Explaining Diffusion Patterns for Complex Health Care Innovations

Jean-Louis Denis, Yann Hébert, Ann Langley, Daniel Lozeau, and Louise-Hélène Trottier

Why are some less solidly supported health care innovations widely adopted while others with apparently stronger scientific support remain underused? Drawing on four case studies, the authors argue that the way in which the distribution of benefits and risks map onto the interests, values, and power distribution of the adopting system is critical to understanding how innovations diffuse.

"Evidence-based decision making" or the promotion of clinical and organizational practices grounded in scientific evidence has become an influential "movement" in the health care arena in both Europe and North America.[1,2] Overall, the movement draws its vitality from the observation that there seems to be a significant gap between what is known and what is used in practice and that this may have serious consequences for people's health.[3–5] For example, in the introduction to their book on evidence-based medicine, Sackett et al.[1] note:

> Given the extremely rapid growth of randomized trials and other rigorous investigations, the issue is no longer how little medical practice has a firm basis in such evidence; the issue today is how much of what is firmly based is actually applied in the front lines of patient care. (p.7)

Why does this gap occur? Many researchers have tackled this question by focusing on the choices of individual professionals, examining factors such as information availability, cognitive styles, the nature of "evidence," professional networks, and opinion leaders.[5] However, many of today's innovations are not easily reduced to a decision within a physician's office: They have broader organizational implications, sometimes requiring displacement of resources. In this article, we report on four case studies of clinical innovations with significant organizational implica-

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tions, tracing over time their diffusion within a defined geographic area. The diffusion processes involved multiple levels of decision making where individual professional choices are embedded in collective or organizational contexts. Such decisions seem likely to be both more complex and particularly significant for the penetration of evidence-based decision making. Our initial research question was a simple one: Why are some less solidly supported health care innovations widely adopted while others with apparently stronger scientific support remain underused?

THEORETICAL BACKGROUND

As Drazin and Schoonhoven[6] indicate, innovation research has been dominated by two types of empirical work: (a) cross-sectional studies aimed at identifying contextual, organizational, and individual predictors of innovativeness (seen almost universally as a desirable characteristic of organizations); (b) longitudinal event history studies aimed at predicting diffusion rates for specific innovations across organizational populations as a function of community, population, and organization level variables (e.g., spatial proximity; prior adoptions, etc.). Both these streams adopt an arm's length approach to the understanding of how organizations integrate innovations, using coarse-grained predictors to summarize the complexity of organizational processes thought to be relevant to innovation.

However, Mohr[7] has criticized this type of research for its lack of attention to the organizational microprocesses by which individual innovations penetrate the organization. He argues that traditional variance studies are condemned to instability: The jumbling together of a wide variety of innovations and eclectic organizational samples is unlikely to produce cumulative knowledge or useful generalizations. The need to take into account technological and organizational context specificities suggests the usefulness of studies that adopt a processual perspective on the adoption and diffusion of a small number of innovations with known characteristics. This is the approach we propose to use in this research.

In fact, the literature suggests that the innovation adoption and diffusion process may take a variety of different forms. For example, Abrahamson[8] contrasts a rational model of innovation based on technical efficiency and effectiveness considerations (e.g., rooted in scientific evidence) with an institutional model in which innovations are adopted through imitation of more prestigious organizations or through the participation of professionals in communities of practice.[9,10] Another set of authors have noted the micropolitical nature of organizational decision making surrounding complex innovations, suggesting that if scientific evidence is used, it will often tend to play a strategic role of persuasion and justification among groups of actors with competing interests.[11–13] This approach would imply a political model of innovation adoption and use of evidence.

This article thus starts from the premise that the dissemination of innovations is not necessarily a linear process and that scientific evidence is likely to be only one element in it. In particular, in order to understand the role of rational, institutional, and political forces, we will examine how different actors within organizations and organizational networks see the particular innovation and the evidence associated with it and how they interact with each other and with the innovation over time to produce particular patterns of diffusion. The design of our study (described below) reflects this view. As the study advanced, our theoretical perspective was refined to account more completely for our observations. A more complete conceptual model derived from the data, but building on these initial ideas will be presented later in the article.

METHODS

In this study, we traced the dissemination processes for four innovations through quantitative and qualitative research techniques using a multiple case design with embedded units of analysis.[14] The choice of the four cases was driven by our research question and by the desire to select a variety of practices with both clinical and organizational implications. Statistical data were collected to trace diffusion patterns through the region. Qualitative data from interviews were used to understand the reasons behind these patterns.

We used a two-by-two grid design for case selection. The two axes of the grid reflect variations in timing between the emergence of "evidence" and the adoption of innovations (see Table 1). For example, on one axis, we attempted to identify cases where scientific evidence about effective and efficient practices emerged prior to adoption ("leading evidence") and conversely where evidence was either late ("lagging evidence") or ambiguous. The other axis classified innovations as rapidly or slowly adopted. The four cells gave us two "anomalous" cases (called underadoption and overadoption) and two "success stories" (one involving rapid adoption following the emer-

TABLE 1

GRID FOR CASE SELECTION AND SELECTED CASES

	Leading Evidence	Lagging Evidence or Ambiguity
Rapid adoption	**1. Success** Low molecular weight heparin (LMWH) for deep vein thrombosis	**2. Overadoption** Laparoscopic cholecystectomy
Slow adoption	**4. Underadoption** ACT—Assertive community treatment	**3. Prudence** Multiple use dialysis filters

gence of supporting evidence and one involving slow adoption in the face of lagging or ambiguous evidence). The design aimed to allow us to develop within case understanding of the events leading to different overall outcomes (anomalous or successful) as well as cross-case comparisons that would enable us to replicate emerging theoretical interpretations. Within each case study, individual clinicians or managers and their organizations became embedded units of analysis enabling us to examine variations in the dynamics and timing of adoption from site to site and from person to person.

The final choice of cases was made from a short list of candidate innovations in collaboration with a steering committee that included representatives from a Quebec government technology assessment agency (l'Agence d'évaluation des technologies et des modes d'intervention en santé), professional groups concerned with clinical practice (Quebec College of Physicians, Quebec Pharmacological Council), a physician working for the Montreal Regional Health Board, a physician-administrator from a large hospital, and a university specialist in family medicine and practice guidelines. In addition to criteria related to evidence and rates of adoption, committee members promoted the inclusion of cases where significant attempts to influence practice had occurred, or where the issue appeared to be representative of typically problematic situations.

We based our initial assessment of axis 1 (the state of the evidence and the timing of its emergence) on the medical science literature. We paid particular attention to meta-analyses published in academic journals or by independent technology assessment groups. We based our assessment of axis 2 (the timing and speed of adoption) on observations of diffusion of the practices in the Montreal region and more generally across the province of Quebec, using statistical information and ad hoc telephone surveys.

For each of the selected practices, we first refined our analysis of the sequence of adoptions across the region and then identified the key organizational and individual actors involved in the diffusion process, seeking representatives of earlier adopters, later adopters, and in some cases nonadopters of the innovation. These individuals (including key physicians, nurses, administrators, and other professionals) were interviewed indepth concerning alternative forms of treatment, the process of adoption, the arguments for and against, the process of implementation, the nature of the evidence considered and the definition of evidence preferred by the respondent. In all, we conducted 63 interviews (23, 4, 23, and 13 for cases 1 to 4 respectively). We obtained excellent access to informants for three of the four cases. However, we experienced more difficulty for the case of laparoscopic cholecystectomy, where we were able to obtain just four rich interviews with general surgeons (to some extent, we believe our difficulties may be considered as "data!"). To supplement the interviews, we obtained considerable documentary information and validated our analyses with other outside observers.

Data analysis proceeded in two stages. First, for each case, the research team member who had carried out most of the data collection developed a detailed narrative describing the process of adoption across sites for that particular practice, analyzing within site and across site data (these narratives—in the original French—can be obtained from the authors on request[15–18]). Then, we conducted comparative analyses, identifying similarities and differences among each of the cases. This led to a series of four propositions and a more general conceptual model. In the next section, we present a short descriptive analysis of the four cases. These descriptions draw attention to the distinctive features of each case in terms of the people involved, the relationship between adoption and evidence, and the resulting diffusion process. In the following section, we present a general conceptual model and consider cross-case generalizations and implications.

FOUR CASES OF INNOVATION ADOPTION AND DIFFUSION

1. "Success:" Low Molecular Weight Heparin for Deep Vein Thrombosis (LMWH for DVT)

The innovation and the evidence. This case concerns the introduction of a new form of the drug heparin to treat deep vein thrombosis, that is to say, a blood clot in the vein of the leg. Evidence for the new practice was well established by 1996[19] and adoption across the Montreal area was quite rapid ("success" in Figure 1). The new form of the drug enables patients to be treated in the community rather than in the hospital as was done previously, provided regular blood tests are taken during the next 3–5 days to determine when the treatment can be terminated. In the Montreal case, this community followup was most often achieved through signed agreements with partner organizations (local community clinics) though sometimes patients were asked to return to the hospital's ambulatory care center for tests.

Diffusion patterns. Two different patterns of diffusion were identified among the sites studied. One of these involved initiation by individual clinicians interested in the most up-to-date clinical practices. The other pattern involved initiation by hospital administrators attracted by the possibility of reducing pressure on beds. The case revealed different interpretations of the nature of evidence (e.g., clinical vs. economic evidence; scientific evidence vs. evidence of adoption by peers). It also illustrated how an innovation that appears well defined in theory (a drug) can prove to be much less well defined when implementation issues are considered. Such issues included questions about the intensity of followup, the organization responsible, the location of patient training, and so forth. Because these peripheral issues had to be negotiated with other organizations that might have made different prior arrangements with other partners, they could sometimes make adoption quite complex despite multiple reasons to proceed.

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2. "Overadoption:" Laparoscopic Cholecystectomy

The innovation and the evidence. This case concerns the introduction of a new surgical procedure for the removal of the gall bladder. We classified this case as overadoption not because the technique is not effective under appropriate circumstances, but because diffusion progressed faster than the emergence of the evidence and because imprudent adoption patterns led to high complication rates initially.[20,21] The previous standard procedure for gall bladder removal (open cholecystectomy) involved a major abdominal incision done under general anesthesia followed by a hospital stay of 3–8 days and a convalescence of 4–8 weeks. In contrast, laparoscopic cholecystectomy (LC) involves a different technique requiring new skills on the part of surgeons: The gall bladder is removed using 3–4 small holes in the abdomen. By blowing in gas, it is possible to insert a miniature camera and the instruments necessary to carry out the procedure while viewing the internal organs on a video screen. When carried out successfully, the technique has obvious advantages. The operation can often be done in day surgery, requiring no hospital stay and a short (1-week) convalescent period.

Diffusion patterns. This case provides an example of what can happen when an innovation has major pressures in its favor, hidden risks, and limited opposition. Laparoscopic cholecystectomy was introduced to Quebec in 1990 and by 1992–1993, 62 percent of cases were done this way as compared with less than 1 percent in 1991–1992. This wave was accompanied by a 24 percent increase in the total number of cholecystectomies as well as an increase in the number of complications. Two factors underlie this pattern. First, the new technique offered obvious advantages to patients (no scar, short stay, short convalescence) as well as to hospitals. Insurance companies began to refuse to compensate long convalescence periods and patients began to demand the procedure. It became imperative for general surgeons to quickly learn the technique or be forced to withdraw from a practice that represented 25 percent or more of their revenues. Second, the need to learn the technique rapidly produced two undesirable consequences. First, surgeons who took a cautious approach began using the technique on patients whose condition was less serious before progressing to more complex cases. This in part explains the increase in numbers of procedures. However, the more serious result was the initial increase in complications caused by the procedure being applied by inexperienced practition-

ers. Although courses were held at one of the Montreal teaching hospitals, these were of short duration and there was no formal certification.

3. "Prudence:" Reusable Filters for Hemodialysis

The innovation and the evidence. Hemodialysis involves the removal of waste products from the blood for patients with kidney disease. A key part of hemodialysis equipment is the filter, which is normally replaced after use. The innovation described here involves the adoption of reusable filters that are cleaned and sterilized after use, to be reused up to 20 times, always on the same patient. Various technologies exist for the reconditioning of filters: formaldehyde, renalin, and heat treatment (more recent and safer). The proven advantages of this innovation are economic, not clinical, and reuse naturally raises concerns about contamination. However, studies suggest that rates of patient mortality and morbidity are not significantly different between reusable and single use filters provided appropriate cleaning procedures are followed.[22]

Diffusion patterns. Only 7 of 22 dialysis centers in Quebec have adopted reusable filters. All are in Montreal, suggesting a very localized pattern of adoption. The earliest adoptions date back to the 1970s and involved a manual procedure. Some early adopters transferred to a formaldehyde procedure in the 1980s but three sites switched back to single-use filters. As of 2000, one site had adopted the heat procedure. The main factor in explaining the spotty diffusion process appears to be that the assessment of benefits and risks is also local and highly context dependent. There was generally little a priori enthusiasm from physicians or patients for the adoption of a practice with no obvious clinical benefits. However, the potential cost savings could sometimes be leveraged to create a favorable coalition. For example, in one case, nephrologists agreed to implement the procedure in order to obtain funds to develop a peritoneal dialysis program. Clearly, reuse has the potential to become an ethical/legal responsibility issue, made particularly salient since the HIV-tainted blood scandal. Reuse has raised opposition from certain patient groups and in some cases effort has been expended to convince activists of its safety.

4. "Underadoption:" Assertive Community Treatment (ACT) for Psychiatric Patients

The innovation and the evidence. Assertive community treatment (ACT) is an approach to treating severely troubled psychiatric patients in the community. It involves a multidisciplinary team including a psychiatrist, nurses, and other professionals who take on 24-hour/day, 7 day/week responsibility for education, support, treatment and rehabilitation of a limited number of patients with severe psychotic disorders. ACT was developed as an alternative to hospitalization in the 1970s in Wisconsin. Over 30 studies, including randomized control trials, have investigated its performance.[23] Benefits include improvements in level of functioning, quality of life, medication compliance, drug and alcohol consumption, patient satisfaction, and costs. Some difficulties in interpreting this evidence remain, however, because of the complexities of disentangling the various components of the approach to determine which of its elements is the "active ingredient."

Diffusion patterns. Given the level of scientific support, adoption of ACT in Quebec appears to have been slow. However, closures of psychiatric beds recently led to the development of two ACT-like programs, one in a large general hospital and a second at the city's English-speaking psychiatric hospital. The second program is the only one that closely approaches the Wisconsin model seen as the standard in the U.S. literature. The program is led by a psychiatrist who is exceptionally committed to this approach. His advocacy has taken the form of developing a website dedicated to ACT and co-organizing a colloquium on the topic. Since then, a number of other events have contributed to promoting more ACT-like initiatives. One of these was the preparation of a report by an economist for a Quebec-based technology assessment center. The cause was also taken up by the Quebec Hospital Association, which saw in ACT a way to ensure that the acute care psychiatric hospitals would retain a major role in psychiatric care despite the trend towards deinstitutionalization. In parallel with this, neighborhood clinics and other community groups had developed over the years their own programs of community care. These groups were inclined to reappropriate to some extent the ACT label, while at the same time resenting the monopoly that the hospital-based programs appeared to claim over it and criticizing their "medically oriented" and "coercive" approach to care (reflected particularly in the emphasis on medication compliance). (Note that the reappropriation of the concept was perhaps facilitated by the fact that the direct translation of the words "assertive community treatment" into French, "suivi intensif en communauté" does not have the reified status in the literature as the English

term ACT. Proponents of the purer form of ACT tried adding the words "en équipe" [meaning "by a team"] to the above label to distinguish their approach from other related practices.) Overall, ACT raised greater passion than any of the other innovations we studied. As the practice has diffused, stimulated both by cost pressures and by concern for patients, it has generated an ideologically and politically driven polarization of groups for and against hospital-based and community-based psychiatric care. At the same time, the complexities of implementing "high-fidelity" ACT (the Wisconsin model) have led to the implementation of all kinds of variants. The result is considerable confusion about definitions combined with attempts by some groups to close the debate around a preferred definition and by others to keep it open. Clearly, there is more to this than a question of scientific evidence.

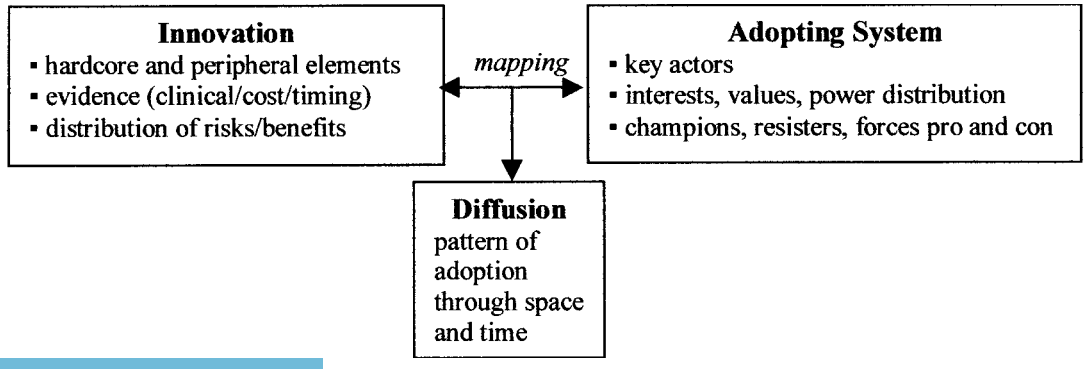
CROSS-CASE ANALYSIS: AN INTEGRATIVE MODEL

In the previous section, we sketched four different innovations, the scientific evidence related to them and the different ways in which they diffused across a specific region. The LMWH case was classified as successful because the practice diffused rapidly following the emergence of supporting evidence. The diffusion process involved multiple paths (clinical vs. administrative initiation) and network effects as the need for interorganizational linkages sometimes helped and sometimes hindered diffusion across different sites. The laparoscopic cholecystectomy case was classified as overadoption as the surgical procedure diffused rapidly in advance of clear evidence. The diffusion process could be described as a self-reinforcing spiral or bandwagon effect as surgeons felt they had to transform their practice or perhaps lose it. The hemodialysis filters case was classified as a case of prudence as evidence was initially ambiguous and adoption was slow. The diffusion process could be described as localized and sporadic depending on how the economic benefits of the new procedure were distributed. Finally, the ACT case was classified as a case of underadoption as scientific evidence for the efficacy of the approach existed long before adoption. Yet, we noted the ambiguity surrounding the nature of the innovation and the highly emotive reactions it engendered. We may characterize this as a polarizing and intertwining effect as competing models emerged and sometimes redefined themselves with respect to the ACT language. In this section, we step back from the individual cases in an attempt to identify the common forces that are driving these four different diffusion patterns. We begin by presenting an integrative conceptual model and then examine in more depth four of its components as they apply to the different cases.

Overall, analysis of the cases leads us to view the process of diffusion as an interaction between two entities: (a) an innovation with its key characteristics, and (b) an adopting system composed of actors with a certain set of values, interests, and power dependencies (see Figure 1). Each innovation has a hard-core

FIGURE 1

CONCEPTUAL MODEL OF THE DIFFUSION PROCESS



element that is well defined and fixed and a soft periphery that is less clear and more flexible to manipulation by the adopting system.[24] Over time, interactions between the two entities lead to a distinct pattern of diffusion.

Our conception of the diffusion process has some of the features identified by actor-network theorists.[25] In particular, we share with them the idea that objects may have different meanings for different actors and that this is key to understanding whether and when adoption will occur. We also share with them the conception of innovations and networks of supporting actors as coevolving over time. Moreover, like other recent writers on health care innovation,[26] we draw attention to the dynamic nature of the adoption and diffusion process. In the following analysis, we present four aspects of this model, contrasting it with the pure evidence-based logic.

1. The Distributed Nature of Benefits and Risks

The evidence-based decision-making perspective essentially views adopting systems as unified rational actors. From this perspective, evidence of clinical and/or cost-effectiveness can be integrated into a single calculative decision to adopt. However, in reality, adopting systems are not unified rational actors and the benefits and risks of the innovation are distributed unevenly among the people involved. In addition, different people may have different degrees of power to influence the process as well as different individual appreciations of the same risks and benefits. Table 2 illustrates some of the differences that exist between perceived costs and benefits for different individuals within the four cases. The groups mentioned are those that appear to be most powerful in determining adoption outcomes. Note that patients are clearly interested actors but certainly not the most powerful on the lists, partly because of their vulnerability as patients and partly because of information asymmetries. Overall, this suggests a first proposition.

> Proposition 1: The more the pattern of benefits and risks surrounding the innovation maps onto the distribution of interests, values, and power of the actors in the adopting system, the easier it is to create a coalition for adoption and the faster the adoption process.

For example, in the LMWH case, the scientific evidence was clearly favorable and adoption proceeded steadily. However, different groups were affected differently by the change (see Table 2). For hospital administrators, it was a way to save beds because the treatment allowed followup in the community. For some physicians, it was a "best clinical practice" as well as a way to increase throughput (and maybe income) while for others, it implied a reduced ability to follow their patients adequately (and perhaps reduced income). For nurses, it could mean more time spent on teaching. For community clinics, it involved increased responsibilities not necessarily covered by increased budgets. For patients, it could be a welcome way to avoid hospitalization, or perhaps an increased cost and inconvenience. Negotiating across interprofessional and interorganizational lines made convergence complicated, although the benefits for a variety of actors provided multiple entry points in the push to build a coalition in favor of adoption.

In contrast, as described earlier, the laparoscopic cholecystectomy case had characteristics that produced an overwhelming proinnovation coalition despite certain risks and limited evidence, while the dialysis filter innovation resulted in a local and sporadic adoption process because of its limited appeal for powerful groups (see Table 2). Finally, despite supporting evidence, the ACT innovation, like LMWH, had unevenly distributed benefits and risks. This led to adoption in contexts where there was strong mapping of these benefits and risks onto the interests, values, and power distributions of their organizations, but not in contexts where the fit was lower. Moreover, the nature of what was adopted shifted from one site to another depending on how each site evaluated the feasibility and interest of different forms of intervention.

2. A Variety of Value Foundations to Legitimate Choices

The discussion above might lead one to believe that in making choices to adopt innovations, actors mainly consult their own economic or other personal interests. While we do argue that the consideration of these interests is indeed important, our observations also suggest that change is more successfully promoted or resisted if it can be grounded in values that legitimate the chosen position and that may also rally others to the cause for "good" reasons as well as interested ones.

> Proposition 2: In the mapping of the innovation onto the adopting system, the capacity to mobilize actors appears to depend on both interests (economic, other) and on values that can legitimate actors' positions.

TABLE 2

PERCEPTIONS OF BENEFITS AND RISKS ASSOCIATED WITH FOUR INNOVATIONS (ILLUSTRATIONS)

	Leading Evidence	**Lagging Evidence or Ambiguity**
Rapid adoption	1. Success: LMWH Doctors: (+/−) Benefits of being on the leading edge; easier life in emergency room . . . but loss of control of patients and possible loss of revenue + "Doctors like to work in a milieu where they have the impression everyone is up to date" (d4) + "For the emergency physician, it's good. They can take patients that normally they would have to fight with the staff upstairs to get admitted." (p7) − "If we don't see the patient, we don't make any money—it's a disincentive." (d7) Nurses (+/−) Interesting new teaching responsibilities . . . but possible increased workload + "Ambulatory care is an interesting nursing field. It's the nurse that does the teaching" (i2) − "The patients remaining in the hospital are sicker and require more care." (i6) Patients (++/−) Benefits of being at home for treatment . . . but increased cost for drugs + It's a great advantage to be treated at home (i5) − "Treatment at home leads to a transfer of costs from the public to the private sector" Administrators: (+++) Reduced costs, bed utilization + It was easy to justify to the administration as it avoids hospitalization (md1) Community clinic personnel: (+/−) Recognition of role . . . but confusion in protocols, additional work − Some hospitals don't have the same protocol so we have to discuss it to be sure (c2)	2. Overadoption: L Cholecystectomy Surgeons: (+++/−) Need to adopt to stay in business . . . but costs of learning a new technique + "If I wanted to continue doing cholecystectomies I had no choice. I had to adopt the laparoscopic technique. Patients wanted it, referring physicians wanted it and the milieu wanted it. To stay in the market, you had to learn the technique (e2) − "When you have been working for 20 years with a technique, it's very difficult to change" (e3) Patients: (++/−) Aesthetic advantages, shorter convalescence . . . but hidden risks of complications + "Patients frequently ask me how big will the scar be. I say as small as possible (e2) + For OC, there's 2 months of convalescence and 10 days in hospital as compared with 2 weeks of convalescence and 2 days in hospital for LC (e4) − There was an increase in deaths following cholecystectomy (e1) Administration: (++) Reduction in lengths of stay. . . but equipment costs (sometimes supplied by firms) + "Enormous economic advantages—if you have 2 days of hospitalization instead of 7" (e4) − "The hospital took a while to purchase the equipment." (e3) Equipment suppliers (+) Increased sales + The big companies saw that the money was there and invested heavily" (e1)
Slow adoption	4. Underadoption: ACT Psychiatrists : (+/−) Capacity to improve quality for patients . . . but hard work, need to adapt approach + "I said we have to find a way to offer follow-up to these people because they need it" (e11)	3. Prudence: Reusable dialysis filters Nephrologists: (−−/+) No direct benefit . . . but may benefit indirectly through cost savings + "The administration made a deal with the nephrologists promising them funds for a peritoneal dialysis program that they wanted provided they stopped their opposition to reusable filters." (d2)

TABLE 2 (continued)

	Leading Evidence	Lagging Evidence or Ambiguity
	− "It's the same number of hours but it's much more intensive because we are dealing with ongoing crisis and that's harsh." (e6)	− "There was a devil's advocate who said—well if there's a problem and we all go to jail, then we haven't solved the problem" (n1)
Personnel : (+/−) Rewarding work . . . but not for all	+ For the personnel, its rewarding because you see that people don't come back to hospital (e4) − Many nurses and social workers didn't believe in it, we had to find people who believed in it (e3)	Technicians, nurses (−) Small risk in some cases − "The technicians work with formaldehyde, it can be toxic but we use ventilation to eliminate the vapors"
Patients (++/−) Social integration, perceived risk of coercion, less secure than hospital	+ It's a way to improve patients' lives. (e8) − At a theoretical level, people may say that there's a risk of coercion. There are ethical issues there (e7)	Patients (0/−) Concerns about safety/consent − "Recently, we received a complaint from a patient who refused a reusable filter." (r1) + "Generally patients have confidence in us (n2)
Hospital administrators (+++/−) Closure of beds, monetary savings (?), capacity to retain clientele	+ "less costly—but not as much as you'd think" (e3) + There are political and economic issues re what'll be the role of hospitals in the transformation (e2)	Administration (+/−) Potential cost savings . . . but dependence on single supplier + "It's simply an economic incentive" − "You're stuck with a single supplier for the machine and for the filters." (d12)
Community clinics: (?) Concern vs. reduced role	−/+ "PACT is a medical model imposed on the client. For us, there's no question of controlling the person, just supporting him, with a lot of respect (e10)	Supplier (+/−): Sale of machine . . . but loss on filters +/− The filters are our bread and butter so if we promote reutilization, we shoot ourselves in the foot

It is here that evidence may play an important role as it provides a warrant for the efficacy and safety of the proposed innovation. However, while the evidence-based decision-making model gives priority to scientifically based evidence as a privileged source for value judgments, we observed that the values used to establish legitimacy in specific cases might or might not be related to scientific evidence.

In the LMWH case, evidence was cited by many respondents as influential. However, it meant different things for different people. While the leading-edge practitioner in a large teaching hospital referred to research and the literature as a source of evidence, for

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others, conformity to the standards of care of the top medical institutions was seen to be the key value (reflecting an institutional model of innovation diffusion):

> At the Mayo clinic, they're very conservative. I adopted it because the Mayo Clinic was doing it (. . .) for me, it's not a scientific article that would get me to change my practice, it's when I hear that another institution in which I have confidence has adopted it. We're a small hospital here—this isn't the place to innovate.

In the cholecystectomy case, scientific evidence was slow in emerging. However, the highly visible benefits to patients successfully treated combined with relatively invisible risks made the treatment extremely attractive. As one of the surgeons interviewed said: "The difference was so striking for hospital stay and convalescence between traditional cholecystectomy and laparoscopic cholcystectomy—it's like asking whether the Pope is catholic. You can see that the Pope is catholic, you don't have to prove it." Conversely, in the reusable dialysis filters case, supporting scientific evidence on cost and safety was not always very powerful in a situation where there were no obvious clinical benefits. It was easy to argue that as long as the filter cleaning procedure depended on human intervention, there was always a residual risk. On the other hand, when the dialysis unit was faced with the choice to reuse filters or limit its own development, it was equally easy to argue on the basis of evidence that the procedure could be made safe and that this would allow more patients to benefit from the service, thus saving lives. In this case, both adopters and nonadopters appeared to be equally comfortable that they had made the right choices based on defensible value judgments.

Similarly, for ACT, ideologies that favored or disfavored medical vs. social approaches to mental health care could be mobilized respectively by the proponents and the opponents of ACT. Here, the values mobilized concerned very different interpretations of what was good for the patient placing in stark contrast the scientific model of traditional medicine supported in part by the pharmaceutical industry, and the social model of a community activist movement in which workers accepted salaries considerably lower than those offered in the hospital sector. The ability to defend very different positions was of course assisted by ambiguity concerning the precise elements of ACT that produced positive effects. This brings us to the next issue.

3. The Fluid and Negotiable Boundaries of Innovations

The evidence-based decision model generally assumes that innovations are well defined. The object around which a randomized control trial is conducted needs to be specified for any useful data to be collected. It is then assumed that this object will be adopted as a unit. However, in practice, we observed that innovations were composed of a hard core that was relatively fixed and a soft periphery related to the various ways in which it might be implemented (see Table 3). This leads to the third proposition.

TABLE 3

HARD CORE AND SOFT PERIPHERY FOR FOUR INNOVATIONS

	LMWH "Success"	**L cholecystecomy "Overadoption"**	**ACT "Underadoption"**	**Reusable Filters "Prudence"**
• Hard core	CLEAR: Drug	FAIRLY CLEAR: Surgical procedure	VAGUE: List of standard practices	CLEAR: Reusable product + equipment
• Soft periphery	• Organizational arrangements • Follow-up process • Indications (who should be treated)	• Surgeon skills • Indications (who should be treated) • Conversion (if and when to change to the older technique)	• Which practices to include? • Professional skills • Variations that may be labeled as ACT • Indications	• Variety in technology • Human intervention in cleaning process • Distribution of economic benefits

Proposition 3. Negotiation of the meaning of an innovation in a particular context occurs in the soft periphery of its definition, enabling a variety of pathways to adoption.

The existence of the soft periphery means that the distribution of benefits and risks of an innovation for the adopting system is not entirely fixed because most innovations can be implemented in a variety of ways that are not fully clarified in scientific studies. The greater the uncertainty surrounding modes of application, the more scope there is for controversy, and the more scope there is for different adoption pathways.

This phenomenon manifested itself in several ways. For example, in the LMWH case, the appropriate method of followup remained ambiguous. In some cases, this resulted in conflict. For example, a physician on one site insisted on a larger number of followup blood tests than the other hospitals had agreed to with the community clinics creating an impasse in implementing the program. However, ambiguity in followup methods also allowed a variety of nonstandardized practices and means to implement the innovation depending on the organization and mix of interests and impacts on each site (e.g., the clinician-initiated and organization-initiated approaches described earlier).

In the laparoscopic cholecystectomy case, the surgical procedure itself was quite well defined. The principal uncertainties lay in the level of surgeon skills as well as in the indications as to which types of patients could benefit from the procedure. While some hospitals were restrictive in determining who would be allowed to operate under what conditions and after what degree of training, others were not. In order to accelerate learning, the more prudent hospitals and surgeons tended to broaden indications for the procedure, again playing within the soft periphery.

In the ACT case, extensive randomized control trials had been undertaken to test a complex package of measures with well-supported results. Yet, the role of each of the components of the package was not theoretically or empirically clear. While some argued that the only way to ensure reliable effects was to implement the entire package, others selected from the package those elements that appeared most critical to them and could claim that they were following the principles of ACT. The boundaries of the treatment were to some extent negotiable, leaving both opposing ideological groups the scope to argue for their favored treatment. The stakes were high, especially for the medical and hospital establishment, leading to attempts to solidify the legitimacy of their approach through calls for government and professional body guidelines.

An interesting situation occurred for the dialysis filters case. At first sight, this is the case where the content of the innovation was least negotiable: a hospital either uses reusable filters or it does not. However, what remains undecided is the distribution of the benefits. Especially where benefits are monetary, they are exchangeable for other things. In this case, where adoption occurred, it was often because the administration negotiated with nephrologists to share the monetary savings to develop their service. To achieve adoption, the adopting system had to redistribute the benefits so that they mapped onto its structure of interests, values, and power.

4. The Dynamics of the Adoption Process

The evidence-based decision model essentially assumes a discrete adoption process with two states: before and after. Under this view, adoption is virtually instantaneous and its benefits are obtained immediately. Our observations suggest, on the contrary, that the adoption process is cumulative and may itself be costly with risks and benefits evolving over time. More specifically, the analysis of the cases suggested the following proposition:

Proposition 4. The presence of a strong pro-adoption coalition of interests combined with high need for learning can lead to compressed learning that may be costly for patients.

It is not always realized that innovations often require professionals and/or organizations to learn new modes of functioning. The new competencies required form part of the soft periphery of the innovation: The new technique may be fine if well executed, but not if not. Yet, paradoxically, nothing may ever be adopted if no risks are taken. Organizations and individuals try to find ways to cope with these risks. For example, surgeons often practice on animals and treatments can first be tried on relatively unproblematic cases. All the innovations we studied contained some element of learning and therefore of initial risk. Usually this appeared to be reasonably well controlled. However, when the pressures for adoption are particularly high, the learning process can be costly. First, procedures may be done on patients who do not need them to ensure nonrisky practice. Second (and worse),

errors may occur. Both these phenomena affected the laparoscopic cholecystectomy case. Pressures on surgeons to adopt the procedure were intense: demand was high and surgeons who could not deliver the procedure risked losing their clientele. At the same time, this was an entirely new approach to surgery that required new skills. The result was serious overutilization of the procedure and an increased complications rate. Interestingly, the surgeons we encountered identified a number of other surgical procedures that could be subject to similar problems. Although we cannot affirm this with certainty, it seems likely that the ACT adoption process may also be subject to learning difficulties as professionals used to dealing with patients in the hospital setting discover over time how best to handle patients at risk in the community.

We have insisted in this section on the within-case learning component of the adoption process as it was particularly striking in one of our cases. However, various other dynamic effects are observable when a longer-term view is taken of the innovation process.

For example, the adoption of a given innovation can change the capabilities, interests, values, and power distribution of the adopting system and render it more or less likely to adopt future innovations. Laparoscopic cholecystectomy allows surgeons to learn laparoscopic techniques and makes them more likely to consider this technique for other conditions in the future. Agreements between hospitals and community clinics concerning LMWH and deep vein thrombosis provide a promising base for developing agreements around other kinds of patients. Adoptions of ACT by one organization generated interest by other actors in ensuring the capture of this clientele but not necessarily using the same approach. This appears to have energized the mental health sector, leading to the emergence of a number of creative solutions as well as a continuing struggle over the language and possible regulation of practices.

Because we isolated four unrelated innovations for study, we only touched on their potential dynamic effects. It is nonetheless clear that the arrows between innovations and adopting systems do indeed lead in both directions (see Figure 1). Adopting systems can locally alter the shape of the technologies implemented, notably through negotiations in the soft periphery, while individual technologies may locally change the shape of the adopting systems themselves by creating precedent, developing new skills and empowering certain groups rather than others.

CONCLUSIONS AND IMPLICATIONS FOR PRACTICE

Our observations illustrate the mutual influence between innovations and adopting systems and the sometimes desirable and sometimes undesirable effects on adoption patterns. The diffusion and adoption of innovations is a social and political process in which the benefits and risks of technologies are distributed unevenly, are locally defined, and thus have differentiated influences on individual decision makers. In this context, a model of decision making that supposes a unified calculation based on the evidence is unlikely to fully explain diffusion patterns.

Yet, evidence is not irrelevant. While economic and other personal interests of different groups certainly play a role, most actors draw on some representation of patients' interests in discussing and assessing the pertinence of different technologies. Scientific evidence serves as one source for value judgments on the basis of which technology decisions may be legitimated. However, there are other sources of legitimization. These may include common sense, what the leading institutions are doing, and firmly held beliefs about the appropriate way to treat human beings. The most strongly contested innovation among the four studied was the one for which interests and ideologies aligned themselves into opposing camps.

How then can practitioners (e.g., technology assessment agencies; professional practice regulators, patient advocates) intervene to promote sensible decision making concerning the adoption of innovations? Each of our four propositions appears to have specific practice implications. For example, the first proposition emphasizing the sociopolitical nature of adoption choices suggests that new practices must be analyzed not only in terms of their benefits for patients, but also in terms of their implications for the specific groups of people who need to collaborate in their implementation. Once this analysis has been done, ways may be found to intervene, perhaps by altering the distribution of risks and benefits, or at least by permitting open and frank discussion of personal concerns that may have previously exerted a hidden influence on the dynamics of innovation adoption and diffusion. The second proposition dealing with the role of values in legitimizing technology choices suggests that there is also scope for bringing patient and citizen concerns directly to the table. Patients often lack power in adoption decisions. However, if better ways were

found to intervene on their behalf, perhaps by encouraging participation in discussions of major choices, their positions might well be more influential. Neutral groups such as medical colleges, technology assessment groups, and physician advisory bodies could moderate such discussions.

The third proposition draws attention to the ill-defined nature of many innovations. Herein lie both opportunities and risks for practice. Opportunities come from the realization that there may be a number of different ways to achieve effective implementation of useful innovations and that negotiation within the soft periphery can render feasible practices that initially appeared destined for failure. However, there may be risks in this due to the potential for diluting the active features of the innovation through compromise (e.g., as could happen with ACT?), or of dispersing the benefits in ways that do not necessarily improve patient care (e.g., a consideration in dialysis filters?).

Finally, both the first and last propositions warn us of the dangers of innovations with obvious benefits for a wide variety of people, but with hidden risks and high needs for learning (the case of laparoscopic cholecystectomy). The paradox with this type of practice (typical in surgery) is that clear evidence about the appropriateness and conditions for good practice rarely emerges until the innovation has been experimented with for some time precisely because learning is required to optimize it. In the mean time, serious mistakes can be made. The problem is aggravated when professionals' survival in the market depends on rapid adoption, as was the case here. To avoid similar problems, professional regulatory bodies clearly need to consider regulating more seriously these procedures to ensure that those using them have received the necessary training.

In summary, this study suggests that those interested in promoting wisdom in the adoption of innovations must become deeply aware of the specific ways in which they are likely to interact with their social contexts. Only then can measures be taken to ensure that beneficial innovations receive the support they deserve and that risky ones are treated with circumspection.

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