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THE NONSPREAD OF INNOVATIONS: THE MEDIATING ROLE OF PROFESSIONALS

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Two qualitative studies in the U.K. health care sector trace eight purposefully selected innovations. Complex, contested, and nonlinear innovation careers emerged. Developing the nonlinear perspective on innovation spread further, we theorize that multiprofessionalization shapes "nonspread." Social and cognitive boundaries between different professions retard spread, as individual professionals operate within unidisciplinary communities of practice. This new theory helps explain barriers to the spread of innovation in multiprofessional organizations in both health care and other settings.

> I think all the evidence about innovation in general practice points to the fact that rarely, very rarely, does a single method change people's behaviour.
>
> Primary care doctor interviewed for this study

Why do innovations not readily spread, even if backed by strong evidence? The study of the spread of innovations is an enduring focus of interest. More recent studies in the research literature have developed from earlier linear and stagelike models (Rogers, 1995) to offer fluid and interactive approaches (Van de Ven, Polley, Garud, & Venkataraman, 1999). We here report evidence that adds to Van de Ven and colleagues' model of "messy" pathways: specifically, we argue that strong boundaries between professional groups at the micro level of practice slow innovation spread. We develop an alternative theory of the impact of high professionalization that contrasts with the conventional theory in which high professionalization is seen as enhancing innovation spread. Proponents of that latter theory assumed innovations would diffuse rapidly through uniprofessional networks or professional associations (Coleman, Katz, & Merzel, 1966; Robertson, Swan, & Newell, 1996). However, complex organizations contain many different professional groups, each of which may operate in a distinct community of practice. These conditions retard spread, given strong social and cognitive boundaries between local professionals and professional groups. This new theory of the retarding impact of conditions of multiprofessionalization on the spread of innovations is useful in other settings, such as global organizations, in which there is a wish to share innovations across disciplines.

This article reports our analytic journey from our initial research design, through iterative analysis, to final theory building. In the next section, we describe our theoretical framework at the start of the research; then we outline our research design and methods. In the third section, we provide an overview of our initial results, and then in section four explain our reanalysis of data to search for more refined explanations. In the final section, we induce theory and discuss wider implications.

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THEORETICAL FRAMEWORK

The Presenting Problem: Evidence-Based Innovations in Health Care

The spread of innovations reemerged as an important theme within the health care sector with

the rise of the evidence-based medicine movement, according to which clinical practice should be based on rigorous evidence rather than on clinical opinion.[1] This premise implies a need for innovations to realign existing clinical practice with evidence. The evidence-based medicine movement is evident in a number of health care systems, including those of America and Canada, and it is a policy focus in the U.K. National Health Service (NHS), whose policy makers and managers wish to understand more about the diffusion of evidence-based innovations. The initial research focus proposed for us by our research commissioners, the NHS Research and Development Directorate, was, *Are evidence-based innovations readily diffusing across health care organizations? If not, why not?*

Research Precedents

In designing empirical studies to address these questions, we drew on various ideas and research streams. The following paragraphs summarize them.

The implementation of change in professionalized organizations. The literature on organizational change is immense, but some prior work has focused specifically on change in professionalized organizations. These organizations have been described as "negotiated orders" (Weick, 1979) in which ambiguous professional work is "enacted" in local groups. Prior research has established distinctive features of change in the health care sector. (McNulty & Ferlie, 2002; Pettigrew, Ferlie, & McKee 1992). Professionals have the power to block change in this sector, so they must be engaged in a change process for it to succeed. A second distinctive characteristic of the health care sector is collective rather than individual leadership in change (Denis, Langley, & Cazale, 1996; Pettigrew et al, 1992). The distinct features noted in prior research led us to question rationalistic and managerialist perspectives on evidence-based medicine implementation in highly professionalized health care organizations.

[1] Over about the last 20 years, efforts to ensure that clinical practice is based on "good science" rather than on personal opinion have been salient. One such effort is the rapid growth of randomized control trials (RCTs), in which patients are randomly allocated to experimental and control groups. RCTs thus provide very strong scientific evidence as to whether an intervention is clinically effective or not across a cohort of patients. The Cochrane Collaboration, named after a pioneering author in the field, has promoted these ideas and techniques internationally.

Postlinear models of diffusion. In a classic work, Rogers (1995: 163) identified five stages of innovation: knowledge, persuasion, decision, implementation, and confirmation. These stages are pictorially represented as a linear flow. More recent management research has moved away from this stage-like perspective. Van de Ven and coauthors's (1999) study of the careers of innovations (including some in health care) stressed their messy, dynamic, and fluid quality. The innovation journey was not sequential or orderly, but nonlinear and disorderly. Innovation processes were ambiguous and took place in multiple and fluid arenas. There was no one single decision point but numerous decision events performed by many people over time: "The process does not unfold in a simple linear sequence of stages and substages. Instead, it proliferates into complex bundles of innovation ideas, and divergent activities by different organizational units" (Van de Ven et al., 1999: 10). We were interested in using such ideas to explore our own research problem.

The sufficiency of robust evidence. Is a strong scientific base enough to change behavior? The policy domain initially neglected the question of the implementation of evidence-based medicine in favor of concern with the production of high-quality evidence. Some Canadian evidence-based medicine literature suggests implementation is highly complex (e.g., Lomas, 1993), endorses postlinear models of diffusion, and advocates including a marketing component in implementation efforts.

Research on science policy also contains arguments that science "push" needs to be complemented by other forces before it is strong enough to effect behavioral change. Williams and Gibson (1990) outlined a sequence of four models of the diffusion of scientific knowledge that display an increasing concern for social as well as scientific factors. The fourth model—the *communication and feedback model*—includes a feedback loop from users, a recognition that users' interpretations of evidence affect outcomes. Actor network theory (Callon, Paredo, Rabeharisoa, Gonadr, & Leray, 1992; Latour, 1987) stresses the support building or so-called *translational and enrollment strategies* performed by scientists as critical to the spread of new scientific knowledge. Persuasion from product "sponsors," coalition building across groupings, and local reinterpretation are all important in successful spread, according to this network theory.

Focal and complex innovations. Some evidence-based medicine innovations are focused, highly bounded, and at a micro level: for example, persuading clinicians to offer a new drug or treatment has these characteristics. Other complex innova-

tions may involve (1) an interrelated set of changes and (2) corporate implications. An example is an organizational intervention (such as "business process reengineering") that mixes technical components (new information technology systems) and social components (a change management strategy). It might be thought that complex innovations face greater barriers to their spread than focused ones.

METHODS

Overall Principles of Design

We developed the theme as defined by the NHS commissioners into the following lead research questions as we went into the field: (1) Are innovation pathways in health care linear or messy? (2) Is robust scientific evidence sufficient to lead to successful diffusion? (3) What impact does greater innovation complexity have?

These questions guided further design of our enquiry. We adopted a looser design than a precise hypothesis-testing one, but we did not adopt a "grounded theory" strategy. Pure induction was balanced against early structure (Langley, 1999) to avoid the peril of "drowning in data." Our final research protocol outlined an explicit sampling strategy of comparative cases. This framework guided us in the field, but in retrospect we own that it did not adequately sensitize us to the role of professionals. We return to this gap later.

We used a qualitative approach, specifically, constructing eight comparative and longitudinal case studies of innovation careers. Interpretive methods are adapted to the description, interpretation, and explanation of a phenomenon (Lee, 1999), rather than to estimation of its prevalence. They address questions of *process* well; the input-output model of much quantitative research, on the other hand, is not well suited to addressing questions of process. Qualitative research contains many variants, but our stance was that of process researchers. Process research is the dynamic study of behavior within organizations, focusing on organizational context, activity, and actions that unfold over time (Pettigrew, 1997). The study of the variation in change outcomes is here explicit: Why did *this* innovation spread more rapidly and *that* one more slowly? Such research is field based, involving interviews with—and observation of—various stakeholders (not just senior management). While process research can be quantitative (Scott Poole, Van de Ven, Dooley, & Holmes, 2000), we used the narrative strategy of qualitative process research (Langley, 1999), constructing a story from data. These narratives should produce not only chronology, but also concepts, understanding, and theory closely linked to data (Golden-Biddle & Locke, 1997).

Case study research is strong on *internal validity* (within-case data are strong and "truthful") but weak on *external validity* (the ability to generalize outside the cases is poor). Our funding enabled us to conduct the research in two ways that increase the external validity of case study efforts: a team of researchers conducted the studies, and multiple cases were investigated. Methodologists have considered how patterning, or middle-range theory, can be established across cases. Eisenhardt (1989a) suggested theoretically driven sampling facilitates comparison and theory building. Within such designs, how can one reduce the data into a manageable length? Eisenhardt (1989b) reduced primary data from her cases through cross-case summary tables. Another strategy is to produce "rich" primary data from a subset of critical cases—polar opposites, outliers, or exemplary cases—so that conclusions drawn evidently link back to data (Langley, 2001). We mixed these strategies here, compiling tabular information for all cases as well as case vignettes to add vividness, and exploring critical cases in depth.

Purposeful Case Selection

We constructed a two-by-two cell design to explore effects of stronger/weaker scientific evidence and the degree of innovation complexity on spread pathways: "The goal of theoretical sampling is to choose cases which are likely to replicate or extend existing theory" (Eisenhardt, 1989a: 537). We undertook theoretical rather than random sampling, choosing a pair of innovations in all four cells, giving us a total of eight cases. Yin (1994) warned against using a random sampling logic as one would in a social survey. Instead, multiple case studies should be based on replication designs in which each case serves a specific purpose. Each case should be selected to see whether it produces the same results for predictable reasons (a literal replication) or contrasting results for predictable reasons (a theoretical replication). In our studies, the within-cell comparisons represent literal replication, and the cross-cell comparisons represent theoretical replication. If the predicted outcomes do not occur, modification should be made to the original theory.

Case Study Selection

We conducted two studies; the first was in acute care settings, and the second, a replication, was

within primary care settings. The criteria for innovation selection were identical for both studies: two innovations with strong scientific evidence supporting their medical value and two with more contestable evidence were examined in each study. This uniformity addressed the question of whether robust science by itself leads to successful diffusion. We judged evidence for the medical value of an innovation to be strong on the basis of results from randomized control trials (RCTs) and advice from clinical specialists acting as external advisors. For the second dimension of concern, innovation complexity, we calculated the number of organizations and occupational groups involved in implementation of an innovation. Thus, innovations were selected according to whether they involved only one organization or occupational group or several.

The design of each case was a two-stage one, and the research was carried out between 1996 and 1999. In the first stage, factors affecting the career of the selected innovation across an NHS region (in the acute study) or in a local health authority (in the primary care study)[2] were assessed, through interviews with opinion leaders in three key professional groups: clinicians in public health, nursing, and physiotherapy. Initially, NHS contacts supplied names in response to our request for respondents from different occupational groups, and we added further names through "snowballing." This stage assessed each change outcome within a geographical patch. For this stage of the research, in the acute study a total of 71 interviews were completed, while in the primary care study there was a total of 73 interviews. This work produced a set of eight macro cases.

In the second stage of the research, we undertook a micro analysis within a live clinical setting to produce our micro case studies. The micro sites included four different hospital settings in the acute care study and four different health centers in the primary care study. This stage included interviews with doctors, nurses, and allied health professionals. Secondary data collected here included minutes of meetings, guidelines, and reports and other papers not found in the formal, peer-reviewed academic literature. We also drew on informal observation. For this stage, 48 more interviews were completed in the acute study, and 40 more were completed in the primary study. This work produced eight micro cases linked to the macro cases. Different informants were selected for the macro and micro stages. Table 1 shows the numbers of informants who provided information on each innovation in each study.

In total, we undertook 232 interviews and produced eight comparative case studies. The interviews were semistructured "pro formas" administered by the site lead researcher, each with a standard core to facilitate comparative analysis as well as an innovation-specific section. The questions gathered material on the career of the innovation, traced decision-making processes, and established the influence of different factors on diffusion. The interviews lasted between 1 and 2 hours and were taped, transcribed, and subjected to content analysis against the core questions in the pro forma. In this analysis we classified the verbatim text into categories suggested by the pro forma questions, although further coding was not undertaken as we were using narrative process research. We then produced single case studies with common formats as an intermediate output. This article provides the results of a thematic analysis conducted across the two studies. Readers may consult our earlier articles (FitzGerald, Ferlie, Wood, & Hawkins, 1999, 2002; FitzGerald, Ferlie, & Hawkins, 2003; Ferlie, Wood, & FitzGerald, 1999; Ferlie, FitzGerald, & Wood, 2000) for an "audit trail." Table 2 outlines the rationale for case study selection and indicates how we built the sample.

Innovations Examined in the Acute Care Study

As described above, the acute sector study, examining the nationwide careers of four innovations, was conducted in hospitals. The four innovations were the use of low-molecular-weight heparin (LMWH) following elective orthopedic surgery, the use of laparoscopic surgery for inguinal hernia repair, the introduction of a new computer-supported system to manage anticoagulation service provision, and the introduction of a new service delivery system for the care of women in childbirth. The following accounts of these innovations are introduced by abbreviations that include "AC," for "acute care," and a key descriptor for the particular innovation.

AC heparin. The use of low-molecular-weight heparin as a drug for antithrombolytic prophylaxis following elective orthopedic surgery was the first innovation. Older people in particular require planned operations to restore functioning to hips and knees. The danger of deep vein thromboses

[2] Acute care innovations were studied nationally, and primary care ones, locally, because innovations that diffuse from one large hospital to another are likely to move across large geographical areas, whereas the diffusion path of innovations in local primary care services is likely to be neighboring primary care practices.

TABLE 1
Numbers of Interviews

Study and Innovation	Macro Case	Micro Case	Total
Acute care			
Low-molecular-weight heparin after orthopedic surgery	17	10	27
Laparoscopic inguinal hernia repair	17	11	28
Managing anticoagulation service provision with a computer support system	19	9	28
Defining risk in pregnancy and childbirth	18	18	36
Acute care total	71	48	119
Primary care			
Aspirin for prevention of secondary cardiac incidents	16	12	28
Hormone replacement therapy for prevention of osteoporosis	17	13	30
Treatment of diabetes following the St. Vincent Declaration	20	4	24
Direct employment of physiotherapists in general practices	20	11	31
Primary care total	73	40	113
Grand total	144	88	232

(blood clots) that can lead to a fatal clot in the lungs accompanies such surgeries. Anticoagulation treatment using LMW heparin has been supported within vascular surgery as a safe way of preventing deep vein thromboses, and our advisors judged this innovation as having a strong tradition of randomized clinical trials. Excessive anticoagulation can result in uncontrolled bleeding and infected hip and knee joints; these are seen as major risks by orthopedic surgeons, who are the key professional group involved in the potential use of this innovation.

AC hernia. The very common inguinal hernia, in which organs of the stomach extrude through the abdominal lining, has traditionally been repaired with a radical surgery, a laparotomy, involving a ten-centimeter incision. Standard repairs can have poor results, especially in the hands of interns. From the late 1980s, less invasive laparoscopic ("closed" or "keyhole") surgical techniques have been used for inguinal hernia repairs. At the time of our data collection, evidence for the value of the use of laparoscopic surgery for inguinal hernia repair was still developing, and few RCTs had been conducted. Surgeons are the key professional group involved in the potential use of this innovation.

AC anticoagulation for stroke prevention. The introduction of a new computer-supported system to manage the delivery of oral anticoagulants to potential stroke victims was the third acute care innovation studied. A common cause of death in the United Kingdom for which people with high blood pressure are at risk, stroke can be prevented by oral anticoagulants, drugs that prevent blood clots. There is a strong evidence base to support such treatments. Presently, therapy is delivered through pressed hospital clinics run by interns, who often do not provide expert service. Technological advances in testing suggest that this service could be devolved to primary care, where it would be led by a senior nurse rather than by a doctor and supported by a diagnostic computer program. Patients, who can be monitored in local and user-friendly settings when this innovation is adopted, have welcomed it.

AC birth. There has been a national policy debate and initiative on the care of women during childbirth, with political as well as scientific criteria prominent. A new service delivery system for the care of women in childbirth was outlined in the report *Changing Childbirth* (Department of Health, 1993). This system gives more informed choices to women and provides various options. Controversy about the extent to which childbirth should be medicalized stems from the view that it is not an illness, but a natural condition. Midwives and some active pressure groups have resisted extensive medicalization. Against this, obstetricians

TABLE 2
The Original Matrix: Case Study Selection[a]

Stakeholders	Stronger Scientific Evidence	Weaker Scientific Evidence
One focal stakeholder	Case 1, Acute: Low-molecular-weight heparin after orthopedic surgery	Case 2, Acute: Laparoscopic inguinal hernia repair
	Case 3, Primary: Aspirin for prevention of secondary cardiac incidents	Case 4, Primary: Hormone replacement therapy for prevention of osteoporosis
Range of stakeholders	Case 5, Acute: Managing anticoagulation service provision with a computer support system	Case 6, Acute: Defining risk in pregnancy and childbirth
	Case 7, Primary: Treatment of diabetes following the St. Vincent Declaration	Case 8, Primary: Direct employment of physiotherapists in practices in general practices

[a] The case numbers were assigned for the overarching research effort. As they are not needed in the current presentation, they are subsequently omitted.

have argued that the safety of the mother and child should be paramount. *Changing Childbirth* extends choices, especially for low-risk women; specifies quality criteria, such as continuity of care; and sets targets. The question of who decides which women are low and high risk—and how they decide—is critical to the potential use of this innovation.

Innovations Examined in the Primary Care Study

The primary care sector study, examining the local careers of four different innovations, was conducted in health centers. The four innovations were the use of aspirin for the prevention of secondary cardiac incidents, the use of hormone replacement therapy (HRT) for the prevention of osteoporosis, treatment of diabetes in primary care, and the employment of physiotherapists in primary care. The following accounts of these innovations are introduced by abbreviations that include "PC," for "primary care," and a key descriptor for the particular innovation.

PC aspirin. There is strong RCT evidence that aspirin is effective for the prevention of secondary cardiac incidents and that such prevention is applicable to large groups of patients in primary care. Such locally based services also suit many patients. We originally saw this as a unidisciplinary intervention involving mainly primary care doctors, but in the field the role of nurses became more apparent.

PC HRT. Hormone replacement therapy has long been available for the alleviation of menopausal symptoms, and some claim that it can prevent osteoporosis (brittle bones, which are liable to fracture). There is a controversy about whether evidence supports this position and about whether HRT raises women's risk of disease, including breast cancer. When selecting this innovation, we saw it as involving only primary care doctors, but in the field the role of nurses became apparent.

PC diabetes. Diabetes affects between 2 and 5 percent of the U.K. population, can produce long-term complications, and accounts for between 8 and 9 percent of the NHS budget. The international St. Vincent Declaration, promulgated by the World Health Organization and the International Diabetes Federation, sets out principles designed to decrease blindness, renal failure, gangrene, coronary health disease, and stroke among diabetic patients and to normalize pregnancies for women with diabetes. These principles can be applied in a primary care setting. Often care is provided through a multiprofessional team.

PC physiotherapy. The absence of robust research evidence to support the efficacy of physiotherapy in primary care is acknowledged. But many primary care doctors saw offering a physiotherapy service as a service improvement for a large group of patients for whom little else was available (such as those with lower back pain). Patients' views favor a physiotherapy service. Primary care doctors

TABLE 3
Change Outcome by Innovation[a]

Spread across the System	Significant Spread but still Contestation	Debated and some Spread	Small Pockets	Pilot
PC: Aspirin for prevention of secondary cardiac incidents	AC: Defining risk in pregnancy and childbirth	*AC: Low-molecular-weight heparin after orthopedic surgery* *AC: Laparoscopic inguinal hernia repair* **PC: Treatment of diabetes following the St. Vincent Declaration**	PC: Hormone replacement therapy for prevention of osteoporosis PC: Direct employment of physiotherapists in general practices	AC: Managing anticoagulation service provision with a computer support system

[a] "PC" is primary care; "AC" is acute care. Three indicators of spread applied were geographical spread across sites; spread beyond champions to a wider population; and spread across organizational, occupational, or sectoral boundaries.

In the body of the table, bold type indicates a more strongly evidence-based innovation. Italic type indicates there was only one focal stakeholder for an innovation.

have increasingly employed physiotherapists, leading to a need for these physicians and physiotherapists to agree jointly to new working practices.

RESULTS OF THE INITIAL ANALYSIS: NONLINEAR PATHWAYS

Table 3 reports our assessments of the change outcomes of the studied innovations at the end of fieldwork. We based these assessments on our reading of our cases against three indicators of spread: (1) geographical spread over a range of sites, (2) spread beyond early change champions to a wider population of adopters, and (3) spread across organizational, occupational, or sectoral boundaries (for example, from secondary to primary care).

Spread pathways were slow, complex, and contested. For only one innovation (PC aspirin) was spread assessed as wide. Strong limits to spread were evident among the evidence-based innovations, indicating limits to "science push." The two innovations still seen as focused, or concentrated, after fieldwork lay in the middle of the table rather than at the "widespread" end (on the left). Fieldwork had suggested higher levels of innovation complexity than originally supposed in the cases of the use of aspirin and HRT, where innovation spread was found in the field to depend on changes across medicine and nursing.

Our studies confirm nonlinear models of innovation spread (Van de Ven et al., 1999). There is no linear flow or prescribed sequence of stages; indeed, "flow" is a radically inappropriate image to describe what are erratic, circular, or abrupt processes, which may come to a full stop or go into reverse. Could we also develop nonlinear theories of innovation further using these data?

REANALYZING THE EMPIRICAL RESULTS

The strength of the evidence and whether or not innovations were focused did not explain differing change outcomes. We had not originally expected the innovations to exhibit such complex spread pathways. We needed to retheorize our results (Yin, 1994). One strategy for inducing theory is to present polar cases with crystallized patterns (Langley, 2001). Our positive and negative outliers—both strongly supported by scientific evidence but displaying very different change outcomes—represented such polar cases.

Positive Outlier: Aspirin for Prevention of Secondary Cardiac Incidents

There was widespread and up-to-date knowledge, and widespread adoption, of this innovation, "PC aspirin," in the local primary care practices (the health centers) studied. All of the primary care practices were using aspirin. Behind this widespread adoption lay a combination of positive factors, including a particularly strong evidence base. This innovation affects many patients in primary care who face serious adverse outcomes; it is easy and cheap to administer, and there is good patient compliance with this popular treatment. There was a top-down national policy to secure practice change, with three of the four health authorities in the study noting that the use of aspirin in primary care was a local policy priority. In the macro-case health authority, a reinforcing audit had been undertaken across all local primary care practices.

The second-stage micro-case study (the nature of the micro cases was defined previously, in our Methods section) was drawn from a primary care

practice with six doctors, many active in continuing professional education and local university departments. This health center was an early adopter, and one partner had published a paper on this topic in the *British Medical Journal.* There was thus a local and credible champion within primary care. After publication of the paper, a "chronic care special interest group" consisting of interested doctors, nurses, and attached staff met regularly to develop a protocol for the management of patients. There was also at this practice a weekly meeting to which all staff members—including receptionists and administrators—were invited (and attended).

Once a protocol had been developed, a nurse-led arterial clinic was set up to monitor patients. The shift of responsibility for routine monitoring from doctor to nurse was important. The nursing group in the practice decided how the nurses should work in the new clinic. At the time of this writing, the practice ran three clinics a week, nurse-led, but supported by a doctor. The patients came to the nurse for check-ups, reassurance, and encouragement to question the doctors. Doctors and nurses had access to further evidence (continuing professional education; membership in the British Hypertension Society; postgraduate study; and contacts with consultants and university staff) for updating. Continuing debate led to periodic changes in aspects of clinic regime, such as dosage, which were agreed upon across the practice. As one doctor said:

> I think we are very team orientated and I think we recognize the other members of the team far more than other places do, and encourage them to develop their own skills and interests.

This innovation was successful in shifting care to a multiprofessional process on a widespread basis. The social boundaries between groups of doctors in different primary care practices were overcome through multiple means. The spread of evidence was actively supported by a top-down policy push from the health authority. This push was matched by a participative audit process and ownership by change champions, as seen in the micro study. Since this innovation was contained within primary care, the professional staff involved all shared some basic common values about community-based and holistic care. Thus, the social barriers between doctors and nurses were easier to bridge. Finally, both doctors and nurses perceived that there were relevant incentives for participation. In the micro study, doctors and nurses agreed to role redefinition, drawing on established systems for interprofessional dialogue. This innovation did not challenge the basic cognitive assumptions of doctors and nurses. In the micro study, shared cognition was supported by an outward-facing culture that valued knowledge and evidence. So although the innovation had to cross two key boundaries, between different organizational settings and between doctors and nurses, its doing so was effectively managed.

Negative Outlier: Managing Anticoagulation Service Provision with a Computer Support System

This innovation remained firmly stuck at the pilot stage. This finding is curious because managing anticoagulation service provision was an initiative that was related to the highly successful aspirin-use innovation outlined above and also sought to shift routine work into primary care. Similar features included a strong evidence base, a large patient group in primary care who faced serious adverse outcomes, ease of administration, and good patient compliance. Unlike the aspirin innovation, however, managing anticoagulation service provision met difficulty in crossing the organizational and professional boundaries it confronted.

This initiative was an evidence-based Regional Health Authority R & D intervention, with support from the cardiac department of the hospital concerned but aimed at decentralizing routine services so that local primary care health centers could provide them. A key opinion leader was a cardiologist from outside primary care. Many hospital-based cardiac outpatient clinics are overstretched. A special R & D task force assessed if patients with certain chronic heart conditions associated with a high risk of major stroke could be treated differently. The plan was to delegate anticoagulation control in three ways (1) from a hospital clinic to a primary care setting, (2) from an intern-led system to one in which a senior nurse had a more prominent role, and (3) from a diagnostic process provided solely by clinicians (often junior doctors) to one supplemented by a computer-based information and advisory system. RCT-based evidence supported the innovation; yet it did not spread. While this case illustrates some positive characteristics that might have been expected to stimulate diffusion, the impediments to diffusion were strong. The innovation had to cross organizational and professional boundaries. Initially, the innovation would have crossed a knowledge boundary between more abstract research (and researchers) and more local practice (and practicing clinicians). To do this, researchers had to communicate evidence to professional groups in both acute care hospitals and primary care practices.

The interprofessional boundaries in this case, be-

tween hospital-based cardiologists, haematologists, and interns on the one side, and doctors and senior nurses in primary care and new professional groups of computer systems designers and Health Services researchers on the other, are complex. All these groups held stakes in the project. All had been educated and socialized in different ways. The few change champions in this case could not exert persuasive power over such varied groups. The key clinical shift was from hospital-based interns to a practice-based senior nurse. However, the senior nurse found it difficult to enact an enhanced role, remaining isolated. The hospital doctors doubted that the new technology could be supported by nurses. These role barriers were reinforced by suspicions between the primary care doctors and the hospital consultants, employed in different organizations. The interorganizational boundaries between the regional health authority, local hospitals, and primary care practices were also important in relation to shifts in financial resources and medico legal responsibility that went alongside the transfer of clinical work.

> It is something we have become particularly sensitized to, the dumping of work onto primary care without any additional resources. (primary care doctor)

These two polar cases are differentiated in three ways: (1) more social and cognitive boundaries in the negative than the positive case; (2) the actors in the positive case had a foundation of shared social identity and values and, in the micro case, an established base of sound relationships; (3) therefore, actors in the positive case were able to cross boundaries.

Inter- and Intraprofessional Boundaries in Nonspread

Let us define and apply this boundary idea more widely. We see a "boundary" as a relatively impermeable frontier between different professional groups that inhibits the spread of new work practices. We focus attention not primarily on the physical, geographic, or formal boundaries between organizations, nor on the boundaries of a single profession, but on the underpinning social and cognitive boundaries that membership of a profession creates in relation to other professions. There may be multiple and reinforcing boundaries that vary in their impermeability from case to case. Inter- and intraprofessional boundaries are key, as a stakeholder analysis across the cases confirms the extensive range of professional groups involved. By contrast, health managers were important in only two cases, as were consumers or patient advocacy groups. Cross-case comparison also identified the different cognitive frameworks brought by professional groupings. The "knowledge boundary" between different worlds of research and clinical practice was important in a cluster of cases. By contrast, the technological/human boundary in the negative outlier case was present only there.

Table 4 summarizes the social groups involved in advancing the innovations, together with the intergroup issues needing to be resolved before the innovations could spread. For example, the acute care study intervention concerning defining risk in pregnancy and childbirth revealed many contestable work practices: the use of ultrasound during pregnancy, processes for prenatal testing, cesarean section, and above all the question of where and by whom care should be delivered. Should all babies be delivered in a hospital? Which (if any) mothers should be cared for by midwives, and which by obstetricians?

This debate was associated with a national policy initiative on the care of women during childbirth that enjoyed political support and brought in new actors. A national working group set up on this issue included representatives of the professions, of mothers, and of advocacy groups. The working group engaged in data collection and consultation before producing its policy document, *Changing Childbirth* (Department of Health, 1993), which recommended giving mothers more information and providing options, particularly for low-risk births. Change implementation called for a shift in the roles of—and interactions between—two key professions, obstetricians and midwives. Change implementation also depended on the use (or even introduction) of joint guidelines for risk definition and management. There were strongly held views and vested interests for both midwives and obstetricians (and for mothers!). The proposed shift from obstetricians to primary care doctors and midwives was highly contested. One obstetrician commented:

> I suppose the main sweeping change has been the less active participation in pregnancy care by consultant obstetricians and more active involvement by other colleagues, namely the general practitioners and midwives. I have no idea how actively involved they are, they tell me they are and since they are accountable to themselves, they are their own masters. They have not invited me to comment, so then I believe them.

One midwife reflected on the variation in practice across units, and why a policy of "active childbirth" was not supported in a nearby unit:

TABLE 4
Occupational Groups and Cognitive and Epistemological Issues and Disputes

Case	Professional/ Occupational Groups Involved	Organizations	Argument: Within and/or between Professions	Research: Active or Passive Debate	Quotation Exemplifying the Depth of the Debate or Dispute
AC: Low-molecular-weight heparin after orthopedic surgery	Orthopaedic surgeons, vascular surgeons	Acute care hospitals	Within	Active, ongoing research controversy	In the U.K., there is still some resistance to LMWH and why this is no one can answer. (consultant surgeon) It is very, very hostile and people feel strongly that what they do is right. (consultant orthopaedic surgeon) Everyone will say that it is better to restore the anatomy than put metalwork in, but there is no evidence to suggest this is right. (consultant surgeon)
AC: Laparoscopic surgery for inguinal hernia repair	General surgeons	Acute care hospitals	Within	Low-level debate, due to weak research base	There are two front runners, Liechtenstein and laparoscopic. (clinical director of surgery) There are 10% of surgeons that will never be able to do it properly, because they have not got the links up here [i.e. in their heads], somewhere to let them do it two dimensionally. (clinical director of surgery) What happened in laparoscopic surgery is that it was introduced and everybody jumped on the bandwagon. Then certain people said they could do anything with the laparoscope. There were races for this and that, but now it is drawing backwards and we are finding out what it is useful for. (consultant surgeon)
PC: Aspirin for prevention of secondary cardiac incidents	Primary care doctors practice nurses, health authority managers	Primary care practices, health authorities	Within/extending between	Nil; strong agreement	The ISIS trials show that aspirin reduced the platelet stickiness, and that this was a good thing to do in people with heart disease, they ought to be treated with it. It is the same way that most new treatments come in . . . then it becomes obvious that some people say—well I put my heart patients on aspirin and that is the recommended treatment. It is a diffusion process really. (general practitioner)
PC: Hormone replacement therapy for prevention of osteoporosis	Primary care doctors, practice nurses, consumers	Primary care practices	Between	Passive; only small-scale studies	My thought process on this one [i.e., RCTs] is that it is very difficult. I suppose this is the point [i.e., primary care] where drug companies, medicine and people meet. How do you actually work it out where you cause least harm and reap most benefit from a medication in such a way that it means you are spending state money sensibly. And obviously a randomised, controlled double-blind trial is extremely important and yes, I am going to be influenced by the trials that are properly produced and are sound. But at the same time, I am going to be looking at a conglomeration of all the trials in other countries, as well possibly, because we have ethnic minorities as well. (general practitioner)
AC: Managing anticoagulation service provision with a computer support system	Cardiologists, primary care doctors, practice nurses, computer system designers, health services researchers, regional R&D	Acute care hospitals, primary care practices, regional R&D	Between	Active; debates between researchers/ practitioners and between RCTs and health service research	The problem is the number of patients on anticoagulants has gone up because the indications for anticoagulation treatment have widened and it's a real nuisance; it's one of those total nuisance things . . . so anything that takes away a routine burden from doctors is welcome. (hospital consultant) I think in this particular instance, we are talking about something [anticoagulation] that is a very fine line between an absolutely disastrous therapy and something that is clinically ineffective . . . it is one of those problems that is ideal for a computer to be able to solve. (clinical researcher)

(Continued on next page)

TABLE 4
Continued

Case	Professional/ Occupational Groups Involved	Organizations	Argument: Within and/or Between Professions	Research: Active or Passive Debate	Quotation Exemplifying the Depth of the Debate or Dispute
AC: Defining risk in pregnancy and childbirth	Obstetricians, midwives, consumer groups, politicians, primary care doctors	Acute care hospitals, health authorities, National Child Birth Trust, Department of Health	Between	Active; obstetricians, midwives, and users; also RCTs vs. qualitative studies	I think the difficulty is the evidence. First of all, it is terribly difficult to keep up to date with literature and a lot of trials are small and a lot of results are conflicting and you don't change your practice based on isolated trial results. (consultant obstetrician). I don't agree with that (i.e., a fixed labor protocol with prescribed interventions). I think you have to take into consideration the mother's wishes, the state of the foetus. I don't think you should dive in and do things. If she is making progress, although slightly slower, and she is confident about it, I don't see any reason to intervene. (senior registrar) Research has shown that CTGs have not brought down the mortality rate. It is not particularly efficacious; all the research shows that there are no real benefits in using a monitor provided the midwife is well qualified. (community midwife)
PC: Treatment of diabetes following the St. Vincent Declaration	Primary care doctors, hospital medical consultants, practice nurses, community nurses, optometrists	Primary care practices, acute care hospitals, community NHS trusts, British Diabetic Association, health authorities	Between	Active; acute consultants, general practitioners, public health, health promotion	The trouble with most RCTs is that they are imperfect in all sorts of ways. It is encouraging that people try to find out the evidence but they are always imperfect. And I think that it is always the dilemma. (general practitioner and general practitioner tutor) There is a general policy to push diabetics out of hospital into primary care. (general practitioner partner). The diabetes nurse specialist service is great—but not enough. (general practitioner)
PC: Direct employment of physiotherapists in general practices	Primary care doctors, physiotherapists, practice nurses, community trust managers, hospital consultants	Primary care practices, community NHS trusts	Between	Passive; very limited research base; small scale cost-benefit analysis	Some GPs are very pro-physio. and will refer to us early, some will use drug management and exercise first, perhaps giving the patient 3–6 weeks to see if the problem resolves itself spontaneously, then if it doesn't, use us as back up then. (physiotherapist) The [doctors] they think it is great, because we have been able to choose really well, the physiotherapists who the doctors feel are very well qualified and very good with their patients. (practice manager) They [the health authority] don't think physiotherapy is a very effective way to spend money. Patients like it and it keeps them amused while they get better. (general practitioner)

> I think it is the dominance of the medical team in that unit. I think the midwives are not speaking out. . .we are actually quite progressive, we do try to speak out. We do not always get through of course, but we are allowed to speak.

Behind this statement lay controversy about the degree to which childbirth should be medicalized, on which obstetricians and midwives had different views. The midwife also stated this:

> We talk about informed choice and one does have the right to choose, but it must be informed with neutral not biased medical orientation.

In the micro case, several factors explained the more positive pattern. Obstetricians and midwives had built sound relationships, based on trust, over a period of time. The midwifery manager had strong strategic and political skills and actively worked to maintain relationships. A post of research midwife had been created, which acted as a bridge between the medical and midwifery groups (Fitzgerald et al., 1999).

Across all the cases, implementation locally depended on effective relationships and cooperation between different health care professions. As Table 4 illustrates, there were important intergroup issues, sometimes disputes, concerning social and role boundaries. Innovations often attempted to shift routine work to lower-tech settings (from hospitals to primary care, from doctors to nurses). These innovations then encountered boundaries between professional groups as new, joint, work practices had to be agreed on and enacted for the innovation to spread.

There were cognitive as well as social boundaries: knowledge did not readily flow from one group to another. For example, in the acute care innovation case on the use of heparin to prevent postsurgical bloodclots, orthopedic surgery was a resilient professional group with its own national professional association, journals, and conferences. Orthopedic surgery had not generated a strong RCT research base historically, but it was resistant to strong and relevant RCT-based knowledge acquired in the neighboring fields of vascular and general surgery. This knowledge was not seen as directly applicable: "Orthopaedics is different" was a rallying cry. The interpretation of new evidence varied by the surgical groups' tasks: vascular surgeons were preoccupied by the dangers of thromboses and reluctant to move away from LMWH; orthopaedic surgeons were more concerned with problems caused by excessive anticoagulation, notably bleeding and infected joints, and they resisted excessive LMWH use. Even in surgery, knowledge and, more fundamentally, a shared interpretation of evidence, found difficulties in crossing between two neighboring surgical specialties.

THE MEDIATING ROLE OF PROFESSIONALS IN INNOVATION NONSPREAD

Earlier work (Van de Ven et al., 1999) has analyzed the roles of *managers* rather than *professionals* in the innovation process. We argue that in the cases we studied, (1) social boundaries and (2) cognitive or epistemological boundaries between and within the professions retarded the spread of innovations. These barriers are especially problematic when different professions are colocated within multiprofessional organizations. This argument contests prior work presenting professional networks as positive facilitators of innovation (Coleman et al., 1966; Robertson et al., 1996).

Strong Social Boundaries: Uniprofessional Communities of Practice

The cases suggested the presence of strong social boundaries between health care workers from different professions, boundaries created by well-developed professional roles, identities, and traditional work practices. For example, individual professionals within so-called multidisciplinary teams often found it difficult to agree to the role redefinitions indicated by evidence-based practice (for instance, in the acute care anticoagulants cases); established professional roles and "jurisdictions" got in the way (see Abbott [1988], which our finding here confirms). We focus here on the micro behavior of individual health care professionals and local groups that interpret and enact research, rather than on professional bodies at a national level. How can we theorize our empirical results? We suggest that research and its implications for practice were usually discussed within uniprofessional communities of practice (work-related communities created through sustained collective pursuits of shared enterprises [Brown & Duguid, 1991; Wenger, 1998: 45]). Two acute care study cases are exemplary here, the LMWH case and the laparoscopic hernia surgery case. Much interaction around day-to-day work practices takes place at a local level in such a community, which thus provides a strong basis for collective learning and change. We here bring research on communities of practice into the study of the professions in a novel way to explain the limits of joint learning and change across professional boundaries. Single-profession-based groups and associated networks provide authentic and powerful communities of practice in that they are a prime basis for face-to-

face interaction, for information and experience exchange, and for learning in relation to day-to-day health care practices—but usually for members of the same profession. Members' interactions within such a community of practice are richer than their interactions with higher managerial tiers of their organizations or members of other communities of practice. Clinicians are often located within teams based on single specialties (for instance, the group of orthopedic surgeons in the acute care heparin micro case who sought to agree on a collective treatment regime). Thus, one doctor cannot adopt significantly changed practices without discussion and consent from colleagues from the same speciality. Uniprofessional communities of practice can be seen as a micro layer within the professions.

This argument develops the concept of a community of practice within the specific context of large organizations that contain multiple professions. Innovations are often enacted within such communities, but we highlight barriers to learning and change *between* them. The professional communities of practice we encountered display three features whereby they differ from those in the nonprofessional work contexts Wenger analyzed. First, professional communities of practice are often unidisciplinary, with great effort needed to create a functioning multidisciplinary community of practice. Secondly, they typically seal themselves off, even (or perhaps especially) from neighboring professional communities of practice, defending jurisdictions and group identity. An example is the tension between the orthopedic and vascular surgeons' communities of practice in the heparin case (in the acute care study). Thirdly, these communities of practice are highly institutionalized. Macro institutions reinforce the identity of micro groups; self-regulatory and unidisciplinary machinery ("Royal Colleges" in the United Kingdom, and expert advisory groups worldwide) control entry into and exit from the professional groups, set and examine training programs, validate research, and enforce professional standards. Professional roles are prescribed sectorally, shaping the identity of individual professionals.

This argument contrasts with Wenger's (1998) argument that communities of practice have permeable peripheries and can be readily constructed "from scratch" in new settings. A community of practice emerges through negotiation in a work context over a short period of time (Wenger's example related to the social construction of a negotiated order among claims processors). Wenger's work is reinforced by that of Knorr-Cetina (1999) and Robertson et al. (1996), who showed how networks across organizations form positive links for diffusion of innovations. However, Swan, Scarborough, and Robertson (2002) suggested that managers' attempts to create a community of practice involving clinical personnel clashed with existing communities and inhibited diffusion. So communities of practice may be built up where individuals share common roles or an epistemic culture.

Brown and Duguid (2001) examined the way that knowledge manifests "stickiness" and "leakiness" simultaneously. They argued that sociocultural accounts offer richer explanations than focusing on the properties of knowledge itself. By shifting their analysis to concrete practice, they underlined the link between learning and identity, arguing that work identities are built through participation and social contact. Knowledge diffuses within communities of practice, but it will "get stuck" where practice is not shared. The presence of strong professional roles and identities makes it even less likely that knowledge will flow across social boundaries.

Embedded communities of practice of professionals are more cellular, self-sealing, and institutionalized than are communities of technicians (Barley, 1996), claims assessors (Wenger, 1998), and managers (Schoenberger, 1997). The professional communities stimulate learning and change internally but block such processes externally, given the social boundaries between neighboring professions. We found considerable social distance between the members of colocated communities of practice. For example, three cases, the heparin case in the acute care study, and the hormone replacement and physiotherapy cases in the primary care study, suggested strong social boundaries existed between doctors, nurses, midwives, and physiotherapists, even though they were all nominally members of a multidisciplinary team. The heparin case is an example of how the colocation of many different professions produced a loose multidisciplinary arena in which there were protracted disputes about role change, rather than a multidisciplinary community of practice. The rhetoric of multidisciplinary team working in the primary care case involving new ways of handling diabetes treatment was belied by continuing debate about the significance of evidence among the different groups. The construction of a genuine multidisciplinary community of practice was rare, but possible: evidence comes from the micro site in the primary care aspirin adoption case and from some sites in the acute care birth-pregancy case (see Table 4 and quotations throughout the text). However, the "default mode" is for communities of practice to be uniprofessional.

Strong Cognitive Boundaries between Professions: Different Knowledge Bases and Research Cultures

Important knowledge boundaries as well as social or identity boundaries inhibited diffusion. The evidence or knowledge underpinning the innovations did not readily flow across the professions: rather, it "stuck." Professions display different research cultures, agendas, and questions. Barriers have a cognitive as well as a social or identity-based element. Are all health care professionals guided by the same scientific norms? Classic accounts stress the communalistic, universalistic, and disinterested character of scientific knowledge (Merton, 1973). Contrarily, Kuhn (1970) suggested disciplines with developed paradigmatic status display distinctive cognitive assumptions. Paradigms may be not only different, but also incommensurable (Burrell & Morgan, 1979), advancing noncompatible claims to knowledge. Their adherents talk past each other, lacking common ground for productive dialogue. Beck (1992) argued that increased scientific differentiation leads to surplus knowledge production and to hypercomplexity, which paradoxically enables the end user of research to exercise choice between potentially clashing but ever more plausible knowledge claims. We found distinctive research approaches linked to professional groupings. Table 4 provides examples of topics of contention and dispute about evidence between and within professions.

The hospital sector was the heartland of the established biomedical research paradigm. Many hospital consultants proclaimed the randomized clinical trial (RCT) as the "gold standard" in theory (while sometimes critiquing trials with which they disagreed). The "hierarchy of evidence" model associated with evidence-based medicine places "well-conducted RCTs" at its apex. A few hospital consultants— such as surgeons and obstetricians— felt that there were important craft-based aspects of clinical experience difficult to express in RCTs, but most hospital-based clinicians accepted the RCT paradigm. By contrast, primary care doctors took a more holistic view of research methods and were less wedded to the RCT, seeing difficulties with the recruitment of control groups (which they viewed as denying potentially useful treatments to patients). Influential research was seen as overly grounded in the hospital sector (as in the diabetes management case) and not directly applicable to primary care:

> That is one big problem with primary care evidence-based medicine at the moment, that is most of the evidence that we are encouraging GPs to change their behaviour on is actually very much secondary care–based. (primary care doctor)

Primary care doctors display enduring relations with individuals and family groups and deal with patients with multiple pathologies. These conditions limit their willingness to use RCT-type evidence and the relevance of RCT results for them. For example, many primary care doctors suggest that trials exclude older patients, but their patient population is predominantly elderly. They felt that the power within the research arena lay with the acute sector, leading to a pressure to adopt methods inappropriate in primary care. Despite reservations about RCT dominance, however, there was not a sharp paradigmatic dispute.

The novel health services research culture found in the aspirin-for-anticoagulation innovation in our acute care study was associated with expanding research groups such as computer system designers and health economists. This group had received external funding for evaluations. It was receptive to clinical trials but also used novel technologies (computer support systems) and methods (service utilization data and costs data).

The developing nurse and therapist research cultures (relevant in the acute care birth case and in the primary care physiotherapists case) were interested in service delivery mechanisms as well as clinical outcomes, using more sociology-based and qualitative techniques to explore patient experience. These implied different questions (and methods) than did a biomedical perspective, including an interest in the quality of interpersonal relationships in care contexts. The birth-pregancy treatment innovation revealed contest between obstetricians, midwives, and social advocacy groups in relation to the evidence on effective care of mothers. Some midwives felt available evidence was skewed to high-risk cases, reflecting obstetricians' control over research agendas. "Evidence" within obstetrics was contested in multidisciplinary care groups where different voices were heard. Midwives underlined the limits of RCTs, arguing they were not holistic enough and did not embrace the views and experience of mothers (for instance, no trial had addressed pain during childbirth). They felt too much research reported on narrow clinical outcomes and that different, more qualitative research methods were needed to establish an alternative research base. Obstetricians rarely accepted this view.

Different research traditions and conceptions of what constituted knowledge and evidence were apparent. For traditionally subordinated professions and segments (nursing and therapy; primary care

medicine), the development of an academic base is part of a professionalization project that would enable them to build autonomy and jurisdiction vis-à-vis the elite profession of medicine. Research bases are being built and differentiation is occurring. So how conflictual or consensual are the relations between these research cultures? Only in one case in our research, the primary care aspirin innovation, was there strong agreement between stakeholders about available evidence. In other cases, the relationship might be described as passive coexistence, as in the physiotherapy case, with physiotherapists offering little or no active challenge to different medical views of research evidence. In the heparin case, there were no overt challenges from other professions to the surgeons' views of RCTs (though there were internal disputes between surgeons). In other cases, there was active challenge, debate, and even dispute about evidence, illustrating a clash between different research paradigms. In our birth-pregnancy case, there were substantial differences between the professions about the definitions of risk and effective care. Even within medicine, family and hospital doctors expressed significant differences on care for diabetics.

DISCUSSION

Additive Theoretical Contribution

Our results reconceptualize the nonspread of innovations within large, multiprofessional organizations. Previous studies (Coleman et al, 1966; Rogers, 1995) contain the argument that professional networks spread innovations but represent a uniprofessional perspective. The dynamics are more complex in multiprofessional organizations. Many global organizations in the public and the private sectors contain multiple groups of professionals, specialists, and experts, so our results have implications beyond health care. Developing the work of Van de Ven and colleagues (1999), attention should now focus on the boundaries between professional groups, individual professionals, and associated communities of practice in the local enactment of innovations.

We have sought to move research on communities of practice into the study of local professional groups within innovation processes, arguing that professionals construct and operate within uniprofessional communities of practice not easy to influence from outside (contrary to Swan et al. [2002] and Wenger [1998]) Professional groups produce strong social and cognitive boundaries. While these boundaries originate from membership in the professions, they are evident in the manner in which communities of practice operate. These are key arenas in which evidence is interpreted and enacted at a local level, and in which implications for organizational change are considered.

Such professional communities of practice develop internal learning and change but block externally oriented sources of change and learning: they are self-sealing groupings. They are less fluid and permeable than other communities of practice and do not readily allow for multiple membership or fluid participation (contrary to Leigh Star [1991] and Wenger [1998]). The social and cognitive boundaries between these communities help (Brown & Duguid, 2001) account for sticky knowledge flow. Different professional groupings develop distinctive knowledge bases and research cultures within professionalization projects. They talk past each other: concretely, there are different definitions found of what counted as good evidence at the local level. Where communities of practice have different epistemologies, innovations that do not bridge these divides will literally be judged incredible. These social and cognitive barriers may be present in the case of different segments *within* the same profession (such as primary care doctors versus acute sector doctors) as well as *between* professions (such as obstetricians and midwives). Where both social *and* cognitive boundaries exist between communities of practice, these interact and mutually reinforce each other. Such differences can only be overcome through social interaction, trust, and motivation, and they are rarely surmounted where there is a history of distrust. Denis, Hebert, Langley, Lozeau, and Trottier (2002) also underlined that the interests, power, and values of the actors in an adopting system affect their interpretation of science.

External Generalizability

Our data are substantial in scale and not limited to one organization or profession. They reinforce and extend other studies (e.g., Swan et al., 2002) outside health care. They confirm Carlile's (2002) recent ethnographic work on knowledge in practice and knowledge boundaries in American engineering settings within U.K. health care settings and extend his analysis to professional groups. Some non-U.K. health care studies suggest similar patterns: Montgomery and Oliver's (1996) analysis of the adoption of policies for responding to AIDS cases found that in situations of ambiguity, professional behavior does not always conform with policy, but is influenced by multiple factors, especially professional norms. Denis and colleagues'

(2002) work on similar issues of diffusion in Canadian health care discusses the many value foundations and interest groups found and their interplay with interpretations of "good" science. More substantively, we found some segments of the nursing profession were developing more autonomous and internally driven knowledge than Bowker and Leigh Star's (2002) study of nursing "informaticians" indicated. Our results are not, then, isolated or parochial. Beyond health care, our results are relevant for the study of knowledge management strategies in large and complex multiprofessional organizations, in the private as well as the public sectors (for instance, in large consulting firms, pharmaceuticals, and major software houses). Knowledge-based firms are an expanding sector, and many of them are developing explicit knowledge management strategies. Our data, reinforced by private sector studies (Brown & Duguid, 2001; Swan et al., 2002), suggest that for knowledge management strategies to be successful, identification and management of social and cognitive boundaries between different communities of practice are needed, especially where different professions are present in the same organization.

Limitations of the Study

One limitation concerns the one deviant case that we cannot easily explain: the case of laparoscopic hernia surgery. This potential adoption involved only one professional group with no important boundaries. Yet it was slow to diffuse, as adoption was followed by "unadoption." On reflection, this was the result of change in the research and experience base. Early overadoption took place in advance of good evidence, and difficulties and reservations slowly accumulated. The innovation was not as evidence-based as initially thought, so limited adoption was indeed indicated.

Secondly, we have not so far considered issues of differing access to power. What happens when one profession is more powerful than one or more others? Can the powerful profession force an innovation through, or do other groups retain the power of veto? How do differences in rank (for instance, the difference between junior doctors and senior nurses) play themselves out?

Future Research Directions

Finally, we consider questions for future work. Our present work has embraced established professions, aspiring professions, and semiprofessions and has illustrated that professions tend to produce communities of practice that are usually unidisciplinary. Reflecting on the research of Swan and coauthors (2002), one might ask if the boundaries between older established professions and newer expert groups, such as information technology specialists and general managers, create the same barriers? Secondly, will the range of research cultures identified continue to expand (Beck, 1992), or are there limits to such differentiation, perhaps through a more explicit knowledge management strategy? Finally and critically, we found some indications of how to build multidisciplinary communities of practice (at the micro site in the aspirin case and at some sites in the birth-pregnancy case). Future research should urgently investigate which preconditions and mechanisms were effective for bridging the social and cognitive boundaries identified in positive (rapidly adopting) outlying sites. Are there boundary objects (Bowker & Leigh Star, 2002; Carlile, 2002) that move knowledge across groups? Joint protocols would be an example. What, in other words, produces exceptions to the default condition of a unidisciplinary professional community of practice?

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APPENDIX

List of Abbreviations

The following abbreviations are used in this article:

AC:	acute care
DVT:	deep vein thrombosis
HRT:	hormone replacement therapy

LMW: low molecular weight
LMWH: low-molecular-weight heparin
NHS: National Health Service
PC: primary care
RCT: randomized control trial

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