Diffusion of Innovation in Health Care

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I. What Is Diffusion?

HEALTH CARE IS CONSTANTLY EVOLVING. Wave after wave of new technologies, insurance models, information systems, regulatory changes, and institutional arrangements buffet the system and the people in it. But people and institutions, for the most part, do not like change. It is painful, difficult, and uncertain.

Entire organizations in health care are devoted either to promoting innovations—selling the latest drug, imaging system, medical device, software package, or Internet site—or to preventing innovations from disrupting the status quo by counter-detailing, keeping drug reps away from doctors, requiring certificates of need, or disallowing reimbursement. Trying to change the pace at which new ideas about health care spread through the system is a priority of health care professionals; such changes easily have major impacts on cost, quality, and patient satisfaction.

"Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system." So says Everett Rogers, who masterfully represents a vast literature that spans 50 years in his classic *Diffusion of Innovations,* now in its fourth edition. This report draws from that literature to describe how the dynamics of innovation diffusion play out in health care.

About the Report

This report presents the basics of innovation diffusion: the stages of adoption, including the typical "S" curve, and the types of individuals who adopt the innovation at different stages. The ten critical dynamics of innovation diffusion are explored:

1. *Relative advantage.* The more potential the value or benefit anticipated from adoption of the innovation relative to current practice, the more rapidly it will diffuse.

2. *Trialability.* The ability to try out an innovation without total commitment and with minimal investment improves the prospects for adoption and diffusion.

3. *Observability.* The extent to which potential adopters can witness the adoption of an innovation by others improves its prospects for diffusion.

4. *Communications channels.* The paths through which opinion leaders and others communicate about an innovation affect the pace and pattern of diffusion.

5. *Homophilous groups.* Innovations spread faster among *homophilous* groups (those with similar characteristics) than among *heterophilous* groups (those that differ in important ways).

6. *Pace of innovation/reinvention.* Some innovations are relatively stable and do not evolve much while they diffuse. Others evolve much more rapidly and are altered by users along the way.

7. *Norms, roles, and social networks.* Innovations are shaped by the rules, formal hierarchies, and informal mechanisms of communication operative in the social systems in which they diffuse.

8. *Opinion leaders.* Individuals whose opinions are respected (or even just listened to) by others in a population affect the pace of diffusion.

9. *Compatibility.* The ability of an innovation to coexist with technologies and social patterns already in place improves the prospects for adoption/diffusion.

10. *Infrastructure.* The adoption of many innovations depends on the presence of some form of infrastructure or of other technologies that cluster with the innovation.

The dynamics that govern the adoption (or lack of adoption) of new medical and information technologies in the health care industry are complex. This report is intended to help those frustrated with the pace of adoption to understand how diffusion works and how to affect the pace and style of diffusion in their own organizations.

Defining Innovation Diffusion

An outgrowth of sociology, diffusion research first looked at how agricultural innovations spread from farmer to farmer. The first researchers in this discipline sought to explain why one farmer would know about and adopt use of a certain pesticide while his neighbor didn't. The master of this research is Everett Rogers, of the University of New Mexico, who has studied the dynamics of the diffusion of innovations for most of his 45-year career. His classic text, *The Diffusion of Innovations,* summarizes and interprets decades of diffusion research, identifying basic patterns, categories of adopters, and factors that influence the decision to adopt.

Two definitions create a lens through which to view technology diffusion in health care. *Diffusion* is the process by which an innovation is communicated through certain channels over time among members of a social system. (Rogers, 5) An innovation is an idea, practice, or object that is perceived as new by an individual or some other unit of adoption. (Rogers, 11) Though often described as bureaucratic and incrementally changing, health care is also a very dynamic and innovative field. Around the globe, research scientists, private industries, academics, and governmental and nongovernmental agencies work to create new ways to provide better care, find cures, and improve health.

Stakeholders In Health Care

Medical and information technology adoption decisions differ when made by individuals or organizations. Beyond that distinction, the number of stakeholders potentially affected by any technology adoption decision varies greatly. Once a clinician decides to use a new device or piece of technology, the clinician must often consider not only the impact on the patient and on the practice but also what it means for reimbursement, health care policy, and the organization in which the clinician works. A short list of stakeholders involved in a technology adoption decision are:

- The policy makers and regulators who evaluate the safety and efficacy of the technology;

- The payer, such as Medicare or other insurer, who decides whether payment will be made for use of the technology;

- The provider organization (in the form of physicians and hospitals) that must decide whether to provide the technology and then also get the proper training and education to use it appropriately;

- The patient who must know enough about the technology to give consent for its use; and

- The vendor company that researches, develops, and sells the technology.

Change Agents

The vendor representative often plays an important role in innovation diffusion as the change agent. A change agent is an individual who influences clients' innovation-decisions in a direction deemed desirable by a change agency (Rogers, 27). For example, there are almost 60,000 pharmaceutical sales representatives who are perfect examples of change agents. Their job is to influence physician decisions in favor of using their drug over another by providing the physician educational materials, free samples, junkets, etc., in an effort to win them over.

II. The Ten Critical Dynamics of Innovation Diffusion

1. Relative Advantage

The decision to adopt a technology is influenced by (1) the ability of a potential adopter to judge whether the benefits of using the innovation will outweigh the risks of using it, and (2) whether the innovation improves upon the existing technology. The more benefit people anticipate from adopting the innovation relative to what they now do, the more rapidly it will diffuse. According to Rogers, "the degree of relative advantage can be expressed as economic profitability, social prestige, or other benefits."

Examples of relative advantage as a driver of diffusion

■ Some technological advances result in huge improvements in how health care is provided. In 1895, Roentgen discovered x-rays during his study of light phenomena, and within six months the first diagnostic radiograph was performed. X-rays gave physicians the ability to look inside the body without cutting it open. Though by the end of 1896 the negative effects of exposure to radiation were starting to be documented, the value of being able to see the structure and function of internal organs outweighed the disadvantages of radiation. X-ray technology diffused rapidly and is still the imaging modality that generates the greatest revenue today.

A more modern example is minimally invasive surgery, whereby surgeons use specialized instruments, including a video camera, to enter the body via small incisions and move through the tissue to the affected area without having to expose the entire body cavity. Cholecystectomy, the surgical removal of the gallbladder, has been radically changed by minimally invasive surgery techniques. The amount of trauma to the patient, surgical complications, and time in the hospital with laparascopic cholecystectomy is much lower than with a conventional cholecystectomy.

- In many metropolitan markets, having the latest technology is necessary for health systems to be competitive. Having a high-tech reputation increases prestige and is important for attracting the most innovative physicians, as well as for attracting patients. For some patients getting the best and most up-to-date care means judging health systems by the currency of the facility and staff. Such patients might choose the hospital with magnetic resonance imaging facilities (MRI) over one with no MRI facilities.

- Relative advantage promotes a technology when the innovation is easier to use than the previous method, often reducing duplicative and inefficient practice. In the 1980s, computer-based practice management systems were introduced into physician practices to streamline and standardize the business end. These systems automated and consolidated several accounting functions previously calculated by hand. Relative benefits increased as regulation and health insurance policies increased information demands on office staff.

Relative advantage is not always clearly expressed when a technology diffuses.

- Relative advantage does not apply when the benefits of a technology are controversial or are not explicit. For example, the National Institutes of Health and the American Cancer Society have released conflicting recommendations about the appropriate age for mammography screening. Lack of consensus has confused the public and health insurers and hindered the diffusion of mammography for middle-aged women.

- The risk of using a technology can be so great that its advantage does not seem worth it. For some women with a family history of breast cancer, genetic tests can detect specific genes that significantly increase the risk of contracting the disease. With no cure for breast cancer, for some patients prophylactic mastectomy is the preventive measure. Many women choose not to take the genetic test because the perceived benefit of knowing is lower than the stress caused by knowing, not to mention the perceived risk of discrimination by health insurers.

Lessons for Technology Diffusion

- **Understand the end user of the technology,** the person who is measuring the relative advantage of the new technology, vis á vis other decision-making and decision-influencing entities. Though MRIs are very valuable diagnostic tools for many specialty physicians, the technologist using the MRI, the chief financial officer who decides how to fund the purchase of the MRI, and the chair of orthopedic surgery, for example, will all weigh in on the purchasing decision.

- **Recognize the impact of significant behavior change** and be able to illustrate how a new technology will offer significantly greater benefit if it is expected to be adopted.

- **Consider the business case for the adoption of a new technology.** A calculation of the return on investment (ROI) helps potential adopters recognize the tangible benefit of using the technology. For intangible benefits, success stories and testimonies from others who have adopted the technology are a standard part of most marketing packages.

2. Trialability

Trialability is the ability to try out an innovation without total commitment and with minimal investment. In classic diffusion research, the easier it is to try out an innovation without having to commit fully to it, to discard an existing way of operating, or to invest heavily in technology or training, the better the prospects for adoption and diffusion. Trying out an innovation or new technology allows potential adopters to reduce their uncertainty about the risks and benefits. Even when the weight of evidence argues for or against the benefits of adopting a technology, personal experience (one way or the other) can overcome the evidence.

Examples

The free samples that pharmaceutical companies distribute to physician offices are the classic example of using trialability to promote adoption. Prescription drug manufacturers benefit from the trialability of their products in two ways—first, as a new drug is introduced, free samples make physicians aware of the product. Second, once the drug is well accepted, free samples help physicians introduce patients to a new drug. Beyond drug samples, there are many health care technologies that lend themselves to sampling of some sort:

- At professional association conferences and trade shows for medical and information technology professionals, technology vendors give demonstrations that walk individuals through the mechanics of the innovation and a hands-on trial using it on a dummy or model.

- New clinical (and even administrative) information systems can be tried out with little commitment through Web sites and application services providers (ASPs) that do not require fully installing or converting to the new system.

- Simple, stand-alone medical devices that do not require extensive training or need to interact with a complex system, such as new syringes, airway devices, or surgical staples or adhesive strips to hold together skin edges, are, like pharmaceuticals, easy to sample.

- Even when a technology fits into a more extensive or complex system, some components of it may be trialable, such as new reagents in an automated lab system or new contrast media for imaging systems.

- New medical procedures or disease management strategies may be trialable if they do not require a great deal of coordination of care. A single practitioner or office can try them out more readily than a complex health system.

These last examples point to types of innovations that are not easy to try; other approaches to promoting diffusion will be more successful.

- Innovations that require a large amount of training before they can be successfully deployed are not very trialable. New combinations of medical devices and surgical techniques, such as keyhole surgery on a beating heart or arthroscopic repair of cartilage in knee and shoulder joints, do not lend themselves to easy trials.

- Innovations that require hands-on experience to notice the difference may not be very trialable. A new grip on a hand-held device or improved flexibility in a laparoscopic tool may be something a potential user must experience first-hand.

- Technologies that require a large capital expenditure, such as complex radiological instruments, integrated information systems, or telemedicine for remote surgery, are not readily trialable, though it is possible to bring practitioners to demonstration sites.

- Innovations that fit into complex legacy systems—human, organizational, technological, or informational—are difficult to sample because they require adaptation and have repercussions throughout the system. The slow diffusion of electronic medical records (EMRs), for instance, has come in part because, although it is easy to demonstrate the functions and benefits of an EMR, it is very difficult to get a practitioner to try it out in a clinical setting because it must fit in with so many other systems. Similarly, consumer-oriented quality measures interact throughout the health system, making them difficult to try.

Lessons for Technology Diffusion

- **Look for opportunities to carve out some part of a system that is more trialable,** even if an innovation does not obviously lend itself to trials. Divide the overall process into component pieces, some of which can be attacked.

- **When designing a complex new technology or system, think about which components of it could be tried out without committing to the full innovation.** Make sure that the benefits are tangible and even more powerful when deployed in the context of the complete system.

3. Observability

Observability is seeing how an innovation works by watching someone else use it and then acknowledging that the technology is safe and/or beneficial. The extent to which potential adopters can witness the adoption of an innovation by others can determine its prospects for diffusion. The more obvious the evidence of improved experience, increased functionality, and better outcomes, the more likely it will be adopted by new users.

Examples

A non-medical example of observability is infomercials. An infomercial is a program that is an advertisement for a product. During an infomercial, an actor shows how much better, faster, and more efficient a new technology is by demonstrating its use in comparison to the traditional method. The audience is only asked to believe what it sees and is offered to try it, often with a money-back guarantee. Health care technologies are often demonstrated in a similar way:

- During internship and residency programs, physicians are taught by example. When a surgeon is learning a new procedure or how to use a new device, he or she usually watches a more experienced person using the device, often by watching the operation and then repeating the procedure.

- Manufacturers of very complex and expensive medical devices advertise their innovations much more discriminately than with infomercials. Many new medical technology demonstrations are conducted by the vendor of the device or therapy in the office of the targeted clinician or at seminars, often with extra financial or other forms of incentive thrown in to encourage adoption of the technology.

Some innovations are not easy to observe and therefore may diffuse more slowly. It is hard to observe an individual's experience with information technology and even harder when the observer does not know what to look for.

- Innovations that cannot be demonstrated easily with immediately visible results are not very observable. Some innovations improve the long-term health outcomes but show no instant change in results. Examples are devices or drugs to lower the risk of primary or recurrent events, such as cholesterol-reducing drugs to prevent atherosclerosis.

- If a new technology creates observable results that require additional expertise to interpret them and make them understandable, that technology may be slower to diffuse. The more complex the results, the less obvious they become. Examples are novel devices that are likely to benefit a small, but important, sub-population within a disease category, such as an implanted cardiac defibrillator.
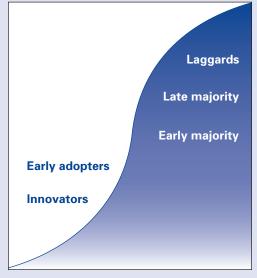
Lessons for Technology Diffusion

- **Make the invisible visible with viral marketing.** One marketing challenge is making non-observable adoption more visible, which is what pharmaceutical companies have done by plastering their logos on free items for physicians. It is also the key idea behind viral marketing. By adopting a free Hotmail email service and allowing Hotmail to put its footer on an individual's outgoing email, the individual says "I'm a hotmail user and proud of it." The use of the Hotmail product makes an act that typically is not observable—the choice of email service—more observable.

The Basics of the S-Curve

The S-curve is by now a quite intuitive model of how technologies and other innovations spread through a population. It is based in a tradition of agricultural research that looked at, for example, the uptake of a hybrid corn variety among farmers in an Iowa county or the spread of irrigation technology in California's Central Valley.

In essence, the S-curve model shows that any innovation is first adopted by a few people (or organizations). As more use it, others see it in use and, if the innovation is better than what went before, others begin to use it. Once the diffusion reaches a level of critical mass, it proceeds rapidly. At some point, the innovation reaches a part of the population that is less likely to adopt it, and diffusion slows to a point of saturation. Figure 1 traces this S-curve.

Figure 1. The Diffusion S-Curve

Source: Institute for the Future

The Basics of the S-Curve, Continued

The S-curve implies a hierarchy of adopters, and Rogers divides this population into five categories, based on when different groups are likely to adopt the technology along its S-curve path. Table 1 summarizes these groups. The shares of the population in each group are an arbitrary division that indicates the rough scale of that group in the total adopter population. (Note that the population base in this analysis is people who adopt. There also are non-adopters, who are not included.)

Table 1. Hierarchy of Technology Adopters

Category	Characteristics	Percent of Adopters
Innovators	■ Venturesome ■ Cosmopolite ■ Geographically dispersed contacts ■ High tolerance of uncertainty and failure	2.5
Early adopters	■ Well-respected opinion leadership ■ Well integrated in social system ■ Judicious and successful use of innovation	13.5
Early majority	■ Deliberate ■ Highly interconnected within a peer system ■ Just ahead of the average	34.0
Late majority	■ Skeptical ■ Responsive to economic necessity ■ Responsive to social norms ■ Limited economic resources ■ Low tolerance for uncertainty	34.0
Laggards	■ Traditional ■ Localite ■ Relatively isolated ■ Precarious economic situation ■ Suspicious	16.0

Source: Everett Rogers, *Diffusion of Innovations.* New York: The Free Press, 1995.

In general, early adopters have more years of education, higher social status, greater empathy, greater ability to deal with abstractions, greater ability to cope with uncertainty, more social and professional contact, more cosmopolite contact, more change agent contact, more exposure to mass media, and a greater degree of opinion leadership than later adopters (Rogers, 276).

4. Communications Channels

Diffusion of innovations is a social process that depends on new ideas being communicated from an individual who knows about the innovation to an individual who does not. Health care professionals and consumers are bombarded by information from many sources, each trying to persuade them to try a product, a procedure, or a point of view. Many specialized communications channels have evolved.

Examples

When the locus of power in health care was clear and concentrated in the hands of physicians, the communications channels were simple to discern and exploit: fund research that was reported in medical journals; buy advertising in those same journals; send detail people to the offices to promote products; show up at meetings of professional societies; and wine and dine the opinion leaders who have influence in each local community of physicians. As power has dispersed to managed care organizations, group practices, and consumers, the communications channels have become more complex and interact with each other in unexpected ways.

- The Internet is the single most important new communication channel to develop in the past century. It has sped up and democratized the dissemination of medical information. The medical literature, traditionally the province of only trained professionals or the most diligent and educated consumer, has become open to all.

- Increasingly, consumers are taking responsibility for their own health care (some voluntarily, some pushed by cutbacks in insurance coverage). They are thirsty for medical knowledge. Many channels have evolved to influence their decisions, including increased coverage of health technology in the popular press, a host of Web sites on health care, and a rash of direct-to-consumer (DTC) advertising of new pharmaceuticals.

- As consumers become better informed about their medical conditions, they themselves have become a communications channel to physicians about medical innovations. This shift in communication pattern can be upsetting to physicians, some of whom report that consumers come armed with the latest research or influenced by the latest DTC ad, demanding medically inappropriate treatments.

- A weakness of traditional, peer-reviewed journals is the time lag between a new finding and when it reaches health care professionals. New channels are opening up to speed that process. Online e-journals now provide early release and discussion of findings. This new communications channel may raise questions about the integrity of information that may not have undergone the rigors of traditional peer-review.

- Personal contact remains a powerful communication channel. Even as consumers and managed care organizations have gained power, pharmaceutical companies have tripled their sales forces. Detailing still works.

- Groups that want to carry a message have learned to piggyback their messages on existing communications channels. Managed care organizations (MCOs) have, for example, negotiated with drug companies to have their representatives carry MCO-determined messages (in addition to their samples and marketing materials) to the MCO's physicians.

Not all communications channels are equally effective and some have either not been adopted widely or are quite ineffective.

- Email, a staple of communications in many business areas, has been very slow to penetrate the doctor-patient relationship. Estimates of how many doctors use email to communicate with their patients range from 10 percent to 30 percent. Despite its popularity with consumers, a range of legal, ethical, and financial issues prevent physicians from adopting email widely. Like the telephone, which was slow to diffuse into medical practice initially, but eventually became a universal communications channel, email likely will reach large penetration in the future.

- Accrual rates of adult cancer patients into clinical trials remain very low, on the order of 2 to 5 percent, compared with childhood cancer patients, some 70 percent of whom reach clinical trials. Diffusion of the best cancer treatments, often represented by the practices in clinical trials, depends on patients becoming informed about their direct and indirect benefits. But many cancer doctors, for whom clinical trials are sometimes unrewarding and burdensome, often neglect to tell patients about the option to participate in trials or indicate that treatment will be determined by "drawing a card." A key communication link is broken, slowing diffusion.

- Scientific innovation depends on the free flow of information. The academic tradition of rapid publication of interesting results has begun to give way to more protective behavior, in which results are not published or are published incompletely until final intellectual property rights are resolved. Breaking or slowing this critical communication link risks impeding scientific progress.

Lessons for Technology Diffusion

- **To *inform* people about an innovation, select mass media and "cosmopolite" sources. To *persuade* people to adopt the innovation, closer links and interpersonal channels are more effective.**

- **To communicate more complex messages, select interpersonal communications channels.** Describing surgical techniques or complex medical devices works best one-on-one with a trusted source.

- **In order to select the right communication channels, select the right target audience.** For example, promoting administrative IT systems to physicians has limited effectiveness. Practice administrators or CIOs are the primary target, and they have their own, often separate, communications channels.

- **Identify individuals who are "Connectors."** Malcolm Gladwell, in his book *The Tipping Point,* identifies a type of individual who has many acquaintances (not necessarily with strong ties to them) and propagates information freely through an established network. People, ideas, and innovations that get the attention of Connectors have a much better chance of diffusing. They are a key communication channel.

5. Homophilous Groups

The degree of similarity among group members across which an innovation diffuses will affect the ease and speed with which the diffusion takes place. Innovations spread faster among *homophilous* groups (those with similar characteristics) than among *heterophilous* groups (those that differ in important ways).

In general, communication is more effective when the source and receiver share common meanings, beliefs, and mutual understandings. Communication among like individuals will be more effective because individuals feel more comfortable interacting with others like themselves. However, differences in training, social status, beliefs, and language can lead to mistaken meanings, thereby causing messages to be distorted or to go unheeded.

Physicians are a relatively homophilous group. The medical profession is a guild with rituals, hierarchy, and rules of professional etiquette that go well beyond their common schooling. Physicians all take the Hippocratic oath, a promise to do no harm. They are trained with a relatively standard curriculum that is focused on clinical skills in diagnosis and treatment. As a group, they enjoy the same high status in society.

Examples

- Most clinicians join professional associations during their careers. Associations count on the homophily of their members in communicating with them and offering services such as conferences, continuing medical education, and special certification. Associations can encompass a broad range of a profession, such as the American Medical Association for doctors or the American Nursing Association for nurses, or it can encompass a much smaller, more specialized community, such as the American Society of Clinical Oncologists.

- Most associations also publish a scientific journal that tracks the latest advances in clinical and laboratory research. Beyond the most widely-read general medical journals such as the *Journal of the American Medical Association* or the *New England Journal of Medicine,* researchers try to publish in specialty journals with specialist physician readers. The researchers and readers are both considering the homophily of the specialty as a way to filter out less pertinent information.

Though physicians are very similar, sometimes homophily is simply not there.

- Executive leadership at health systems is a mix of physicians and administrators. Though the primary incentive to adopt new technology is to improve patient care, the heterophilous nature of the roles in health system leadership and their expertise also influences their decisions. Physicians who leave clinical practice to become full-time administrators are likely to think as an administrator and be so considered by the practicing physician community.

- An example of physician heterophily that has thwarted health care quality advocates is practice variation. Though physicians all over the U.S. are trained using a similar curriculum, practice behavior varies quite drastically depending on the practice standards in the geographic area. Quality advocates attempt to overcome discrepancies in local clinical culture by disseminating clinical practice guidelines and protocols, using the appeal of adherence to generally accepted practices.

Lessons for Technology Diffusion

- **To use homophily as a technology promoter, understand the degree of homophily in the target group.** Though some groups may share training and biases and appear homophilous, when introduced to something that they are not familiar with as a group, such as information technology, their homophily as clinicians may be overcome by their heterophily as IT consumers.

- **Look for other homophilous groups beyond physicians.** Examples of other groups that may share similar needs with each other are practice administrators, health system strategic planners, nurses, specialty nurses, interest groups, and patient advocacy groups such as AIDS or breast cancer. Communication within these groups may speed up diffusion of information.

- **Put the right person in front of your target audience.** People are more likely to be persuaded by like individuals. Doctors respect other doctors because they share training, have the same commitment to heal, and feel the shared pain of increases in managed care administrative burdens, etc. It is valuable to speak to potential adopters from their own perspective and show that you understand their daily challenges.

6. Pace of Innovation/Reinvention

Some innovations are relatively stable and do not evolve as they diffuse. Others evolve more rapidly and are altered by users along the way. The degree of reinvention of any innovation affects both its pace and style of diffusion. Some innovations lend themselves readily to being appropriated and altered by their users, and can diffuse rapidly even as they change, becoming almost unrecognizable as they reach new populations. Others are much less mutable—either they are used as intended or are not used at all.

Examples

Innovations that are general, not specialized, very complex, and that are process-oriented often get reinvented to a larger extent than innovations that are not.

- Physicians are trained to be autonomous, scientific thinkers. As such, many medical technologies get reinvented and reinterpreted in the hands of practicing doctors. Off-label uses of prescription drugs are increasingly common, and compendia are published that list off-label uses, as well as those that are approved. Consumers also will find new applications for existing drugs, as evidenced by the recent publicity about women using Viagra. Surgeons are ever eager to add a personal signature on a new surgical procedure, e.g., off-pump cardiac surgery.

- Other medical technologies, such as lasers, often are reinvented. Sometimes this results in extending the range of conditions for which the device can be used. An example is radiosurgery. Initially applied to only two neurosurgical conditions, it is being used today in a range of applications within and outside of the nervous system, such as epilepsy and abdominal cancer.

- Reinvention is often a necessary step for diffusing a flexible technology into a complex social environment. Most hospitals will insist that their administrative procedures are unique, and that a standardized information system would not fit the local culture. In fact, 70 to 90 percent of the transactions and procedures typically are very similar to those of other hospitals, and only a small degree of customization is required. But the act of customizing—of reinventing—increases acceptance of the technology. A similar phenomenon takes place with practice guidelines. Local providers must put their stamp on standard frameworks to feel that they are locally adapted.

Stages in the Innovation—Decision Process

The decision to adopt an innovation takes time. There is inherent uncertainty to a new untested alternative. There are actions and choices that one must make in order to evaluate the new idea and decide whether or not to put it into practice. Rogers maps this Innovation—Decision Process into five steps.

The Innovation—Decision Process is the process through which an individual (or other decision-making unit) passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, to confirmation of this decision.

Knowledge

Knowledge occurs when the decision-maker is exposed to an innovation's existence and gains some understanding of how it functions. Acquiring knowledge occurs throughout the innovation—decision process.

Persuasion

Persuasion occurs when the decision-maker forms a favorable or unfavorable attitude toward the innovation. Persuasion is when the decision-maker becomes psychologically involved and starts to feel something about the innovation. Early information received or past experience with a similar technology affects the attitude towards the innovation.

Decision

Decision occurs when the decision-maker engages in activities, such as partial trial of the innovation, that lead to a choice to adopt or reject the innovation.

Implementation

Implementation occurs when the decision-maker puts an innovation into use and overt behavior change happens. The new user seeks information about how to obtain the innovation, thinks about what problems might be encountered, and seeks support in putting the innovation in place.

Confirmation

Confirmation occurs when the decision-maker seeks reinforcement of an innovation—decision already made, or reverses a previous decision to adopt or reject the innovation if exposed to conflicting messages about the innovation. At this point, the decision-maker seeks to avoid a state of dissonance or to reduce it if it occurs.

Source: Institute for the Future; adopted from Everett Rogers, *Diffusion of Innovations*. New York: The Free Press, 1995.

Reinvention may be a signal that there is something wrong with the technology as initially released. The fact that it must be adapted and reinvented may indicate flaws in the original design.

■ Pharmaceutical manufacturers must track their products post-approval to be certain that there are no severe adverse side effects not observed in pre-approval drug trials that only are manifested once the product is in wide use. In some cases, such effects result in redesign or reapplication of the drug, for instance limiting its use to specified populations or requiring a diagnostic test to monitor side effects. An example is the routine ordering of a liver function panel for patients shortly after a statin is first prescribed.

■ Many IT systems are reinvented after installation, particularly when the design team did not initially involve the right individuals in the process. This reinvention may reflect poor design and installation, but often is the result of insufficient after-sale training and support. Training and support cost money and time, and so are often overlooked. Change-management experts attest that training is a critical success factor to successful diffusion of new IT systems.

Lessons for Technology Diffusion

Dissatisfaction is the mother of reinvention and reinvention is a source of extremely useful feedback from users. Several devices can be used to exploit that knowledge.

■ **Put in place active listening posts.** Many IT companies have mastered the art of creating, nurturing, and listening constructively to user groups as a source of early warning about problems in a system as well as users' priorities for new features.

■ **Monitor medical technologies very carefully for instances of potentially dangerous misuses.** Early detection can trigger product changes or education campaigns that avert significant liability down the road.

■ **Look for the "work-arounds" that users employ to make a technology work.** Work-arounds are extremely common with information systems users who often do the first thing that works for them, never learning often easier ways to operate.

■ **Don't be offended by reinvention.** It is not a sign that the innovation was inadequate or that users did not really understand the designer's intent. It is typically a sign that the innovation is being put to even greater use than was intended.

7. Norms, Roles, and Social Networks

The norms, roles, and social networks of medicine are very important to the diffusion of new technology. According to classic diffusion theory, the configuration of the social networks through which innovations diffuse help govern the pace and extent of diffusion. Studies in the mid-1960s of physicians' prescribing patterns of tetracycline, for example, showed that doctors with more extensive social networks—those on hospital staffs or who attended hospital staff meetings, those who practiced in groups, those who consulted with other physicians about their cases, and those who were cited as being close friends of other doctors—adopted the drug much more rapidly than doctors who were relatively more socially isolated.[1]

Norms of behavior and expectations about roles are strongly ingrained in health care professionals and affect how new ideas and technologies diffuse into practice. These norms and expectations can be used to target the appropriate social networks to help diffuse a given innovation.

Examples

- Norms that are instilled into physicians in medical school are very difficult to change. Some of the geographical variation in surgery rates such as hysterectomy and mastectomy, for example, derive from differences in how the procedures were taught at different teaching hospitals around the country. A single professor's ideas about when surgery is appropriate can bring about great variations in cost and quality of care. However, doctors in training may learn more than one way to manage a particular problem and what they practice is often determined by local practices because "that's the way we do it."

- Medical and other professional societies are a key node in health care's diffusion networks. An endorsement by a professional society or inclusion of a drug or procedure into a society's practice guidelines can speed diffusion and lock a practice in (or out).

- Practice guidelines (PGs) themselves are a good example of the need to choose the right social network and a group with appropriate norms to maximize the pace of diffusion. Early practice guidelines were derided by many mainstream physicians as "cookbook medicine" that threatened to erode physician autonomy in the service of the financial incentives of managed care. As more providers recognized the problems of practice variation and as more professional societies produced their own PGs, physicians were more willing to get on board, as long as their own autonomy was not threatened. They found a compromise in many specialties by turning to a group—nurses—whose social norm is compliance with routines and orders set by someone else, for which they had a delivery role. Once nurses had responsibility for the implementation of PGs, diffusion was more rapid.

The power of social networks and norms of behavior in medicine also has acted to retard innovation and to reward poor practice patterns.

- Although many steps have been taken over the past decade to improve medical quality and to remove dangerous physicians from practice, a sort of medical *omertà*—a code of silence protecting members of the guild—still exists. That social norm, professional courtesy, and loyalty to the social network can slow the diffusion of better practices.

- Despite progress in the professionalization of many parts of health care delivery systems, the conventional medical hierarchy in which physicians reign supreme still persists in many settings. This affects the diffusion of many technologies. Investments in the latest imaging system (which may be a revenue center) prevail over administrative information technology (which may be viewed as a cost center).

Lessons for Technology Diffusion

An acute awareness of the social settings into which a new technology or other innovation diffuses is essential for affecting its pace. In the case of PGs, the first managed care organization to stop targeting doctors and to start targeting nurses made an insightful breakthrough. Some ideas on social networks:

- **Pay explicit attention to the physical and virtual networks of the groups you wish to reach.** In the past, social networks and geographic proximity were closely linked. Most of a clinician's contacts lived or worked close by. With the advent of the Internet and with the sustained mobility in American society, networks are more far-flung. Look for long links, members of a network who are geographically distant; and weak links, people who are only acquaintances, not close friends. Both are likely to have a social network that diverges from the tighter network and are often a source of innovation.

- **Be aware of opportunities to leverage existing or create new social networks.** People with AIDS, cancer, and many other diseases have gravitated to support groups and online communities. Often these communities have been a rapid channel to diffuse information about new medical technologies and for mobilization of activists. Many pharmaceutical companies have put in place online community spaces for people with a disease their drugs target. One drug company that produces cancer drugs helped the American Society for Clinical Oncology to create a new network of state oncology societies. These societies served as a dissemination channel for ASCO's information into community practice.

8. Opinion Leaders

Opinion leaders are key actors in the diffusion of innovations. Change agents who want to promote a new idea or technology must pay attention to those individuals whose words and behaviors influence that of their peers. In general, opinion leaders have greater exposure to new ideas through the media, by being more cosmopolite than others, by having more exposure to change agents, having higher income and education, and by having wider social networks than most people.

Opinion leaders have been a key vector of diffusion for many medical and information technologies, and a large amount of effort is dedicated to identifying, informing, and convincing them to become early adopters.

Examples

- Drug and device companies have perfected the art of identifying the opinion leaders in a given community or specialty and of courting them through their sales forces. They also have access to detailed databases showing prescribing patterns in different communities. Although the norms of how to influence physician leaders have shifted (free trips to Hawaii are out; unrestricted educational grants are in), their importance has not diminished.

- Celebrity endorsements of drugs, nutritional supplements, or health care facilities are another form of opinion leadership geared toward consumers.

- Patterns of opinion leadership vary depending on the content. Few physicians are opinion leaders on the business of running a practice, medical matters, *and* on information systems, for example. In the mid-1990s a number of pharmaceutical manufacturers and health insurers thought that, because they understood the patterns of physician opinion leadership in their respective fields, they could act as a channel to sell information technologies or disease management methodologies. They quickly found that their sales networks did not translate very effectively.

- For a number of reasons, the diffusion of information systems in health care has been much more fragmented than for medical technologies. Thousands of different practice management software packages exist, few of them with any appreciable market share. The failure to get widespread agreement on which IT system to use, especially in small practices, is due in part to the relative scarcity of physician opinion leaders for guidance about information systems. This is less of a problem for hospital information systems and in larger practices, where IT professionals (with their own patterns of opinion leadership) make those decisions.

Lessons for Technology Diffusion

Apart from the obvious lesson to identify and court opinion leaders, there are several other lessons from the literature on diffusion.

- **Do not mistake early adopters for opinion leaders.** Although opinion leaders typically do adopt many innovations before the mainstream does, they cannot afford to get too far ahead of the pack. Opinion leaders serve to reduce the uncertainty of others in their social system about adopting new technology or behaviors. This also means that, although opinion leaders should be courted, they should not be co-opted. If they adopt innovations that fail too often, they risk losing leadership.

- **Work hard to identify the relevant opinion leaders.** With the advent of the Internet, opinion leadership has, to some extent, become democratized. It is more difficult than before to tell the qualifications of an opinion-holder, because anyone can put together a slick Web page. More than ever, it is essential to be part of, and to map explicitly, the social networks of authentic opinion leaders in health care.

- **Be on the lookout for Mavens.** Malcolm Gladwell, in *The Tipping Point*, (Little, Brown and Company, 2000), identifies The Maven as a type of opinion leader who is very important to the diffusion of new ideas. Mavens are individuals who study markets and technologies to gather information on the latest, and the most effective technologies, sharing that information with their peers. Mavens have a reputation for being knowledgeable and are often deferred to by those in their social network. The Maven is a special type of opinion leader—one who has exposure to a wider range of fields and information than most other opinion leaders.

9. Compatibility

The familiarity of an innovation, its compatibility with the existing environment and behavior, is strongly linked to its diffusion. The more an innovation can integrate and coexist with technologies and social patterns already in place, the greater its prospects for adoption and diffusion. If the innovation is consistent with a potential adopter's past experiences, existing values and needs, the decision to adopt is facilitated.

Precedent behavior or an installed base of technology increases compatibility and improves the likelihood of diffusion. The more compatible an innovation is, the less change in behavior it requires.[2] A new imaging modality will diffuse because an installed base of imaging technology is there, and a new or improved drug therapy will diffuse along the same path of its predecessors.

Exogenous influencing factors, such as financial reimbursement for using the technology, can influence the pace of diffusion. Medical technology diffusion often "follows the money" in that the lack of a clear reimbursement method for a new technology is a significant barrier even if the technology offers a perceived competitive advantage to the physician or hospital.

Examples

- Plug and play technologies, those that mesh with current standards and do not require learning new behavior, are the easiest to diffuse. IV solution bags, tubes, and valves with standard sizes and interchangeability are plug and play technologies.

  Another example of plug and play technology in medicine is the introduction of Palm Pilots and other handheld devices with prescribing capabilities for physicians. Assuming that the clinician using the device already knows how to use it, the introduction of a palm-based prescription program requires no more effort to learn than the new software and reduces error and duplication.

- Most new medical technology improves upon an earlier version of the technology. Ground-breaking, revolutionary technologies that are the first to do something fundamentally differently, such as x-ray technology, are likely to be incompatible with current practice. Such technologies are often the first in what then becomes a new class of technologies and all technologies that follow it build upon the experience with the previous generation of technology.

  Since the discovery of the x-ray, new imaging technologies have diffused by building on a potential adopter's experience of the previous generation. New users of CT scans had expectations of results that were based on their experience with x-ray, and new users of MRI had expectations built on their experience with CT scans.

- The federal government wanted to promote the use of telemedicine in rural areas in the U.S. to address geographic shortages of clinicians and specialty services. In 1997, Congress increased the amount Medicare reimbursed for telemedicine services, bringing about a growth in telemedicine programs.[3] By creating a funding stream for telemedicine, the government encouraged the use of the technology and sped its diffusion among providers and vendors.

The concept of incompatibility helps illustrate why some classes of technology diffuse more readily than others.

- The use of information technology has been correlated with education and income, that is, the more education and income one has, the more likely they are to use personal computers and the Internet.[4] As individuals who have high levels of education and income, physicians are assumed to have an affinity for information technology. In fact surveys show that physicians *do* use information technology, with 70 percent using the Internet and 75 percent using a personal computer.[5] But only a quarter of physicians use email to communicate with patients and only 22 percent use electronic medical records.[6] As a rule, physicians do not use computers in their daily workflow.

- An innovation can be incompatible when an organization or government controls and rations the technology budget. In restricted budgeting environments, such as with Canada and the United Kingdom, a new technology will diffuse only after cost-benefit analysis shows significant improvement over existing technology and then only minimally, rationing the amount of technology available. Such governments do not spend as much as the U.S. on new medical technology; physicians are less likely to refer patients for high-end technological procedures and patients who do get referred must wait longer for the procedure than in the U.S.

Lessons for Technology Diffusion

■ **Understand current behaviors and values.** Look for currently existing behaviors that are similar to the behavior being introduced. Look for and understand both formal and informal hierarchies and power relationships (e.g., nurses are trained to take orders from physicians but have the dominant role in daily patient care).

■ **Innovations that reduce hassles are more likely to be successful.** Features that go beyond the primary function of the technology and make it easier and more pleasant to use will increase its compatibility.

■ **Mimic things from other parts of life.** Software developers have created computer interfaces with icons that represent functions analogous to those in our daily lives (e.g., the word processing software icon for cut is scissors and for paste is a jar of paste, etc.).

10. Infrastructure

The adoption of many innovations depends on the presence of existing infrastructure that can support it. Fax machines are an example of infrastructure's role in technology diffusion; their rapid adoption depended on telephone lines, an infrastructure already in place.

Some technologies diffuse in clusters and are interdependent on one another to succeed. The use of email depends, for example, on a cluster that includes personal computers, email software, modems, voice and data communications networks, servers, and common communication standards.

Examples

■ After CT scans were introduced into hospital radiology departments, they required computers for image display and digital image storage. Though computers had been used in radiology departments for administrative functions, such as scheduling, display and storage functions required different features and created demand for a different type of machine. When MRI technology came along, it depended on that same display infrastructure.

■ Advances in genomic technology promise personalized medicine and gene therapy sometime after the year 2010. Between now and then, the platform technologies for applying genetic and genomic knowledge to drug design and development, such as target validation, must mature. Only then will the majority of newly approved biopharmaceuticals originate from drug discovery based on targets generated from genomic-based research.

A lack of infrastructure or the wrong kind of infrastructure can retard technology diffusion.

■ To the dismay of health IT promoters, the legacy infrastructure of paper patient files is still in place. IT continues to be stored in separate, non-integrated databases, used primarily by non-clinical staff and, other than digital imaging and telemedicine, it is used mostly for administrative and billing functions. The pervasiveness of paper-based infrastructure has made it difficult for IT to diffuse beyond administrative and clinical functions.

■ Regulatory timelines and procedures can be significant barriers to diffusion. Pharmaceutical and medical device manufacturers build the time needed for regulatory approval into their development, and are affected adversely by the time taken up by requests for additional information. The longer it takes for a blockbuster patent-protected drug to make it to market, the more money a drug company loses in market exclusivity. At the opposite end of this spectrum, the FDA instituted a controversial fast-track approval process to overcome this barrier in special circumstances.

Lessons for Technology Diffusion

■ **Look for opportunities to plug and play.** To do this, it is important to understand how technologies are connected to each other, what are the relevant standards and potential contexts, and how the technologies fit into the daily workflow of clinicians. Entrepreneurs creating innovative new IV devices and tubes understand every use of them, who uses them, how they are stored and what remains challenging about the current state of the technology.

■ **Understand current and future regulatory constraints and competing patent protections.**

■ **Look for leapfrogging technology.** In some cases, it is possible to overcome infrastructure barriers by jumping to a different level of technology. An example of this is the diffusion of cell phones in parts of Asia where there are no telephone lines.

III. Epilogue

"Getting a new idea adopted, even when it has obvious advantages, is often very difficult."

— Everett Rogers,
Diffusion of Innovations

THERE WILL CONTINUE TO BE MANY BENEFICIAL health care technologies that should diffuse, but will not. And there will be others—me-too products that offer no real innovation, health information systems that complicate rather than simplify life, expensive new therapies that do not extend life or improve quality—that diffuse despite their shortcomings. This tour through the basics of innovation diffusion should help make clear why getting new ideas and technologies put to good use continues to be both frustrating and rewarding for innovators and users alike.

Quick Tips for Technology Diffusion

Relative advantage

- Understand the end user of the technology
- Recognize the impact of significant behavior change
- Consider the business case for the adoption of a new technology

Trialability

- Look for opportunities to carve out some part of a system that is more trialable
- When designing a complex new technology or system, consider which components could be tried out without committing to the full innovation

Observability

- Make the invisible visible with viral marketing

Communications channels

- To *inform* people about an innovation, select mass media and "cosmopolite" sources. To *persuade* people to adopt the innovation, closer links and interpersonal channels are more effective
- To communicate more complex messages, select interpersonal communications channels
- In order to select the right communication channels, select the right target audience
- Identify people who are "Connectors"

Homophilous groups

- To use homophily as a technology promoter, understand the degree of homophily in the target group
- Look for other homophilous groups beyond physicians
- Put the right individual in front of your target audience

Pace of innovation/reinvention

- Put in place active listening posts
- Monitor medical technologies very carefully for instances of potentially dangerous misuses
- Look for the "work-arounds" that users employ to make a technology work
- Do not be offended by reinvention

Norms, roles, and social networks

- Pay explicit attention to the physical and virtual networks of the groups you wish to reach
- Be aware of opportunities to leverage existing or to create new social networks

Opinion leaders

- Do not mistake early adopters for opinion leaders
- Work hard to identify the relevant opinion leaders
- Be on the lookout for "Mavens"

Compatibility

- Understand current behaviors and values
- Innovations that reduce hassles are more likely to be successful
- Mimic things from other parts of life

Infrastructure

- Look for opportunities to plug and play
- Understand current and future regulatory constraints and competing patent protections
- Look for leapfrogging technology

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