Mrs M time to wake up.’ (Pt still coughing.) ‘OK Mrs M, tickle in the back of your throat (uses suction)… big deep breath, another tickle.’ (Anaesthetist moves the tube fractionally, sats falling from 81% – 76%, ventilating) ‘… I’d like the sats a little bit higher before I extubate… another wee tickle… Just don’t understand why.’
… more equipment moved …
Anaesthetist: ‘Let’s work on the assumption it’s the tube that’s upsetting her, big cough on 3, 1,2,3,’ (extubates) ‘big deep breaths Mrs M.’ (Anaesthetist places the black mask over her face. Saturation climbs immediately to 96%). ‘Happier without the tube, anyway pain doesn’t seem to be a problem, thankful for small mercies.’ (Anaesthetist changes the black mask for a clear plastic oxygen mask.) ‘Look.’ (he points to saturation – 99%). ‘Shall we go into Recovery? Mrs M, finished now.’

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, give X mg of adrenaline, according to a protocol, defibrillate at X joules. But I was thinking: 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. I don’t need six theatre nurses who have been on an ALS [Advanced Life Support] course telling me what drugs to use. We talk a lot about protocols, we talk a lot about clinical governance, we talk a lot about doing things the same way but I think there is a sense in which that ability to provide appropriate care for a particular patient is lost once you start ‘ALSing it’.

(Interview with consultant anaesthetist.)

Repeated reference was made to the need to tailor anaesthetics to individual patients, and the need for
constant vigilance because of the dynamic nature and implicit uncertainty of anaesthesia. This respondent related how he constantly assessed and reassessed the patient’s condition during her anaphylactic reaction to an i.v. antibiotic:

You never have all the information—or you never know that you have all the information. There may be some other information unknown to you. In the situation I was in, it was an evolving clinical pattern. At each stage you make a diagnosis, you work on it, and if it doesn’t fit, if the treatment isn’t working or the situation is getting worse, beyond the expectations that you have for it, then you have to change and reassess.

It’s like watching a film. You don’t just watch one shot of a film; it’s an evolving process that you continue to interpret.

(Interview with specialist registrar, 6 yr’ experience.)

The complexity and inherent uncertainty of anaesthetic practice is revealed in Figure 1. Here a situation evolves moment-by-moment, requiring contemporaneous assessment and interpretation. The anaesthetist repeatedly calibrates the sources of information against one another, demonstrating an implicit understanding of how these sources are mediated. He finally allows himself to respond flexibly, to ‘work on the assumption it’s the tube that was upsetting her’. In this instance, the decision to remove the tube is informed by the anaesthetist’s previous experience, and is clearly the correct response, but is potentially in conflict with more prescriptive approaches that might be found in textbooks or protocols. These would be likely to suggest that the tube should not be removed until the patient’s oxygenation is satisfactory.

Expertise depends to some extent on its social context and so is vulnerable to changes in that context. This respondent talks about a recent change in his working environment:

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 had been a consultant for 15 yr but I felt like a fish out of water. I felt unsafe because the anaesthetic equipment was unfamiliar to me and I was working with staff that I didn’t know and with surgeons that operated in a different way. You’re actually degraded as an expert [emphasis added]. You are having to start to learn again, even though you have been a consultant for 15 yr, and that applies every time you move outside of that field which you’ve built up your expertise in over the years.

(Interview with consultant anaesthetist.)
Figure 2 provides an example of the details that are incorporated into a routine over time: the patients are anaesthetized in theatre having already been administered midazolam; lidocaine is applied to the vocal cords; and the dislike of leaving succinylcholine in the cannula. Moreover, the ‘choreography’ between the physician and the anaesthesiologist dictates responsibility for the patient’s head and airway at any given moment, and even minute decisions such as the removal of pillows from under the patient’s head, are tacitly embedded in routines.

So, if knowledge derived from practice is always context-specific, and mediated, how can expertise be acquired over the longer term?

Acquisition of expertise

Learning to read and reconcile different types of knowledge.
If expertise rests on being able to balance different streams of knowledge, how is this learnt? The following extract is taken from a tutorial where a consultant anaesthetist is teaching senior house officers about obstetric anaesthesia:

A1 talks about respiratory changes in the pregnant woman. ‘This has very little bearing on the real world, just for interest’. A1 goes on to talk about how pregnant women desaturate extremely quickly and the implications of this for general anaesthetics for Caesarean sections: ‘it is not theoretical, you must formally pre-oxygenate for 3 min, 5 min if you can, even if the surgeon is screaming at you. The books say two attempts—those are two quick attempts’. A1 emphasizes this, pointing to the reality that the failed intubation routine came out of obstetric anaesthesia.

This leads on to a digression from the physiology to talk about the equipment you would need to intubate a lady for Caesarean section. Two of the SHOs respond ‘a polio blade’ (I get the impression this is a textbook answer). A1 asks whether anyone has actually used a polio blade, ‘It’s incredibly difficult … what do you actually need?’ A short handled laryngoscope is the answer he is looking for. He then discusses why and how the polio blade was developed.

(Ob6: observation of tutorial.)

Here, factual information as presented in textbooks is interpreted through the senior anaesthetist’s knowledge from experience. Whilst ‘the books’ might give the two subjects—respiratory physiology of the pregnant woman and the failed intubation routine—equal prominence, clearly the latter is of greater practical importance. The expert is allowed to act as arbiter of explicit knowledge, and interpret it for the less experienced practitioners.

Working with experts. Acquisition of expert knowledge requires exposure to it. Figure 3 describes anaesthetic induction and shows how a trainee is encouraged to practise a technique to develop this skill. The consultant tries to convince the trainee that by increasing the dose of propofol slightly, it is possible to omit the usual middle step of ventilating the patient after administration of the drugs and before insertion of the laryngeal mask. The consultant insists the trainee practise this method of induction because ‘that’s how you learn, that’s how I learnt’. The consultant acquired knowledge of this routine from another consultant by working alongside him, imitating him and practising the technique. The same process is repeated with this new trainee.

Working alone. In addition to practising under supervision, independent practice allows situated, context-specific knowledge to become embedded:

You have to be on your own for things to ‘click in’ right in your mind. As long as someone else is around he will always ‘interfere’, not interfere, but he will always do something with you. You will learn subconsciously—being with a consultant is necessary—but being on your own is a must.

(Interview with specialist registrar, 4 yr’ experience.)

The ‘click’ referred to above is also described in the following data taken from the observation of a trainee who has been working in anaesthetics for approximately 6 months. On one of the few occasions in which he was working independently the researcher asked how skills develop:

(Trainee) said he finds it difficult actually practising a technique as when he works with others he is always shown different methods. He gave the example of femoral blocks. So far he has been shown four different methods and he says that he just needs to practise one and learn how it feels.

(Noted during observation of senior house officer, 6 months’ experience.)

To deepen his knowledge of the technique he must learn how it feels and acquire a sense of what feels ‘normal’. The one-dimensional explicit knowledge conveyed by the teaching about blocks is fortified with knowledge that is also personal, cognitive, and tactile. Thus, knowledge is not simply transferred from the expert to the trainee; it is ‘worked on’ by the learner and incorporated into his/her practice.

Flexible routines. Working with experts and working alone show the process of exposure to knowledge and the embedding of that knowledge in practice. Here, practitioners move from the apparently piecemeal process of collecting items of knowledge, to a more structured, coherent, and individualized approach to anaesthesia. One consultant interviewed referred to a ‘great soup of anaesthetic
techniques’ learnt over many years, from which particular techniques are selected for appropriate circumstances. He suggested that whilst he had a preferred way of working, he was ready to adapt this to changing circumstances by choosing alternative ‘ingredients’.

Expertise is demonstrated as much in everyday routine practice as in managing complex or difficult cases, or when unexpected problems occur. The development of routines is in itself a hallmark of expertise. Observation of the new trainee reveals conscious and deliberate effort to remember the correct sequence of actions, which with experience becomes telescoped into the seamless practice of the expert. In fact, routines, in the sense of sequences of actions and anticipated events, can almost be regarded as ‘route maps’ which set out the expected course of an anaesthetic, and against which a dynamic conception of the patient’s physiological status may be plotted. Unexpected events are thrown into sharper focus against the background of the routine and therefore can be recognized more readily. As repeated routines develop into the slick, almost subconscious execution of tasks, the expert becomes quicker at responding to deviations.

The ability to ‘keep watch’ in this way is clear in Figure 2. This extract demonstrates how a routine can help trainees to learn. When the flow of the routine is disrupted, it highlights the gaps in the knowledge of an inexperienced practitioner. This is seen when the consultant prompts the junior ODP about the laryngoscope blade so that the ODP can replace it...
before it is required. By incorporating learners into the routine and making them breach the gaps in the routine, implicit knowledge is made visible.

How is such context-specific, tacit knowledge then drawn from one experience and utilized in the next? A hint is given above: learning ‘how it feels’ and developing routines helps to highlight deviations from the norm. This ability to distinguish normal from abnormal allows problems to be recognized and dealt with promptly.

**Discussion**

**Nature of anaesthetic expertise**

A key characteristic of expertise in anaesthesia is the simultaneous balancing of many different streams and types of knowledge. Anaesthetists have to recall what they have learned in the past (both formal learning and previous clinical experiences), and to interpret emerging and potentially misleading electronic signals about the state of the anaesthetized patient.

We began with a simple dichotomous model of professional knowledge—with explicit and tacit components. Tacit knowledge is defined as ‘knowledge that has not been (and perhaps cannot be) formulated explicitly and therefore cannot be stored or transferred entirely by impersonal means’. It is typically acquired by demonstration followed by practice. The importance of this tacit knowledge is well recognized in other domains, for instance the design and testing of nuclear weapons, and in doctoral students’ laboratory work. It has been identified previously in healthcare, but has not been extensively studied in anaesthesia. Our findings have prompted us to move beyond the simple tacit/explicit divide to a more complex and subtle understanding of the aggregation of professional knowledge we term expertise. For instance, in the observation of the tutorial on obstetric anaesthesia reproduced above, the trainees’ suggestion that a polio laryngoscope blade be used for intubation, although clearly a factually correct answer supported by published sources, demonstrates the one-dimensional nature of their knowledge on this subject. It also shows that knowledge from experience is needed to make sense of explicit knowledge. This example—where two interpretations of a body of factual knowledge interplay—is much simpler than the simultaneous use of multiple knowledge streams that appears to take place during the process of anaesthesia, but serves to illustrate the principle.

Some elements of our findings resonate with other work on the nature of professional practice and expertise, for example, Dreyfus and Dreyfus’ emphasis on a ‘deep situational understanding’, and the embodied appreciation of uncertainty that Schon suggests is required by the reflective practitioner. Medical work in general may fit with such models, but the practice of anaesthesia differs from other medical work in important respects. For instance, our data show considerable discrepancy between the anaesthetist’s apparent inactivity during routine anaesthetic practice, and ‘cognitive density’ as the anaesthetist continually assimilates information from many sources. Sources of information are interpreted against a dynamic conceptual model of the patient based on knowledge of physiology and pharmacology, but enriched by past clinical experience and information gathered moment-by-moment as the anaesthetic progresses.

Nonetheless, the literature in this field is scanty. A psychological model of anaesthetists’ decision-making processes was described by Gaba. Some aspects of our findings echo his ‘procedural level’ of decision-making, where the anaesthetist uses the information collected about the patient to identify and anticipate problems. Nyssen and De Keyser followed a similar approach and demonstrated differences in problem-solving strategies between novices and experts. The approach adopted by Klemola and Norros was similar to ours: they undertook detailed interviews with a small number of anaesthetists, and their resulting conceptual framework was led by the data rather than prior hypothesis. They focused on how anaesthetists conceptualize and relate to their anaesthetized patients, and identified two types of orientation towards the patient. The ‘realistic orientation’ described anaesthetists who focused on the uniqueness of each individual patient, communicating with them as if involved in a joint process. This group tended to recognize the uncertainty inherent in the process of anaesthesia. The ‘objectivistic orientation’, on the other hand, described anaesthetists who had an authoritative relationship with the patient, viewing them in terms of controlling physiological changes and carrying out a specific plan. Later work identified differences in the way these different groups of anaesthetists used information available to them. This suggested that ‘interpretative’ responses were associated with a realistic orientation, whereas ‘reactive’ responses—where information was simply used to confirm expectations and which Schon might describe as technical-rationalist—were linked to an objectivistic orientation.

The problem with analyses rooted in cognitive psychology is that they often fail to account for the social context within which groups work and interact. As Fletcher and colleagues point out ‘it is important that the particular social environmental context of the anaesthetic task is taken into consideration, such as interactions with team members, limitations imposed by the layout of the workspace, and the organizational culture of the medical system’. Our approach addresses this need to study the acquisition and use of knowledge in anaesthesia in its social context. Using Klemola and Norros’s approach we might have expected to find a spectrum of responses, ranging from highly rationalist to very interpretative. However, we found little evidence of an ‘objectivistic’ conceptualization. The focus of our study, however, was more on the types and integration of knowledge. We suggest that anaesthetists...
may use knowledge similarly even though their conceptualization of the patient is different. Thus, the same processes of drawing on a number of knowledge sources simultaneously go on, but then may be differently incorporated into the anaesthetist’s mental image of the patient according to Klemola and Norros’s classification. There are other reasons why our findings may differ too. First, British anaesthetists may be different in some way, by virtue of their training and culture. Secondly, selection bias might have been operating. We interviewed only seven of the 12 consultants at the study site, and five of a possible 15 trainees working there during the data collection period. Two individuals declined to be interviewed, one of whom expressed doubts about the nature and purpose of the study. Had we been able to interview these individuals, they may have presented discordant opinions. Thirdly, the rationalist view may simply be inadequate as an explanation of practice. Our observation and interviews were with clinicians who, above all, were practitioners.

**Limits to explicit knowledge**

Mental and manual dexterity are required in expert practice, and an ability to recognize and respond to changes in the condition of the anaesthetized patient. This contrasts dramatically with the view of anaesthetic work as largely technical and formalized. However, even training specifications set by anaesthetists themselves are written in terms of demonstrable competencies and do not appear to acknowledge the complexities we have documented. This is not unusual; Ernaut notes that ‘the cultural pressures within higher education to prioritize discipline-based “scientific knowledge” are at the expense of other forms of professional knowledge’.

Within much current research in medical settings and healthcare policy too, explicit knowledge appears supreme, perhaps because it is so easily translated into evidence-based guidelines. Our data suggest that anaesthetic expertise is comprised of a complex balance of explicit and tacit knowledge. This balancing process does not easily lend itself to incorporation into protocols and guidelines, yet these are now the ‘tool of choice’ to weed out unwanted variation in practice. Anaesthesia is an exemplar of expert practice whose rich contextual detail cannot easily be made to fit within such approaches. Attempts to train non-physicians to administer anaesthetics under supervision, in the UK, at least, would doubtless require a protocol-driven approach. In line with Berg, we suggest that any guidelines governing core anaesthetic practice would need to acknowledge the types of interpretation we have described.

**Implications for training in anaesthesia**

How then is the ability for this simultaneous, delicate balancing of heterogeneous streams of knowledge, essential for patient safety, acquired? How can knowledge as a whole, or more specifically the knowledge needed for the successful integration of the other knowledge described above, be taught? Collins and Roberts suggest that direct personal contact between expert and learner allows the passage of tacit knowledge. If this does not take place, there are two possible consequences. First, the tacit knowledge is simply lost. Secondly, given suitable opportunities, learners can reinvent the knowledge for themselves. The current trend in anaesthetic training in the United Kingdom is to organize trainees’ work patterns to allow them to work with consultants for the majority of their clinical sessions. This provides opportunities for transmission of the tacit elements of practice. We believe that trainers should make the most of these opportunities by stressing, wherever possible, the tacit elements of anaesthetic work. We are concerned, however, that the restrictions on trainees working independently, and over-emphasis on supervision, may hinder the development of coherent but individualized approaches to anaesthesia.

**Study limitations**

Our study has generated a substantial amount of detailed data. The methods we have used may be unfamiliar to many anaesthetists and may raise a number of questions. For instance, is it possible that the observational work might have introduced an element of bias? We considered using video and/or audiotape for data collection but did not do so. First, we felt that video would have been more intrusive and threatening than the presence of a single human observer. Anaesthetists are very accustomed to working and being watched in some way by others, whether it be assistants, trainee anaesthetists, or other theatre staff. Indeed, many of those we observed commented that they forgot they were being observed for this research and simply ‘got on’ with the work at hand. We do not feel that the Hawthorne effect (where the presence of an observer changes what is being observed) occurred. We also felt that videoing would give a fixed, limited view of events, unless the equipment was moved or redirected, which would be cumbersome and hazardous. Recording field notes with a notebook and pencil allowed the researcher to filter out extraneous detail and focus more closely on the subject of interest. There is, of course, a risk that different researchers ‘see’ different things. This is inherent in all such research and researchers are trained to think reflexively, that is, consider constantly how possible preconceptions, prejudices and so on might affect the conduct of their work. This was particularly relevant for the research fellow, who had to attempt to see what was already very familiar in a new light—to ‘question the apparently familiar.’

Using two researchers ‘in tandem’ for some observations was a further check on this and produced similar accounts. We also had the opportunity to ‘debrief’, either by asking questions directly after observation sessions to clarify what had been observed, or by inviting anaesthetists to comment.
on the transcripts at a later date. Such debriefing increases the rigour of the study and helps validate what the researchers ‘saw’.

We feel that our data accurately reflect the experiences and meanings of the participants of the study. This was confirmed by some of the participating anaesthetists individually and at group feedback sessions. Readers from within the profession of anaesthesia will also be able to judge for themselves how far this reflects the way anaesthetists think about their practice. A further test is the extent to which findings have relevance to those in similar settings. Quantitative work makes inferences about the statistical generalizability of findings. Our qualitative analysis is transferable to other similar settings—this was confirmed by the work carried out at the second study hospital. However, our work is firmly grounded in British anaesthetic practice and we can only speculate on ways of working elsewhere in the world, and differences in the relative contributions of different types of knowledge, especially in settings where anaesthesia is practised not only by physicians.

In conclusion, tacit forms of knowledge are vital for skilful practice in anaesthesia but are downplayed in formal statements of training. Although by definition tacit knowledge are not explicitly taught or assessed, it is argued that anaesthetists should be encouraged to acknowledge the central role of these elements in learning and maintaining their expertise.

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