Codifying knowledge to improve patient safety: A qualitative study of practice-based interventions

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A B S T R A C T

Although it is well established that health care professionals use tacit and codified knowledge to provide front-line care, less is known about how these two forms of knowledge can be combined to support improvement related to patient safety. Patient safety interventions involving the codification of knowledge were co-designed by university and hospital-based staff in two English National Health Service (NHS) hospitals to support the governance of medication safety and mortality and morbidity (M&M) meetings. At hospital A, a structured mortality review process was introduced into three clinical specialities from January to December 2010. A qualitative approach of observing M&M meetings ($n = 30$) and conducting interviews ($n = 40$) was used to examine the impact on meetings and on front-line clinicians and hospital managers. At hospital B, a medication safety 'scorecard' was administered on a general medicine and elderly care ward from September to November 2011. Weekly feedback meetings were observed ($n = 18$) and interviews with front-line staff conducted ($n = 10$) to examine how knowledge codification influenced behaviour. Codification was shown to support learning related to patient safety at the micro (front-line service) level by structuring the sharing of tacit knowledge, but the presence of professional and managerial boundaries at the organisational level affected the codification initiatives' implementation. The findings suggest that codifying knowledge to support improvement presents distinct challenges at the group and organisational level; translating knowledge across these levels is contingent on the presence of enabling organisational factors, including the alignment of learning from clinical practice with its governance.

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1. Introduction

In many health care systems, use of codified knowledge to improve service quality, increase accountability, and support the governance of health care organisations is growing (Denis and Lehoux, 2013). Codified knowledge is formal, systematic and expressible in language or numbers, making it easy to store, transfer, and utilise across space (Amin and Cohendet, 2004). Codified knowledge is often seen as the counterpart to tacit knowledge, the latter an experiential resource that helps inform medical practitioners' decision making and is acquired by junior staff via apprenticeship-style learning (Nicolini et al., 2008).

Interventions based on research evidence aimed at improving patient safety in hospitals through knowledge codification have been propagated e.g. clinical practice checklists (Pronovost et al., 2006) and communication tools to prevent deterioration of patients (Mackintosh et al., 2012). In relation to patient safety in the English NHS, codified systems such as the National Reporting and Learning System (NRLS) are used to facilitate adverse incident reporting, improve the governance of risk, and investigate serious adverse events (National Patient Safety Agency, 2009).

Partly due to the top-down nature of their implementation, such systems have prompted questions about potential unintended effects on clinicians' tacit knowledge use (Nicolini et al., 2011; Waring, 2005). This paper investigates the responses of health care professionals to one form of codified knowledge, use of local practice-based data to improve patient safety within two English NHS hospitals. We analyse two codification initiatives to further

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develop understanding of how tacit and codified knowledge might be combined to support improvement. These initiatives related to, first, codifying aspects of traditionally informal, peer-led Mortality and Morbidity (M&M) meetings to support their governance organisationally and, second, feedback of a medication safety 'scorecard' to ward-based staff to facilitate discussion around local codified data on medication safety risks.

While recognition exists that health care practitioners draw on tacit and codified knowledge, there is no consensus about how these forms of knowledge could be combined to support quality improvement and patient safety. Sociological studies of clinical guideline use often depict tacit and codified knowledge as competing, encouraging the latter to be interpreted as a potential threat to clinicians' exercise of personal judgement (Berg, 1997). Focussing on how medical knowledge is used in practice has helped to challenge top-down approaches to improving patient safety, what Waring (2009) terms 'measure and manage' solutions, e.g. centralised adverse incident reporting systems. Such studies highlight how socio-cultural practices at the micro (front-line service) level shape how clinicians learn and engage with these managerial interventions (Waring, 2005). However, accounts that emphasise how clinicians learn through 'everyday' social practice (i.e. developing tacit skills and know-how through interaction within a clinical community) have not focussed as much on the limits to tacit knowledge and how its mediation by codified knowledge might play a complementary role. Building on a number of sociological studies that analyse the merit of tacit and codified knowledge, and the ways in which the two interact and combine, in relation to patient safety (Flynn, 2002; Iedema et al., 2006), we contribute empirically to this literature by exploring the responses of health care professionals to knowledge codification projects for improving local practices of patient safety.

Next, we describe the theorised complementarity of tacit and codified knowledge in the organisational learning literature, and find a more ambivalent relationship between the two forms of knowledge in studies conducted within health services research that emphasise social practices of learning e.g. emphasising tacit 'mindlines' derived by primary care clinicians from interaction with colleagues relative to use of formal guidelines (Gabbay and Le May, 2011). We analyse the limitations of tacit knowledge in relation to the implementation of quality improvement and revisit knowledge codification as a potential means to overcome this downside to tacit knowledge. We then describe the two patient safety initiatives and discuss the findings relating to attitudes among health care professionals to knowledge codification.

2. Theorising the relationship between tacit and codified knowledge

The distinction between tacit and codified forms of knowledge has attracted attention in the organisational learning literature (Nonaka and Takeuchi, 1995). Although tacit knowledge is often subconscious in nature, making it difficult to articulate or adapt, an individual can assimilate it into their subsidiary awareness by participating in the social systems through which 'skilful action' is practised (Tsoukas, 2003). An example is a medical student learning to detect signs of pulmonary disease in a chest X-ray: what initially appears as an image of 'shadows' and 'spidery blotches' becomes 'a rich panorama of significant details' (Polanyi, 1962, p.101) with training and practice. Being socially situated, tacit knowledge is 'sticky' and difficult to transfer across contexts (Von Hippel, 1994). By contrast, 'knowledge that has been codified into informational messages can be reconstituted at a later time, in a different place, or by a different group of individuals with varying degrees of effectiveness depending upon the "cognitive

framework" of those attempting to use this information' (Cohendet and Steinmueller, 2000, p.197). Understood as a social process, codifying knowledge presupposes different participants agree on the need for codification and possess a common language, rules and capacity for interpreting the code (Cowan et al., 2000).

Both tacit and codified knowledge have been shown to be used in the field of patient safety. The sharing of tacit knowledge among registered nurses, enhanced by trust and mutual understanding, contributed to patient safety by supporting problem-solving, knowledge acquisition, and the detection of medical errors (Chang et al., 2012). Codified knowledge used by health care providers includes scientific research outputs, clinical guidelines and operating manuals (Denis and Lehoux, 2013); electronic libraries, data mining tools, and service-related audit data (Nicolini et al., 2008). Codified patient safety knowledge can also be materially embedded. Mesman (2012) has shown how the physical layout of a neonatology ward, including the presence of an isolation room, automatic doors and regulated air pressure, reflects scientific and technical standards.

In the organisational learning literature, codified and tacit knowledge are often conceptualised as being complementary (Johnson et al., 2002). Since tacit knowledge is required to interpret codified knowledge, and codification mechanisms allow tacit knowledge to move beyond the local scale, innovation may be stimulated by interaction between the two forms of knowledge. According to Nonaka and Takeuchi (1995), organisations innovate via a four-stage cycle: establishing a trusting environment for sharing tacit knowledge (through 'socialisation'); translating this knowledge into explicit concepts ('externalisation'); embedding this knowledge within the organisation's existing knowledge base ('combination'); and making it available across the organisation for learning by other employees ('internalisation').

The complementarity of tacit and codified knowledge identified in studies of organisational learning has not been borne out by evidence from the health services research literature. Part of the argument against their combination comes from claims about the practice-based skills needed to perform medical work, reflecting debate about the extent to which tacit knowledge is codifiable (Cowan et al., 2000; Johnson et al., 2002). Studies conducted within a health services context often treat tacit knowledge as the key resource, whereas codified knowledge is assumed to play a supporting role. At the micro level, Greenhalgh et al. (2008) argue that use of standardised outcome measures in clinical decision-making is underpinned by tacit judgements about patient management. At the organisational level, claims that clinicians share tacit knowledge to learn from medical practice explains resistance from doctors to top-down systems for improving patient safety that rely on managing codified knowledge (Waring, 2005).

While underlining the importance of tacit knowledge for making use of codified systems, these studies draw less attention to the reciprocal role codified knowledge might play in learning by augmenting tacit knowledge use. Relying solely on tacit knowledge to support the implementation of innovation to improve quality has potential drawbacks. Firstly, the durability of tacit knowledge (d'Andrade, 1995) may inhibit path-breaking learning because perceptions are made within existing interpretative schemes (McShane, 1991). At the micro level, little is known about how this downside to tacit knowledge prevents adaptation in decision-making contexts where codified research evidence may conflict with a practitioner's personal experience (Kothari et al., 2012). Secondly, tacit knowledge is socially-embedded, meaning that social and cognitive boundaries often develop around groups possessing different interpretative schemes (Nooteboom, 2008). At the organisational level, these boundaries can undermine the

implementation of innovations requiring the coordination of multiple professional groups (Ferlie et al., 2005).

These contextual factors, which are likely to influence how tacit knowledge is used in health care, suggest a potential role for codified knowledge in helping to facilitate learning at the micro level (among individuals providing front-line care) and organisationally by helping to bridge inter-professional boundaries within hospitals. However, previous studies of the implementation of knowledge codification systems have highlighted limitations of their use, including practitioner 'gaming', narrow assessments of quality, and unduly limiting agency (Denis and Lehoux, 2013). Additionally, the association of patient safety initiatives with 'governance' imperatives (i.e. managerial assurance) rather than learning may discourage clinicians from helping to realise improvement goals (Nicolini et al., 2011). Managerial priorities may also be met through softer or 'post-bureaucratic' means (Iedema et al., 2006). Within the English NHS, Flynn (2002) suggests that 'clinical governance' based on codified clinical standards co-opts doctors into taking responsibility for improving quality and performance management.

One method of addressing potential barriers to implementation is to develop practice-based interventions that acknowledge the existing social dynamics of knowledge formation experienced by the intended recipients (Denis and Lehoux, 2013; Waring, 2009). Interest has grown in delivering quality improvement through 'clinical communities' that combine horizontal collaboration and sharing of 'know-how' with vertical coordination, leadership and resources, although difficulties of aligning different professional interests and norms exist (Aveling et al., 2012). In the multi-professional context of the hospital, a particular challenge is developing forms of codified knowledge to support improvement that resonate with, and can effectively span, different social practices (Nonaka and Von Krogh, 2009). Potential enablers of conversion are 'knowledge brokers' that participate in both professional and managerial communities and use practice-based expertise and legitimacy to externalise the knowledge of one group and combine it with that of others (Waring et al., 2013). Further research is needed to understand how practice-based approaches to quality improvement negotiate the interests of multiple professional groups in processes of codifying knowledge. The aim of this paper is to evaluate the challenges of designing and implementing practice-based codification projects, including how they were influenced by professional interests and managerial priorities, to improve patient safety within two NHS hospitals located in a large English city.

3. Study context and methods

The first study examined the codification of the governance of M&M meetings. Historically, surgeons used M&M meetings to review in-hospital deaths for professional development; they were closed to other professions and hospital management. So construed, M&M meetings represented a locally-organised forum for sharing tacit knowledge, but interest has developed in improving their internal effectiveness (Campbell, 1988), to reduce 'blame' and defensiveness (Orlander et al., 2002), and in utilising meetings to support quality improvement and assurance (Deis et al., 2008). Relating this to the knowledge 'conversion' process (Nonaka and Takeuchi, 1995), interest exists in improving the sharing of tacit knowledge (socialisation) and codifying this knowledge organisationally to support improvement. M&M meetings have not, however, been widely standardised to support quality improvement in the English NHS (Briffa, 2013). The development of a standardised mortality review (SMR) process, led by a group of senior managers and clinicians within one hospital (A), aimed to improve effectiveness by increasing consistency of M&M

review and facilitating reporting to a hospital-wide governance committee, which was introduced during the study.

The second study explored the impact of feedback to health care professionals on aspects of medication safety at ward level. Medication safety is a multiprofessional task involving the prescription (typically doctors), dispensing (pharmacists) and administration (nurses) of drugs. Within the English NHS, strategies to improve knowledge sharing between these professions, e.g. by moving pharmacists from the dispensary onto hospital wards, are used to support learning locally (Turner et al., 2013). At a national level, codified systems (e.g. NRLS) are used to support system-wide learning through adverse incident reporting and investigation (NPSA, 2009). With regard to the knowledge 'conversion' process, incident reporting appears to rely on the 'externalization' of tacit knowledge through clinicians' narration of error (Iedema et al., 2006). However, health care professionals express concern about the lack of feedback after reporting an adverse incident, discouraging engagement with formal systems (Firth-Cozens et al., 2004). Providing feedback on medication risks using a scorecard was recommended by senior staff in hospital A because it aligned with the hospital's 'scorecard culture'. It was taken up by a second hospital (B) because it aligned with their interest in monitoring different aspects of medication safety at ward level. The findings on medication safety are drawn from hospital B because this site included feedback observation, facilitating comparison with the M&M study regarding adoption. Both studies received approval from King's College Hospital NHS research ethics committee (ref 09/H0807/74; 09/H0808/78).

The co-design process in each hospital involved university and hospital-based staff collaborating through a national patient safety and service quality research centre. The project teams represented part of the knowledge 'conversion' process in aiming to develop interventions that would support patient safety by helping to 'externalise' practice-based knowledge for use in organisational interventions. This means that the impetus for the interventions, and resources used in their development and evaluation, cannot be traced solely to the hospitals' 'daily activities' (Nonaka and Takeuchi, 1995). However, our findings add to the knowledge conversion model by underlining the multiple influences on how tacit and codified knowledge are combined at different organisational levels within hospitals (via central and local leadership) and outside (participation in inter-organisational networks; external regulation).

Collaboration helped to implement the interventions in practice, but introduced potential bias because particular professional groups were involved in their early development. We acknowledge that the practice-based interventions were influenced by managerial views on how safety was governed within the hospitals and approaches towards designing interventions that were likely to be acceptable to clinicians and support improvement, as well as the 'bottom–up' views of front-line staff involved in refining and testing the interventions. Interviewees were selected and interviewed by university staff within the project team. As interviewees were aware that the interviewer helped develop the intervention, it is possible that front-line staff were less inclined to problematize the intervention. However, both positive and negative views were expressed during the interviews and observational data were also collected to help mitigate this risk.

The impact of each intervention was studied using a controlled before and after design and reported elsewhere (Higginson et al., 2012; Ramsay et al., 2014). Embedded in each study was an interpretive qualitative study of implementation processes to explore managers' and clinicians' responses to the codification initiatives, the focus of this paper. In the M&M study, the project team co-developed with hospital staff an SMR form for analysing the

causes of death, deriving lessons arising from the patient's care, and assigning actions (online Appendix 1). From January to December 2010, M&M meeting observation and semi-structured interviews were carried out in five care groups in general medicine and a specialist division: three agreed to test the form (one later declined); two were 'control' groups (Table 1). Observational data, recorded as field notes during the meetings, assessed how the form was incorporated into the meetings' format and the reaction of the meetings' members to its use. Interviews, conducted throughout the study, examined interviewees' perceptions of the role of M&M meetings in relation to quality improvement and governance of patient safety.

The medication safety scorecard measured performance against indicators of safety related to medicines storage, administration and prescribing (online Appendix 2). The indicators were selected by a pharmacist at hospital A based on known medication safety risks (NPSA, 2009), and amended in collaboration with hospital B to reflect local priorities. From September to November 2011, feedback sessions and staff interviews were conducted on two wards selected because they administered a high volume of medicines (Table 2). Face-to-face feedback, which lasted approximately 15 min, involved presenting the headline performance against each indicator, comparing this with the previous week's performance, and discussing possible reasons for, and potential solutions to, any issues identified. As staff became familiar with the process, ward-based staff took greater responsibility for leading the feedback sessions relative to the project team's members, and observations focussed increasingly on inter-professional interactions in response to the scorecard data. Notes were made to record observations during the meetings; these were typed up following each meeting and elaborated as the events were recalled. Interviews, conducted at the end of the study, explored participants' perceptions of the feedback process and were structured using a copy of the medication safety scorecard.

The interview transcripts and observation notes from both studies were analysed through 'abduction' in which the emerging findings (qualitative data) are interpreted recursively with 'theoretical sensitivity' in order to develop provisional concepts or theories that explain the research evidence (Timmermans and Tavory, 2012). An initial set of themes (power, organisational learning, attitude to knowledge sharing, clinical culture) for coding the qualitative data was agreed during discussions between three members of the research team (ST, JH, NF), based on a subset of the interview transcripts and key concepts from the knowledge-based and innovation literature (e.g. codified and tacit knowledge distinction). These themes were applied to the remaining transcripts and observational data; sub-themes were specified and adjustments made to the categorisation of data. A theme emerging during this process was differing attitudes toward the sharing of

Table 1
M&M study: meetings observed and interviews conducted.

	General medicine			Specialist		Number
	Test 1	Test 2	Control	Non-test	Control	
Meetings observed	10	6	3	10	1	30
Interviews at local level:						
M&M chairs	1	1	1	1	1	5
Consultants	2	1	1	1	1	6
Doctors in training	2	1	1	1	1	6
Nursing staff	2	2	1	1	1	7
Interviews at divisional level	4			4		8
Interviews at senior executive level	8					8
Total						40

Table 2
Medication safety study: feedback sessions observed and interviews per ward.

	Elderly care ward (A)	General medicine ward (B)	Total
Feedback observations	Medical ward round (2) Nursing staff handover (2) MDT meeting (2)	Medical ward round (2) Nursing staff handover (7) Postgraduate education meeting (1)	18
Interviews	Pharmacy meeting (1) Medical consultant (2) Deputy ward manager (1) Junior doctor (1)	Pharmacy meeting (1) Medical consultant (1) Senior staff nurse (2) Staff nurse (1) Ward manager (1) Junior doctor (1)	10

codified knowledge at the micro and organisational level. Contextual factors that might explain variation in acceptability, including intervention type and professional community, were discussed, incorporated into the analysis, and any differences in interpretation resolved through debate.

4. Results

Four themes emerged through the qualitative analysis. Firstly, professional attitudes to codifying knowledge were not universal (e.g. characterised by resistance) but differed according to the context in which each intervention was applied. Secondly, variation in perceptions of health care professionals was due partly to the interventions embodying different professional interests, influencing how they were received by clinical staff. Thirdly, inter-professional boundaries and power asymmetries between doctors, nurses and other professionals were not only a barrier to sharing tacit knowledge in current practice: they also shaped processes of knowledge codification. Finally, tacit and codified knowledge complemented one another with regard to learning from M&M cases and medication safety, but codification had limited impact on existing professional boundaries associated with tacit knowledge use, rather these boundaries were often reproduced in the codification process.

5. Attitudes toward codifying knowledge to improve patient safety

In the M&M study, responses to codifying the content of these meetings differed between general medicine and the specialist units involved. Some doctors in the specialist group that declined to participate expressed concern that information shared during M&M meetings might be used for purposes other than learning (e.g. medico-legal analysis) which could undermine the open discussion of cases sought in M&M meetings, as a senior doctor explained:

'*how one discusses things is very different from how one would approach things from a medical legal aspect, and if there are implications on the medical legal side then people might tend to withhold or take up discussions within M&M and I think some people feel very defensive about that*'.

For some doctors within this unit, one consequence of codifying data from M&M meetings would be release of previously confidential information and opinion for legal analysis in other parts of the hospital or beyond, raising fear of blame and litigation. Situating M&M meetings within the hospital's formal governance structure was perceived to be driven not only by quality improvement, but also locating blame to meet a different agenda of risk

assurance, to which a senior doctor referred: '*there is a punitive element to governance here that is not all that helpful*'. This aspect of governance was also described by the division's manager in relation to hospital-acquired infections, who stated that '*the chief executive is personally seeing every consultant who has one [MRSA case], and if there is evidence of failure of care … I think that punitive action will be taken*'. The association of the SMR form, and its '*punitive element*', with governance processes meant that formalisation of the M&M meetings was interpreted as a threat to the meeting's original purpose of peer-led learning from M&M cases. As the meeting's chair argued, keeping a formal record of meetings could compromise patient anonymity and '*restrict the discussion*'.

In general medicine, M&M meetings were recently introduced into the hospital's governance structure and were not an established part of physicians' clinical practice. This allowed the meetings to become a governance tool more aligned with managerial priorities. Recognition of limitations of peer-led review was part of the rationale for formalising the meetings. For senior executives, knowledge codification offered a means to break the perceived association of tacit knowledge use with the operation of self-governing professional groups, by ensuring that possible contributory factors in an unexpected death were not '*swept under the carpet*' (Executive director). This interviewee stated that having a standardised review process would help relatives to feel '*very reassured that there is a transparent process*' following a patient death and that demonstrating this was important were a complaint to proceed to litigation. While the embedding of 'governance' processes within this division gave managers greater latitude to attend and influence M&M meetings, our observations suggested some resentment among clinicians e.g. a manager attending one care group's M&M meetings had negotiated during a separate governance meeting (that included the meeting's chair) to start entering data from the SMR form onto a database, stimulating the following exchange at the next M&M meeting:

> At the end of the meeting [the manager] asked for the chair to hand over paper copies [of the SMR form]. I'm not sure how deliberate this was but he seemed reluctant and didn't just give her the whole pile. She insisted though and he finally handed them over. A little tension there because the chair has voiced concern about having managers at the meeting (field notes).

In the medication safety project, while scorecard data were seemingly valued by front-line staff, fitting feedback into the busy context of the ward was challenging. Feedback was appreciated by some doctors who reported a lack of awareness of making prescribing errors: '*no-one actually comes back and tells us we're not doing as well as we thought*' (Junior doctor, ward A). Establishing space for reflection was difficult because some clinicians remained preoccupied with events on the ward: '*The culture of the ward round wasn't very responsive … I was engaged in the conversation, and found it quite enjoyable, but I looked over at [another medical consultant] and I know [s/he] was keen to get back out there*' (Medical consultant, ward A). Several feedback sessions on the elderly care ward were cancelled due to competing time pressures, '*you can't give feedback to nurses today because it eats into MDM [multidisciplinary meeting] time*' (Nurse, ward B). Some consultants regarded medication safety as a basic skill less deserving of precious teaching time: '*It's not something that's high on my agenda of things that I'm actively teaching. That doesn't mean that I don't think it's important*' (Medical consultant, ward B).

The concept, held by some senior medical staff, that medication safety was a rudimentary task influenced others' perceptions. Doctors and nurses were easily distracted during the feedback sessions because the topic, while of interest to pharmacists who co-developed the scorecard, often failed to maintain other professions' attention. This is a point of difference with the M&M study which mapped onto a more established aspect of clinical practice, one in which doctors already engaged in peer-led discussion of perceived failings in care, suggesting that clinicians' responses were not only a product of how the codification process altered knowledge use, but also their professional interest in the clinical domain targeted by the intervention, and involvement in its co-development. As noted earlier, however, the extant interest of clinicians in discussing M&M cases locally also prompted some concerns about external intervention.

6. The codification process reflects different professional interests

Rather than being driven solely by the intended recipients, the codification projects reflected different professional interests influencing clinical engagement. This may explain the indifference of some doctors and nurses toward the scorecard data as the measures of medication safety used were shaped by pharmacists within the hospitals. Although the measures were discussed with ward-based representatives of other professions, the proposed design tended to be 'rubber stamped' rather than critically scrutinised.

Differences in the priority given to medication safety were illustrated during one feedback session. One scorecard measure assessed whether medicines were prescribed generically, rather than by brand names. Generic drug names usually indicate the drug's pharmacology, facilitating safety considerations, e.g. drug interactions, and UK hospitals have long purchased generically (with some exceptions), to manage drug costs. A nurse was unsure why generic prescribing was usually preferable. The pharmacist leading the feedback explained the reasons linked to pharmacology and safety, adding that generic prescribing could save the hospital money. The cost advantage struck a chord with the nurse who responded with '*you should use that to sell to people*'; she would '*spread the word*'. The language of cost saving was understood more readily than that of medication safety. Conversely, the nurse and pharmacist shared an insufficient background of tacit knowledge (linked to differences in professional training and recognised competencies) to share a 'pharmaceutical' interpretation of the codified data. This example also highlights that competing interpretations of the scorecard data existed and that, from the pharmacists' perspective, encouraging other professional groups to focus on medication safety involved appealing to patient safety and other factors (e.g. reducing costs).

In the M&M study, the intervention involved adapting an established education forum used by surgeons and was led predominantly by clinicians with additional governance and risk roles. The introduction of a standardised approach to meetings, and its extension to other clinical areas, capitalised on a concurrent drive to improve monitoring of mortality across the hospital, in response to national policy developments following the initial investigation into Mid Staffordshire NHS Trust's high mortality rate (Healthcare Commission, 2009). Some senior executives emphasised the importance of making mortality data available higher up the organisation to give assurance that deaths were being monitored and lessons learnt where necessary, '*it's in the interest of the [hospital] in terms of litigation to have a clear process of management of an unexpected death*' (Executive director).

The reference to litigation substantiates concerns among doctors that attempts to codify the verbal exchanges from the meetings could be used to apportion blame for an unexpected death (contrasting with the executive director's concern that contributory factors may be '*swept under the carpet*'). For another group of

doctors that combined managerial and clinical roles, a clear distinction between their interests was less apparent. One doctor in such a role recognised that systematic data collection could support organisational learning: '*it's also important to have structure within that [meeting] so that you have ways of tracking subgroups of patients that have got things that have gone wrong*' (Consultant surgeon & Trust clinical governance lead).

These dual interests, of providing managerial assurance and monitoring safety to support improvement, were encoded in the form's design: this allowed contributory factors in M&M cases to be catalogued, including delays in diagnosis or procedure, drug errors, and communication and resource issues. The issues identified could be communicated to other groups within the hospital, including the risk office and governance committees, meaning the review process could include both non-local and non-clinical actors (the form asks clinicians to code contributory factors as 'green', 'amber' or 'red' in line with the hospital's formal risk assessment procedure).

In summary, while the shaping of the medication safety project by pharmacists created a tendency for the performance data to be marginalised by other professions, in the M&M study some doctors were concerned that codified knowledge might be reinterpreted by managers beyond the local context.

7. Professional boundaries as a barrier to codified knowledge use

Social relations within and between the professions involved aspects of power and hierarchy which shaped knowledge codification. In the M&M study, power asymmetries existed within the medical profession, and in their relations with other professional groups, meaning that a limited number of voices tended to dominate. In general medicine, the domination of the meetings by medical consultants was visible in a physical division between consultants who occupied the front of the room and other participants who sat at the back (Registrar, general medicine test 1). This doctor also described the chair's style of running the meeting as '*dictatorial*'. In the specialist control unit, although a cross-section of staff was represented at M&M meetings, doctors led the discussion and nursing staff could feel '*intimidated*', as a matron told us: '*certainly when we bring certain staff, they just sit there, although they find it really good, but they're not going to participate or challenge any decision, or ask any questions*'. Nursing staff felt that standardising the process for reviewing deaths aimed to make it easier for other professions to contribute to the discussion, but in practice their involvement smacked of tokenism:

'*There was no input to say, well what do the nursing staff think what happened about the death, what does the therapist think in terms of the death? So there was no input from us, although we were present at the meeting*' (Matron, general medicine test 1).

In the medication safety project, similar power dynamics were identified. During feedback to doctors on ward A, one of the medical consultants directed questions at the junior doctors, probing their knowledge of prescribing and asking how confident they felt about medication safety, based on their undergraduate teaching. It was a one-way discussion, from consultant to junior doctor, with the juniors responding briefly to the questions, but raising few themselves. In terms of inter-professional relations, scorecard feedback was provided separately to nurses and doctors, but the nursing staff soon requested joint feedback sessions on the grounds that prescribers affected some measures of 'nursing' performance (we were told during this feedback session that the potential for omitting doses of medicines grew when doctors did not inform

nurses verbally about a change in patients' prescriptions). Subsequently, feedback was provided to both groups at the start of multidisciplinary meetings. The medical consultants remained vocal, but the nurses were quieter: the former group asked the latter to account for why doctors' decisions had not been actioned (i.e. regarding omissions), but little challenge came in response from nursing staff, regarding the concerns they had voiced separately. The scorecard appeared to aid collaboration more readily between nursing and pharmacy staff. During the 'scorecard' feedback sessions, it was not clear whether responsibility for aspects of medicines storage lay with pharmacists or the nursing staff. On recognising the problem of ownership, one pharmacist (ward B) said: '*if we make more effort, they might do the same*'. Stimulated by the feedback of local data, the ward manager stated that the nursing staff was being more proactive.

8. Re-evaluating the relationship between tacit and codified knowledge in patient safety interventions

Rather than support a view of tacit and codified knowledge as 'competing', our findings highlighted that the relationship between the two forms of knowledge differed according to the context of intervention. In the medication safety project, tacit and codified knowledge were complementary, as clinicians used experiential knowledge to interpret the scorecard data. Codified knowledge was critical, however, in prompting the discussions through which tacit knowledge was shared. Firstly, doctors on both intervention wards asked for practical examples to contextualise the codified data e.g. prescriptions that were unsigned or drugs inappropriately prescribed by brand. Secondly, in response to examples from the scorecard, anecdotes were often told by senior medical staff to communicate past experiences of error that had contributed to patient harm in similar circumstances. Thirdly, the nursing staff in particular asked questions about the validity of the performance measures, using experiential knowledge of confounding cases from the ward to show that the putative score might be inappropriate or unjust e.g. consecutive dose omissions due to a drug not being available were attributed to pharmacy sometimes being slow to replenish drug stock.

In the M&M study, some clinicians were wary of codifying knowledge because it allowed sensitive information to travel upwards in the organisation raising concerns about its reinterpretation. However, our observations of M&M meetings prior to the intervention being introduced highlighted potential deficiencies with their more 'informal' practice: a lack of planning sometimes meant cases were reviewed hastily (in one meeting 42 cases were presented within an hour '*with very sparse discussion of any of them*' (field notes)); the discussion could range from '*dictatorial*' through to '*very woolly*' (Governance manager, general medicine); and action points arising from case reviews were not always assigned or formally recorded (in one case that '*there were not enough beds*' to transfer a patient to the intensive therapy unit was discussed but no action was recorded (field notes)). Conversely, following pre-agreed steps for reviewing M&M cases may encourage a more open culture by making '*everybody comfortable with the notion of standing there and airing their dirty laundry*' (Medical consultant, general medicine control). Having a standardised process was deemed important for larger groups '*who don't work closely together on a daily basis*', compared with smaller groups that have built up trust and were more prepared to '*constructively criticise*' (Medical consultant, general medicine test 1). Use of codified knowledge may compensate for the lack of shared experience otherwise acquired by closely-knit groups through everyday interaction. Equally, aspects of the meetings' situated practice were not captured by the SMR process, including catharsis derived from discussing a long

stay patient to whom one of the specialist teams had become emotionally attached or the number and type of actors involved in completing the SMR form, which could be done personally by the meeting's chair or produced more collectively (field notes).

9. Discussion

Our study suggests that, at the micro level, codification of local practice-based data can support professional learning in relation to patient safety and therefore complements use of tacit knowledge. First, codification helped to broker discussions about patient safety issues. In the medication safety project, one of the benefits of the intervention lay in establishing a time for reflection: presentation of scorecard data was critical for stimulating and focussing the discussion. Second, codified knowledge appeared to increase the potential for learning by structuring tacit knowledge practices. In the M&M study, by adding focus and structure, formalising case presentation, and establishing a link to action, codification helped to steer interactions within the meetings toward learning and changing practice. Third, codification highlighted differences in understanding across professional groups. The potential role of codified knowledge in stimulating and structuring interactions adds to previous work on knowledge use in medical decision-making that emphasises the tacit component (Gabbay and Le May, 2011) or that assumes clinical resistance to codified systems without considering the organisational dynamics associated with their use (Denis and Lehoux, 2013).

Despite demonstrating these benefits, organisational barriers to the implementation of the codification initiatives existed. Supporting earlier work on organisational approaches to patient safety (Nicolini et al., 2011), we found that the translation of learning through everyday clinical practice into wider 'governance' or quality improvement initiatives was resisted by some health care professionals. Where clinicians resisted the interventions, this appeared to be due more to the consequences of sharing knowledge with actors beyond the local context (as illustrated by some reactions to the M&M intervention), rather than a perception that codified knowledge could add little to tacit knowledge. Different challenges are involved in codifying knowledge to support quality improvement at the group and organisational level. At the group level, participants appeared to judge the codification initiatives by the relevance of the knowledge produced for improving local clinical practice, while the structuring of social practice helped to reveal differences in professional interests (medication safety) and participation (M&M meetings). At the organisational level, some clinicians were concerned about the 'combination' of knowledge produced at a local level (the third step in Nonaka & Takeuchi's model) with other forms of organisational knowledge, notably risk management systems and the potential for 'punitive' action to arise from sharing knowledge.

The stubbornness of the professional boundaries identified in this study has implications for designing practice-based patient safety interventions. First, it highlights the difficulty of adapting existing clinical routines due to health care professionals needing to 'unlearn' (Hedberg, 1981) the tacit knowledge invested in current practice. The implementation of change we observed appeared to be stronger where learning routines led by doctors were less established e.g. where M&M meetings had a shorter history and, for the medication safety study, in feedback sessions that were held outside established multidisciplinary meetings. Read another way, organisational spaces not 'sedimented' with existing conventions (Cooper et al., 1996) may be easier to align with new practices of learning, whether those stem from specific professional interests or managerial attempts to connect with professional practice through

alternative 'post-bureaucratic' means (Iedema et al., 2006). Second, it illustrates the difficulty of encapsulating practice-based forms of learning within an intervention's design, no matter how laudable this aim might be relative to top—down approaches that may neglect the social and material context of medical work. This context is enacted differently by different professional groups based on the collective safety norms to which each group adheres (Turner et al., 2013).

The presence of these multiple interests leads us to question the virtue of relying on professional communities to enhance patient safety, as this presupposes that the competing goals of such heterogeneous groups are heard and can be reconciled. Challenges identified in this study with aligning professional interests may stem from a weak 'vertical integrating core' (Aveling et al., 2012) for coordinating the professional groups to support quality improvement. To strengthen the vertical coordination of professional communities, central and local leadership are both likely to be important. At a local level, improving inter-professional trust, e.g. by encouraging informal sociality and brokering interactions concerning different communities' priorities for improving patient safety, may help to build the social capital needed to share tacit knowledge (Chang et al., 2012). In this regard, middle managers acting as 'knowledge brokers' may help to connect different forms of practice-based knowledge by developing know-how and legitimacy in relation to multiple organisational communities (Waring et al., 2013). However, this study shows that local knowledge processes are also shaped by the wider organisational context in which quality improvement initiatives take place. In the M&M study, some clinical resistance was identified where codification offered the means for knowledge to move from the group to the organisational level generating concerns about its reuse for risk management.

In conclusion, codifying practice-based knowledge represents a promising approach for stimulating interaction, and engendering recognition of professional differences, concerning patient safety at a local level. In order to aid use of such knowledge organisationally, this study suggests that approaches to 'learning' in practice and 'governance' of practice need to be aligned at the wider organisational level, implying a strategic role for central hospital leadership. Future research could investigate which organisational factors support the translation of practice-based knowledge from a local to organisational level e.g. hospital leaders communicating an overarching 'knowledge vision' (Nonaka and Takeuchi, 1995) in relation to quality domains such as patient safety and, in turn, how interactions between central and local leadership influence organisational knowledge processes.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.socscimed.2014.05.031.

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