
Embedding instruction in practice: contingency and collaboration during surgical training

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Abstract In this paper we address the ways in which surgeons, in collaboration with other members of the surgical team, create occasions for demonstration and instruction within the highly complex and demanding tasks of a surgical operation. Drawing on video recordings of surgical operations, augmented by field studies, we examine how particular phenomena and procedures are made accessible and intelligible to trainees and the ways in which brief episodes of insight and instruction enable complex procedures to be followed and understood. We consider the ways in which demonstration and instruction are achieved, whilst preserving the integrity of medical practice, and explore how trainees are provided with the opportunity to witness, and learn from, the contingent deployment of formal procedures in particular cases. We conclude by considering our observations in the light of recent discussions of practice and situated learning in healthcare training.

Keywords: social interaction, training, surgical operations, interaction analysis

Introduction

There has been a longstanding interest in the sociology of health and illness concerning medical education and training. Some of the most influential ethnographic studies in the field, including for example Becker *et al.* (1961), Freidson (1970) and Bosk (1979), were concerned with the ways in which expertise, practice and a clinical mentality were established both through formal training and working with others. It is recognised that social interaction, interaction with patients, peers, other colleagues and staff, is fundamental to learning how to accomplish particular activities in the highly contingent circumstances of healthcare delivery. These concerns resonate with a more recent body of research, broadly characterised as the 'practice turn', found in particular within cognitive science and social anthropology, exemplified by the influential contribution of Lave and Wenger (1991), within fields associated with learning and education (*e.g.* Ball and Lampert 1999, Cobb *et al.* 2001) and in quite a different way within studies of healthcare (*e.g.* Timmermans and Angell 2001, Goodwin *et al.* 2005, Prentice 2007). Once again these contributions stress the importance of interpersonal communication and social interaction as the principal vehicle in and through which people are encompassed within, and sustain, 'communities of practice'; that is, the

ways of accomplishing highly specialised activities in concert with others in ordinary everyday situations. Despite the substantial contribution of these and related studies to our understanding of 'situated learning', less attention has been paid to the forms of interaction that occasion instruction and learning and enable students, trainees and fellow clinicians to observe, attempt, and become familiar with technical procedures and practices. In this paper we seek to explore these issues with regard to the surgical operation. The complexity of many surgical procedures, the contingencies of particular cases, the potential risk to patients, and the necessity to perform the task in close collaboration with others, poses particular challenges to both teaching and learning.

A number of recent studies have begun to explore how specialised and professional ways of seeing are interactionally configured and disseminated within working environments, including the operating theatre and other medical settings (see for example Goodwin 1994, Hindmarsh and Pilnick 2002, Pomerantz 2003, Mondada 2006, Koschmann *et al.* 2007, Hindmarsh *et al.* 2008). We draw on these and related studies to consider the collaborative accomplishment of instruction and the ways in which momentary insights enable trainee surgeons to witness, follow and comprehend the deployment of technical procedures with regard to the contingencies of specific cases. In particular whilst recent studies have primarily focused on how the body features in practices of displaying, assessing and understanding, certain phenomena (*cf.* Koschmann *et al.* 2007, Hindmarsh *et al.* forthcoming), we explore how momentary revelations of the 'surgical field' provide the resources to enable students and trainees to follow, comprehend and, on occasions, contribute to, the concerted production of a complex medical procedure. In this regard, we also briefly consider how instruction and training during surgery rely upon the ability of other professionals, including nursing staff and anaesthetists, to anticipate, prepare for, and remain sensitive to these moments or episodes of teaching and to enable the surgeon to interweave the demands of education with the practicalities of the task on hand.

Methods and data collection

Our data consist of video recordings of two 'naturally occurring' surgical operations gathered in a leading ear, nose and throat hospital in central London. These recordings are part of a larger study of work, interaction and collaboration in operating theatres (Sanchez Svensson 2005) – a study that involved about 30 days of fieldwork including field observations, informal interviews and a corpus of 40 hours of video recordings.

These materials were collected following ethical clearance from the Health Trust and the hospital involved in the study, and adhered to guidelines provided by the UK's Economic and Social Research Council (ESRC). We also discussed the study and data collection with the clinical staff and patients involved. The agreement was that the materials could be used as long as patients could not be identified from any images or texts that were published by the researchers.

The video recordings, augmented by conventional fieldwork, have enabled us to consider how tasks and activities in such complex work settings are accomplished through the interplay of embodied conduct, talk and the use of various tools and technologies, to analyse the interactional and collaborative production of surgical operations and training. One particular advantage of video was that it also enabled us to hold a series of joint 'data analysis sessions' with clinicians, where we discussed extracts from the recordings. These joint sessions proved invaluable to help us to become familiar with the more technical aspects of

particular procedures and their performance as well as the background to certain activities and interventions.

We draw on ethnomethodology and conversation analysis and the burgeoning corpus of research concerned with the interplay of talk, visual conduct and the use of tools and technologies that has come to be known as ‘workplace studies’ (see for example Engestrom and Middleton 1998, Luff *et al.* 2000, Heath and Luff 2000). Our interest is in the ways in which ‘occasioned viewings’ are critical to enable trainees to see and inspect certain phenomena at a particular moment, but also for their ability to follow and make sense of the progressive accomplishment of the operation and the deployment of a procedure. This poses certain challenges to an analytic commitment primarily concerned with the interactional production of short, circumscribed sequences of action. In this regard, whilst we focus in this paper on the collaborative accomplishment of moments of insight and instruction, we also briefly consider subsequent episodes of talk and interaction, and the ways in which the occasioned interventions provide the resources for the trainees to comprehend the progressive aspects of the operation.

The operating theatre as an ecology for instruction

The operating theatre is a work setting that has developed both as a platform for a technical activity and as an arena for learning and development. The contemporary versions of apprenticeship in the operating theatre involve a structured training programme during which the trainees work hard to obtain sufficient experience from practice and pass the necessary examinations. In the United Kingdom, for those who follow the surgical path, basic surgical training involves initially learning those aspects of medicine and generic skills common to all varieties of medical practice. After two years of basic surgical training the trainee then takes a post in one of the surgical specialities. This phase of training, called ‘higher surgical training’, is undertaken in the specialist registrar grade where trainees expand their clinical experience, assume increasing responsibilities and develop a specialist interest. Higher training takes five or six years and once complete and all examinations passed, the trainee can become a specialist registrar and apply for a post as a consultant.



Figure 1 *In each of the cases the surgeon is central, surgical trainees stand next to the bed and medical students stand behind. In the left image a scrub nurse (on the left) holds an instrument ready for use; in the right image, an anaesthetist (on the right) monitors the condition of the patient*

There is a longstanding recognition within medical education of the importance of clinical experience and practical case knowledge. One of the more significant aspects of the training is the opportunity to join the senior surgeons in the actual environment of the operating theatre (see Figure 1). The more formal knowledge gained from reading textbooks and handbooks or attending lectures provides the student or trainee with relatively abstract knowledge concerning the ways in which cases are managed and the ways task specific skills and competencies are applied. It is widely recognised that surgery requires a fine mix of intellectual, technical and manual skills and that these skills can only be acquired through the opportunity to observe and discuss actual procedures and how they are applied, in collaboration with others, in actual cases. Indeed, it is recognised that each and every case is in a sense unique and poses particular challenges to the performance of the task and its application.

In teaching hospitals senior members of the surgical team have the responsibility to enable trainees to learn from the case. This may involve the surgeon in showing trainees how to perform particular procedures during minor and routine cases, and in some cases providing more experienced trainees with an opportunity to perform an incision or other minor or less critical parts of the operation under the supervision of the surgeon. Either way, it is important that trainees are able, within the constraints of the emerging task and the environment of the operating theatre, to witness and follow the operation, both as the surgeon prepares the surgical site and applies (a) specific technique(s) to the particular case on hand. In other words, the student or trainee is required to participate as an observer. 'Intelligent' or 'informed' observation relies upon the ability of the surgical team to selectively render visible the performance of the surgical procedure and specific aspects of the case on hand. In this way, the trainee not only develops a familiarity with particular practices and procedures but becomes sensitive to, and aware of, the contingent deployment of those procedures with regard to particular cases.

Recognising the problem and its transformation

The surgical site is a relatively circumscribed domain, consisting in many cases of less than a couple of square centimetres. In order to maximise its availability and visibility to the surgeon, trainees and colleagues in the operating theatre frequently find themselves in positions where the surgical site is inaccessible, even though it may lie in close proximity. In many forms of surgery there is no other way to access the surgical field, unlike the cameras and accompanying monitors used in micro-surgery that enable the site to be displayed to all who happen to be present. Moreover, in most cases trainees will not have hitherto witnessed the performance of the particular procedure, and even if they have observed the general procedure in question on a previous occasion, they may well be unfamiliar with the ways in which a surgeon deals with the contingencies or idiosyncrasies of a particular case. As Pope (2002) suggests, surgeons bring preferences, past experiences, sensory responses and abilities to deal with the contingencies of surgical work. If the presence of trainees in the operating theatre is to have any educational value, it is critical that that they can not only witness aspects of the operation but are able to make sense of the contingent application of the procedure within the developing course of the operation. The surgeon, therefore, in co-operation with other members of the surgical team, has to selectively reveal aspects of the surgical site and the procedure so as to enable the trainees to make sense of, and 'intelligently' follow, the activities on hand despite their limited access to the operation. Moreover, this has to be accomplished so as to preserve the integrity of the task(s) on hand and the proper,

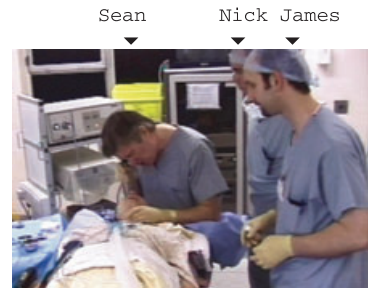
professional practice upon which it relies. This resonates to some extent with the ways in which Bosk (1979) describes how surgeons allow room for the learning experiences of the trainees, without putting the patient at risk.

Let us consider an example. The surgical team is involved in clearing and widening the interior areas of the patient's throat. Some time before, the patient underwent an operation involving the removal of the larynx where the surgeon performed a tracheotomy. This involves making an artificial opening called a stoma in the front of the neck, and bringing the upper portion of the trachea up to the stoma and securing it, providing a permanent and alternative way for air to get to the lungs. Since the operation, the inner area of the throat has become tight, making it difficult for the patient to breathe and causing a number of infections. One of the problems that can emerge in such cases is when connective tissue – granulation tissue – replaces a clot in the healing wound. In order to improve the patient's breathing by clearing the

Case 1 - Transcript 1

1a
↓

1 Sean: Yep
2 (0.3)
3 There's the little
4 she::lf:
5 (1.0)



1a

1b
↓

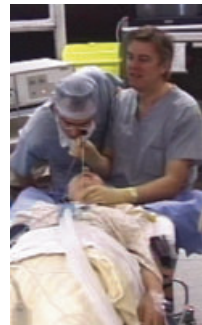
6 Sean: You can see where it s:o
7 na:rrows
8 (3.0)
9 (you see the) shelf and
10 mucus there
11 (1.0)



1b

1c
↓

12 Nick: m:mm



1c

airway and widening the windpipe, the surgeon uses particular instruments: a suction tube to remove tissues and secretion (mucus) and a dilator to widen the narrow parts of the throat. As part of this procedure the surgeon also uses a bronchoscope to see the interior of the throat and examine the progress of the intervention. The bronchoscope is a long telescopic lens that is inserted through the aperture in the throat to enable visual examination.

On this occasion two surgical trainees, Mark and Nick, have joined the surgeon. Nick is still in basic surgical training and has less experience of actual cases in the operating theatre; he knows about the procedure from the textbooks and seminars but has not witnessed it being performed. For him, as it is for all surgical trainees, this is not only an opportunity to learn about the procedure but to experience its performance with regard to the circumstances and contingencies of this particular case.

We join the action in the operating theatre as the surgeon begins the procedure. The surgeon (Sean) takes the bronchoscope, leans over the patient and inserts the bronchoscope through the airway opening. The surgeon begins to examine the interior of the throat with the trainee patiently waiting behind his back. The surgeon then explains what he can see (Case 1 – Transcript 1).

Referring to a discussion that occurred just prior to the procedure commencing, the surgeon informs the trainee that he is now looking at ‘the little she:lf.’ (1a). It is this little shelf, caused by an outgrowth that is where the airway tube meets the trachea (see Figure 2), that is causing the patient’s breathing problems, and the surgeon provides further resources to enable Nick to discover and see the problem for himself.

In response to Sean’s invitation ‘You can see where it s:o na:rrows’, Nick moves nearer to the surgical field (1b), and bends down over the instrument and examines the throat (1c). As he looks into the bronchoscope, Sean encourages him to see the shelf and the surrounding mucus (‘(you see the) shelf and mucus there’). Nick’s glance down the bronchoscope, coupled with his considered response ‘m:mm’, and immediate withdrawal, serves to display to the surgeon that he has seen the problem and recognised it. In this way, in producing a minimal, yet apparently adequate, recognition of the particulars of this problem, Nick enables Sean to immediately begin the procedure, the principal task on hand.

The surgical procedure consists of the surgeon clearing and broadening the throat by successively inserting a series of rods (dilators) of different sizes. By providing the trainee with an opportunity to view the throat prior to the intervention, the surgeon enables Nick to



Figure 2 *An example image of the trachea and the narrowing pathway through a bronchoscope*

Case 1 – Transcript 2

1 Sean: How (doe)s it look no::w
 2 (0.2)
 3 eh
 4 (.)
 5 Nick you see with the (ge)
 6 with the mucus
 7 di::stu::rbed
 8 (0.5)

2a



9 Nick: Yeah=
 10 Sean: =It's looking half
 11 reasonable now
 12 (0.5)
 13 Nick: Yeah yeah



2a

2b



14 Sean: at one time there was a
 15 sort of window across
 16 there
 17 (0.4)

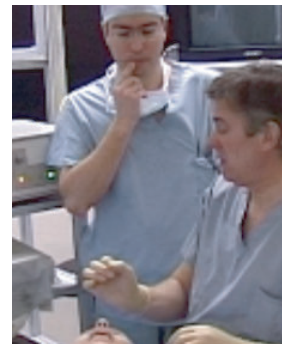


2b

2c



18 Sean: and it was (down to a
 19 minimum)
 20 (0.4)
 21 Much better than it was



2c

understand and follow the procedure with regard to specific qualities of this case: for example, the degree of narrowing and scale of the outgrowth and surrounding secretion that form this particular blockage and the particular qualities of this growth that have caused difficulties for the patient and her ability to lead a normal life. Moreover, the surgeon can draw upon the earlier viewing and identification of the problem to discuss different approaches to the problem, the results from previous operations, the improvements that they can later observe, and what may be expected and anticipated in the longer term.

Having seen and inspected the growth, secretion and the narrow path of the airway, the trainee is able to make sense of a procedure that involves inserting successive dilators of an increasingly large size into the airway to make it progressively larger. The scale of the dilators, and the way in which they are inserted, can be seen with regard to characteristics of this particular case. During the procedure, the surgeon intermittently uses the bronchoscope to inspect the progress of the operation and assess whether the throat has been cleared and broadened. The surgical field, and its transformation, remains largely invisible to the student, but on the occasions where he is invited to view the progress, it is only intelligible by what is known about the specifics of this case and by virtue of the contrast with the original state of the throat.

Five minutes into the operation, the surgeon invites the trainee to view the improvement that successive dilations have made (see Case 1 – Transcript 2 above).

Having encouraged the trainee to glance through the bronchoscope the surgeon attempts to get him to look at how the mucus has been disturbed and how now it is 'looking half reasonable'. He then provides a contrast with the way in which it had appeared on a previous occasion and the extent of narrowing. Until this point, the trainee has had the opportunity to inspect the difficulty prior to the deployment of the procedure. He is only now able to look and see the ways in which the dilators have transformed the area surrounding the little shelf. In this way, not only can the trainee compare and contrast the effect of the procedure on the airway, but is able to see for himself what constitutes for the surgeon 'looking half reasonable'. In other words, the initial insight and the surgeon's accompanying description provide the resources for the trainee to follow and make sense of the procedure and assess how it has transformed the problem with regard to the particulars of this case.

Interestingly, as our transcript reveals (see Transcript 2 above), not only does the trainee affirm his understanding of the current state of the throat (2a) but as the surgeon continues to talk he seeks to demonstrate his understanding. The trainee stands up and makes a gesture with his right hand to show the width of the passageway (2b). In the light of this gesture and whilst he talks about the previous state of the throat, the surgeon produces a similar hand gesture of his own (2c) confirming the characterisation provided by the trainee. The trainee shakes his head as if to show his appreciation of the seriousness of the earlier condition. Before continuing with the case the surgeon concludes that it is now 'much better than it was'.

The ways in which the trainee responds to the assessment and his inspection of the throat and its transformation, provides the surgeon with a sense of the ways in which the trainee has seen and understood the effect of the procedure and the qualitative changes that have been accomplished in this case. The shaping of his fingers illustrates a broader and wider area down the throat, contrasting with the much narrower passage seen earlier. In contrast, the surgeon then uses the gestural characterisation of the trainee to elucidate how this transformation, on this occasion, stands in relation to the severity of the patient's problem on a previous occasion. In other words, whilst enabling the trainee to witness and to follow this procedure and inspect its effects, the surgeon goes to some trouble to delineate this operation within the career of the patient's difficulties and their surgical interventions.

The timely revelation of a problem's characteristics

To enable junior staff and trainees to follow complex procedures and their specific application in particular cases, it is necessary for the 'problem' in question to be seen at certain stages of the activity's accomplishment. Once seen, it is then possible to understand

the contingencies that may emerge when performing a particular procedure, and to become familiar with, or be sensitive to, the ways in which a procedure has to be deployed with regard to a particular case and the difficulties it may afford. It is not unusual, however, for particular 'problems' to be almost invisible, certainly to the untrained eye, and significant time and effort are often directed towards exposing the problem prior to undertaking surgery. It is critical that junior doctors and trainees are able to view the specifics of the exposed problem before the procedure takes place; they are able to understand why the procedure is performed, on this occasion, in this particular way. In a sense therefore, the indexical or occasioned properties of the 'problem' are part and parcel of understanding the procedure and its routine, yet contingent, accomplishment.

Consider the following fragment. We join the action as the surgeon clears mucus around a tumour (an osteoma) in one of the frontal sinuses (a cavity in the frontal bone just above the

Case 2 - Transcript 1

Jane Maria Peter

3a ↓ 3b ↓

1 Maria: Can you see the line there
 2 (1.2)
 3 the little line there
 4 (lying) around it
 5 Jane: Yes
 6 Maria: Do you see it at the
 7 bottom there
 8 (1.0)
 9 that little V::
 10 Jane: mm
 11 (1.0)



3a



3b

12 Maria: Okay
 13 (0.2)

3c ↓

14 Maria: that's where the osteoma
 15 (is) against the back wall
 16 (1.0)
 17 It's very [very tight
 18 [yeahs
 19 Jane:



3c

eyebrows). The surgeon (Maria) has exposed the anterior of the sinus, elevated the bone overlaying the sinus and is using a drill and various other instruments to remove the mucus and to gain access to the tumour. It has taken some time to expose the tumour and render it accessible for surgery. However, in this case, even though the tumour has been exposed, it has grown in such a way that it has become integrated with the bone structure deep inside the cavity of the frontal sinus and this will prove challenging for its removal. Two surgical trainees (Jane and Peter) are attending the operation and providing assistance where necessary (3a). The surgeon stops drilling and places the suction tip in the particular area of interest and produces the utterance: 'Can you see the line there'. The question occasions a reorientation by Jane and Peter; they move forward and turn towards the surgical field (3b).

The trainees' reorientation to and inspection of the surgical field, whilst occasioned by the question, does not provide sufficient resources to enable the surgeon to recognise that they have seen the line and location of the oosteoma. A second or so later, she specifies the location of the line in relation to the oosteoma, 'the little line there (lying) around it' (lines 3-4), and Jane responds with 'yes' (line 5), but Peter, aside from looking more closely, produces no response. The surgeon makes a further attempt to enable Peter, and perhaps Jane, to discover the line in relation to the location of the oosteoma in the cavity of the frontal sinus – 'do you see it at the bottom there?', No vocal response is forthcoming, and both trainees look more closely towards the area of the oosteoma. Once again, the surgeon provides a further specification of the line that lies around the oosteoma in the bottom of the cavity – 'that little V:::' – and what the two trainees should be looking for; a specification that provides a guide as to how it might be found and seen. Again, it receives an acknowledgement from Jane, but no verbal response from Peter. A moment later, when the surgeon delivers the actual statement 'that's where the oosteoma (is) against the back wall', she turns directly towards Peter (3c). Her description is accompanied by a gesture in which she shapes her hand into a representation of the tumour and its location in the cavity of the frontal sinus (3c). The gesture and its accompanying description illustrate what should be seen, and provide Peter, if not also Jane, with the resources to enable them to retrospectively make sense of the tumour and its position within the cavity.

The trainees' sense and recognition of the oosteoma is accomplished through the surgeon's progressive attempts to align their orientation to enable them to see what is almost hidden, a series of actions that is shaped with regard to the emerging participation of Jane and Peter. The very ways in which the location and character of the oosteoma is revealed is fashioned with regard to the visible and vocal conduct of the trainees. Her successive attempts to reveal the line and oosteoma are built though a series of actions that specify a particular alignment and secure an appropriate display that the objects have indeed been found and seen. They progressively emerge with regard to the seeming absence of a sequentially appropriate response from the trainees, in particular Peter, who both fails to claim or show that he has seen the little line and recognised its significance. The surgeon's attempts to secure particular forms of participation and particular ways of orienting to the surgical field, are sensitive to the different alignments of the two trainees in the developing course of producing the activity.

Interestingly, however, this progressive alignment of the participants towards the visual scene of the surgical field appears not to be primarily concerned with revealing the oosteoma. Whilst they have earlier been able to see parts of the oosteoma, the surgeon now encourages the two trainees to see not only where it is, but to locate the object within the particular structure of the cavity and its contents. The identification of 'the little line' and 'at the bottom there', and as characterised as 'that little V:::', progressively reveals the oosteoma's position at the rear of the sinus, tucked against the back wall. The revelation of

the osteoma in this way orients the two trainees to the specifics of this case and thereby to its implications for the application of the procedure that the surgeon will perform. It attempts to provide the resources to enable the trainees to recognise the ways in which the procedure is (and will be) shaped with regard to the contingencies at hand, in particular the difficulties of removing a tumour from a relatively inaccessible location. Her last assessment 'It's very [very tight]' underscores the difficulties that she is now facing and how the procedure should be understood with regard to the particular contingencies of this case, specifically the location of the tumour.

Given the absence of any explicit response from Peter, it is interesting to notice how he, a few minutes later (see Case 2 – Transcript 2) just as the surgeon has finished a round of drilling near the location of the tumour, appears to comment on the location of the osteoma and the problem it entails, barely audibly noting that it is 'very thick'. The remark appears to display an understanding of the difficulties associated with the size of the bone structure and the location of the tumour being deep inside the sinus. The remark occasions a lengthy description from the surgeon, as she explains the surrounding anatomy and the pathology of the problem, and the difficulties the location of the tumour poses for access and removal. During this description, a highly technical description that is critical to the trainees' ability to follow the procedure and understand the particular difficulties in this case, the surgeon temporarily suspends the principal surgical task.

Revealing the location of the osteoma and drawing attention to its 'tightness' serves retrospectively to illuminate, and perhaps account for, the difficulties that the surgeon has faced in accessing the tumour and preparing the surgical field. It also provides the trainees with a sense of the specific characteristics and contingencies that will inform the application of the surgical procedure and the difficulties that it may entail. It enables the trainees to embed the procedure within the practicalities and constraints of this case, and retrospectively and prospectively to make sense of the particular actions undertaken by the surgeon. The perception and determination of the osteoma's location, and the trainee's ability to

Case 2 - Transcript 2



4a



4b

- 1 Peter: (very thick)
 2 (0.1)
 3 Maria: Yeah what she's got: ah on the scan::
 4 (0.2)
 5 you can see she's got a very big ah sort of (0.5)
 6 anterior (0.3) ah frontal septum¹
 7 (0.5)
 8 °if you look on the scan° (She's got) a thick frontal
 9 bone with a sort of (0.4) ah quite thick ah septum into
 10 the anterior cranial fossa²
 11 (0.4)

4a
↓

12 Maria: and then you got a relatively small frontal sinus and
 13 that little bit of (0.2) s: septation³ becomes part of
 14 the intersinus septum which is integrated into the
 15 osteoma
 16 (0.1)
 17 that's the problem and that's what we are on here.
 18 (0.5)
 19 What I am doing is drilling around it
 20 (0.3) 4b
 21 and you can just see:: (1.0) the:: (1.0) freer please
 22 (0.2) ↓
 23 you can just see there::: (1.0) the:: (1.5) juncture
 24 (1.0)
 25 (just there)
 26 (0.5)
 27 between the osteoma

Note:

¹ A septum is a thin partition or membrane that divides two cavities or soft masses of tissue.

² A fossa is a depression or hollow in a bone.

³ A septation is the division or partitioning of a cavity into parts by a septum

comprehend how the procedure is being deployed on this occasion and the difficulties faced by the surgeon, are accomplished in and through the interaction, interaction that provides the trainees with access to, and a way of seeing, the osteoma at this stage or moment of the proceedings. These revelations, through which trainees are provided with momentary access to aspects of the surgical field, are positioned to provide resources to enable deployment of the particular procedure to be intelligible and accessible, even though it may partially be hidden from view.

Supporting instruction: preserving the integrity of the procedure

In the previous case, Peter's comment is immediately followed by a lengthy description from the surgeon concerning the complexities of the case. In this account she relates details of the case to a scan displayed in front of the team, and encourages the trainees to re-examine and inspect the surgical site, comparing the actual problem with the scan of the tumour that has informed the intervention. Maria describes particular characteristics of this case and gestures using both hands to capture the large size of the frontal septum, the small size of the frontal sinus and the relationship between the two. Maria then points to the region of the patient's head saying 'and that's what we are on here', picking up the suction tool. The shift from the characterisation of the case, drawing on the scan, to the actual osteoma encourages both Jane and Peter to turn towards the surgical site and inspect the features described by Maria. As they turn towards the surgical site, Maria then describes the specific part of the procedure she is undertaking 'What I am doing is drilling around it'. Maria starts to use the suction tool as she says 'and you can just see:: (1.0) the:: (1.0) freer please (0.2) you can just see there:::'. Maria then shows the trainees the region around the osteoma. To enable the trainees to more closely inspect the osteoma and its location, the surgeon requires a freer – an instrument for elevating or lifting bone structures. The utterance 'freer please' (line 21 in Case 2 – Transcript 2, see arrow 4b), embedded within this lengthy description, is for the scrub nurse (Susan) standing to Jane's right. The nurse passes the freer in the pause following 'you can just see there:::':

During Maria's long description of the problem, Susan, having placed the drill ready for the next part of the operation, begins cleaning another instrument, occasionally glancing at the scanned image on the display. As Maria completes the description of the problem and says 'and you can just see:', Susan then turns to scan the trolley where the instruments are laid out. When the surgeon asks for the freer, she immediately picks it up from the table and passes it to Maria. The timely and unproblematic passing of the instrument, its deployment just at the moment it is relevant to the illustration, demonstrates the way in which the scrub nurse is both following, and orienting to, the surgeon's characterisation of the problem in the course of its production. The instrument is ready on hand, and ready not simply for the next stage of the procedure but ready to render that the problem is visible, accessible, to the trainees.

At major teaching hospitals surgical operations can include a significant number of participants. As well as the surgeon, one or two surgical trainees and two or three students, there will be at least one scrub nurse, and one or maybe two anaesthetists. Providing instruction or insight into a surgical procedure or practice may require actions from one of the other participants, particularly from those involved in the performance of the operation such as the scrub nurse or an anaesthetist. Those participants, other than the surgeon and the trainees, may have to remain sensitive not only to the progress of the procedure, but to the instruction and informing that arises, so as to enable moments of insight and demonstration to be unproblematically accomplished.

It is worthwhile to return to the throat operation discussed in the first case. When we enter the action (see Case 1 – Transcript 3 below), the surgeon (Sean) is undertaking the procedure but has temporarily stalled the activity to discuss further details of the case with the two trainees (Nick and Mark). The procedure, successively inserting the dilators into the patient's throat, requires the patient to be manually ventilated by the anaesthetist. Here, a small tube is placed in the hole in the patient's throat, the same hole used for inserting the dilators and bronchoscope during the surgical procedure. This tube is connected to a small bag that enables the anaesthetist to manually pump oxygen to the patient's chest. To insert the dilators or bronchoscope the tube is removed. During this period, the patient is receiving no oxygen and it is critical therefore that the tube is replaced at regular intervals. If the patient receives no oxygen for more than 60 seconds then brain damage can occur.

When Sean in our extract (see Case 1 – Transcript 3) says 'Yeah (0.2) seriously (0.2) there is no granulation' (lines 5-8, image 5a) he turns towards the instrument trolley to his right, picks up the bronchoscope and the suction tube and asks the scrub nurse to hold the tube (lines 16-17). He then introduces the ventilation tube ('and we'll just pop in again' – line 19) for the anaesthetist (James) to manually ventilate the patient, so they are ready to proceed with the next stage of the operation.

By manually ventilating the patient, by squeezing the bag, the anaesthetist displays that he is sensitive to this juncture in the operation. It is interesting to note how initially his orientation, away from the surgical scene, seems to be designed not to draw any attention. He occasionally turns towards the surgical scene to monitor the discussion and to watch for the opportunity to ventilate the patient. By ventilating the patient at a suitable and witnessable opportunity he not only produces the actions that are critical to the safety of the patient but avoids disrupting the instructional activity.

The same kind of sensitivity is shown by the trainees. As the surgeon says 'little bit mucus around' (line 10) and starts picking up the instruments, Mark moves to his right and slightly away from the surgical scene. Nick then follows, moving to stand behind Sean and Mark (5b). The trainees, in particular Mark, seem to recognise the upcoming transition from the

Case 1 - Transcript 3

1 Sean: That is all gone now
 2 (0.4)
 3 Mark: Is it?
 4 (0.2)
 5 Sean: Yeah
 6 (0.2)
 7 seriously (0.2) there is no
 8 granulation
 9 (0.4)
 10 little bit mucus around

5a



11 Sean: but (2.0) no actual
 12 °granulation°
 13 (2.0)



5a

14 Sean: O::kay
 15 (0.3)
 16 you can hold that end for me
 17 that would be gre::a:t
 18 (0.2)
 19 and we'll just pop in again
 20 (1.0)

5b



21 Sean: gently



5b

talk and visual conduct of the surgeon. They position themselves to facilitate the upcoming procedure, providing the surgeon with the space, 'the elbow room' to coin the phrase used by Hughes (1958), to perform the procedure. The conduct of the trainees defers to, and serves to preserve, the integrity of the surgical activity.

Just after Sean puts the tube back in, James (the anaesthetist), who has been standing a little back from the bed, moves in and gives the ventilation bag a squeeze to supply the patient with oxygen. The surgeon produces a long summary of the current progress of the procedure, at one moment making it possible for one of the students to see this in the light of what he has previously seen. Sean then goes on to the next round of dilation. Whilst continuing to engage with the trainees, and preparing for the next stage of the operation, the surgeon is also sensitive to the prospective needs of the anaesthetist, inserting the ventilation tube in such a way to give him time to prepare and implement one round of ventilation before the next stage of the procedure. The surgeon himself is also not only concerned with the progress of his own activity, but is sensitive to the ability of others to undertake their tasks and responsibilities and thereby preserve the integrity of the ongoing surgical procedure.

In surgical operations moments of explicit surgical training are interwoven within the ongoing surgical procedures. The transitions into and out of these moments are delicately managed by the participants in the operation – not only by the surgeon and trainees, but also by other members of the clinical team. In various ways anaesthetists and nurses help configure their own activities to enable moments, sometimes episodes, of demonstration and instruction to be unproblematically interleaved within the concerted accomplishment of the operation, preserving the professional integrity of the procedure and its accountability, whilst enabling trainees to observe and in some cases participate in the principal task on hand. In various ways, moments and episodes of instruction and demonstration place contingent demands upon the production of the specialised activities of other members of the surgical team, and as we have begun to see, place demands upon the ways in which they orientate to and understand the particular surgical procedures and the opportunities and occasions they afford for learning. It is unfortunate perhaps that, as far as we are aware, so little analytic attention has been paid to the ways in which the different participants within surgical teams enable instruction and demonstration and the sorts of competencies and resources on which the smooth accomplishment of these episodes rely.

Discussion: formal procedures and their occasioned application

It has long been recognised that the ability to learn highly complex medical tasks relies upon both formal instruction and the opportunity to ‘participate’ in the accomplishment of everyday healthcare practice. It is argued, for example, that through engagement with more senior practitioners within ongoing practice, students and trainees acquire the skills and competencies, the communities of practice, that are required to perform these complex tasks in organisationally relevant and appropriate ways (Lave and Wenger 1991).

In her insightful study, Pope (2002) draws upon interviews and observations of surgical work to identify three ways in which surgical work can be considered contingent: with regard to the case, to the particular surgeon and to other external factors. For example, Pope points to the different ways in which surgeons’ decisions both before and during surgery are shaped by such matters as the particulars of the patients’ circumstances, the skills of their assistants and even the size of their own hands. Pope raises concerns with relying too much on surgeons’ own reports of the contingencies they face as it may unduly prioritise their accounts of their skills and tacit practices. Nevertheless, she suggests, following others (Berg 1997, Wood *et al.* 1998), that by taking contingency seriously the conventional boundaries between practical and technical knowledge may need to be rethought.

By considering the ways in which surgical work is accomplished in practice we can see how surgeons manage these contingencies from moment-to-moment through interaction with their colleagues. Examining those occasions when instructions and insights are provided throws light not only on how their knowledge and skills are deployed but also on how practitioners learn from, and about, the contingent application of formal procedures in particular cases – how ‘situated learning’ is accomplished in practice.

Save for a few insightful studies, such as those concerned with how surgeons provide ‘tacit guidance’ when providing training in manual tasks (Prentice 2007), how practitioners manage the internal boundaries of a community of practice (Goodwin *et al.* 2005), and how ‘professional visions’ are configured within medical environments (Mondada 2006, Koschmann *et al.* 2007, Hindmarsh *et al.* forthcoming), we have little understanding of the

significance of, or practice that underpins, 'situated learning'. In the case at hand, we can begin to see how trainees are not simply provided with an opportunity to observe or discuss the operation, or to handle the instruments and engage in a specific part of a procedure, but with the resources to enable the deployment of procedures to be seen and considered with regard to the particulars and the particular demands of the case. Trainees need to be provided with the resources to be able to witness and follow a surgical procedure, but also to have a sense of why it is done in this way on this occasion; in other words they need a sense of how the procedure is performed with regard to the specific case and practicalities. These viewings are not simply accomplished so that an object or feature can be seen at this moment, but seeing the 'phenomena' provides the means to understand the contingent and occasioned deployment of the procedure. In other words, the surgeon, in concert and collaboration with colleagues, provides trainees with ways of embedding a formal procedure with the reasoned and relevant contingencies of the case on hand; in such ways, a new member comes to know and skilfully apply rules of an organisation (see for example Weider 1974). It is the ability to recognise these reasoned and relevant contingencies, and thereby deploy a procedure, that is critical to the appropriate and accountable performance of medical practice.

The ways in which trainees are provided with the opportunities to discuss cases and with the resources to see, and make sense of, particular phenomena and practices, might appear to rely on the differential status of the participants in a formal training situation: the surgeon, a more senior consultant with teaching responsibilities, and trainees, less experienced members who participate only to receive insight and knowledge about the particular case. It might also be thought that the activities of the trainees are principally concerned with listening to and observing the surgeon or providing relevant support. However, there are a number of aspects of teaching and learning situations in the operating theatre that raise some interesting issues with regard to, our understanding of apprenticeship and situated forms of learning, at least in this particularly complex setting.

First, we can see how moments of instruction have to be positioned not only with regard to the proper performance of the task at hand, as a formally organised activity, but with consideration to what trainees may need to know at certain moments to retrospectively and prospectively make sense of, and (intelligibly) follow, the action and the procedures of occasioned deployment. The timing and place of the insight and instruction provides the resources for rendering the procedures visible and intelligible with regard to the particular case at hand, whilst simultaneously preserving the integrity of the operation and its emerging and contingent demands. Secondly, trainees rely on ways of seeing the surgical phenomenon and the occasioned application of the procedure that 'progressively' emerges, so that for example, seeing this now recasts what has happened and in turn provides a scheme of interpretation with which to see and make sense of subsequent problems, actions and the like. These moments of insight and instruction form a critical element of gestalt that enables an emergent retrospective-prospective sense of the activity in the course of its accomplishment. They are not simply moments of looking, but by virtue of seeing here and now they enable an informed and cumulative sense of the action and the case to emerge. Thirdly, the occasioned production of these insights and instructions by the surgeon necessitates timely and relevant contributions from a range of participants. Scrub nurses and anaesthetists, for example, orient to the requirements of providing instruction and in various ways serve to support these occasioned interventions or breaks from the activity at hand. Being a good trainee involves deference to the emerging demands of the principal activity: the operation. Nevertheless, differing contributions from a number of participants with a range of expertise are co-ordinated to accomplish the task at hand whilst also reflexively rendering visible the ways in which the task is produced.

To disregard the 'situation' of 'situated learning' renders epiphenomenal the social and the interactional organisation through which demonstration and instruction is accomplished within the demanding circumstances of a complex medical procedure. It also undermines our ability to understand what is taught and learnt in these circumstances, in particular the ways in which formal procedures and practices are applied, performed and configured with regard to the contingencies of the case at hand, and the relevant scheme of contingencies that might properly inform the procedure's deployment.

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