

If we only knew what we know: principles for knowledge sharing across people, practices, and platforms

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Abstract

The improvement of health outcomes for both individual patients and entire populations requires improvement in the array of structures that support decisions and activities by healthcare practitioners. Yet, many gaps remain in how even sophisticated healthcare organizations manage knowledge. Here we describe the value of a trans-institutional network for identifying and capturing how-to knowledge that contributes to improved outcomes. Organizing and sharing on-the-job experience would concentrate and organize the activities of individual practitioners and subject their rapid cycle improvement testing and refinement to a form of collective intelligence for subsequent diffusion back through the network. We use the existing Cancer Research Network as an example of how a loosely structured consortium of healthcare delivery organizations could create and grow an *implementation registry* to foster innovation and implementation success by communicating what works, how, and which practitioners are using each innovation. We focus on the principles and parameters that could be used as a basis for infrastructure design. As experiential knowledge from across institutions builds within such a system, the system could ultimately motivate rapid learning and adoption of best practices. Implications for research about healthcare IT, invention, and organizational learning are discussed.

Keywords

Implementation registry, Communities of practice, Healthcare practice improvement, Cancer Research Network

Science tells us what to do; guidelines what we should do; registries what we are actually doing.

- Jack Lewin [33]
American College of Cardiology

The dominant paradigm of translational science that infuses the evidence-based medicine perspective suggests that new knowledge and innovations that may generate improvements in healthcare delivery

Implications

Practice: The informal management and sharing of knowledge across healthcare organizations has the potential to accelerate and broaden improvements in care, service, and affordability if systems are designed and implemented for and largely by practitioners and trigger both their intrinsic and extrinsic motivations.

Policy: Building on established systems that already tie together healthcare organizations can shorten the time required to start up an inter-organizational Implementation Registry.

Research: Linking the analysis of how informal knowledge management and sharing systems function with staff and patient-level outcomes is a rich opportunity for health services and behavioral scientists.

are largely the products of scientific discovery: Researchers discover, practitioners apply. Even when the research in question is practice-based, primacy is awarded to research, not practice. The metaphor of a funnel is often used to depict this paradigm: A large number of efficacious scientific innovations may be winnowed down to the relative few that are robust enough in their effects to survive in the real worlds of clinical practice. Yet, this translational science paradigm is not consistent with numerous empirical studies. The origination of new ideas and their evolution into effective practices, programs, and policies is by no means limited to science. Actual adoption (“translation”) of scientific findings by practitioners may occur through any number of pathways and mechanisms [20]. Research does generate new knowledge. Certain research-based innovations do get translated into clinical practice. But the slow pace, conservative inferential standards and high cost of formal research make it the Cadillac option for knowledge generation. The volume of science-to-practice translation is dwarfed by practice-to-practice translation, reinvention by practitioners, and evidence generation by practitioners of their own new ideas, practices, and programs. Practitioner–implementers are as inventive as researcher–inventors and, by

virtue of their close familiarity with innovations in practice, often contribute more to the effectiveness of innovations [57]. Yet, we lack a knowledge management and communication model that facilitates communication of healthcare innovations regardless of their origin and that fosters adoption and integration into clinical practice [39].

The diverse ways in which innovations enter, are reinvented, and are generated anew in clinical settings present a dilemma for healthcare practitioners and leaders, most obviously in large delivery systems. Healthcare delivery systems tend to become bureaucratic and impersonal as they grow larger and disaggregated or “loosely coupled.” A loosely coupled system is one in which tight functional integration can characterize any one unit, but few structures and processes tie the organization’s various units together [60]. While a given clinical unit in a larger healthcare system may be well organized and provide excellent care, there may well be other units in the same system that are characterized by dysfunction, disorganization, and diminished ability to provide comparably excellent care. Even this simple example shows how loose coupling can exacerbate challenges of communication and coordination in healthcare delivery systems and suggests that organizational attributes can have a marked influence on both “top down” and “bottom up” attempts to change healthcare practice. Further, attempts to *bridge* organizational units often lead to managerial and employee information overload which, when combined with performance pressures, time pressures, and role pressures, can lead to flawed decision making [54].

Even in the best healthcare organizations, *knowledge management*—an accessible and efficient virtual system for knowing who’s doing what and how, with what effects, and a system that is utilized—is nearly non-existent. Two scenarios characterize the opportunity and challenge. When the savvy and well-connected physician retires, the numerous insights learned about the organization, its people, their relationships, and their activities are also retired. The specialty care coordinator whom everyone in a unit-based team relies on for knowing how to get things done with other units is invaluable and still just one person: Even if she stays for years in her key position, her scope of organizational knowledge is very partial and necessarily subjective. Solutions to the problems that impede quality, service, and affordability frequently exist within the very organizations that confront those problems, yet in large loosely coupled organizations the people who experience particular challenges are usually unaware of applicable solutions in their own organizations and may be wary of adopting those solutions for internal political reasons [41]. Being inventive is celebrated; imitating successful others is not [11].

In this article, we introduce the idea of an *implementation registry*, an online resource for healthcare practitioners within and across healthcare organizations for identifying, capturing, and sharing know-how as a systemic solution to the challenges of dissemination, diffusion, and implementation. In contrast to a traditional disease registry, an implementation registry would link data about what providers are doing to solve clinical practice problems (e.g., adherence to mammography screening) with outcomes. The registry would be more than a listing; it would be inherently relational, especially in the strengthening of horizontal ties within and across organizations [27]. This means that the registry should support the means for providers to contact each other, encourage those with solutions to problems to engage with their colleagues in problem specification and solution customization, be a “safe zone” for discussions and examples of what has not worked and why, and provide a forum where participants will feel comfortable in revealing that they need help to solve the practice problems they face [9].

VIRTUAL COMMUNITIES OF PRACTICE

The dramatic growth and diversity of web-based communities speaks to the convenience and potential for success for healthcare practice improvement. Yet, in healthcare as in other sectors, organizational and cultural barriers abound. Healthcare IT departments are strongly focused on the security and management of central and vital service functions in support of care delivery and healthcare coverage, including the collection and storage of patient data, and ensuring security of the data and IT enterprise. Most demands outside of this central purview are of secondary interest, at best, or represent a potential threat to IT’s mission. Moreover, the general ideal of participating in a “free knowledge sharing” system is peripheral to the central role of providers and clinic managers. Their role is patient care. Sharing of information may also be challenging for medical, legal, and other reasons (e.g., intellectual property). Even with these challenges, successful adoption and implementation on the basis of participation in a virtual knowledge sharing community invariably involves:

- Sufficient trust to share knowledge when the rewards for doing so may be unclear, delayed, unacknowledged by one’s employer, or even at odds with the employer’s short-term instrumental objectives
- Reporting failures (e.g., severe side effects from a treatment, a long delay between diagnosis and treatment)
- Identifying problems or challenges (e.g., limited time to determine optimal treatment)
- Rendering improvements or tests of change (e.g., databases and search tools to facilitate treatment decision making, clinical interventions)

- Consideration of the trial experiences of potential adopters
- Implementation experiences of actual adopters

A knowledge sharing community is successful because the value of participating has high face validity and the risks are minimal. Threats to success arise when the means of protection against risks are inadequate or when the gains from participation are not at parity with sharing. Participants may be skeptical and concerned about decentralized control, contributions from someone outside of one's trusted network of advisors, and free sharing of scientific and practice knowledge. Finally, a knowledge management system must rely on IT, but if it is to be nested within an IT environment, there may be competing and conflicting demands with regard to restricted access and information control versus sharing at a level that translates into practice improvement. IT resources may not be immediately directed to knowledge management because the short-term gains may not be evident, especially when juxtaposed against the monumental challenge of devising an IT-mediated system that can be nimble and adaptable enough to keep pace with rapidly changing information needs.

Knowledge management systems represent a form of meta-innovation; they exist so that other innovations in an organization can be shared, disseminated, diffused, and appropriately adapted into each practice setting. The sharing of what works and under which conditions can lead to better decision making and creative solutions to problems and promise more rapid adoption and well-suited adaptations of innovations [27]. Just as importantly, the behavioral modeling of *know-how*—not what others are doing but how they are doing it—can support a community of practitioners invested in practice improvement, implementation, and sustained use [56]. Know-how that is shared through a knowledge management system can address two needs: (1) how to change an innovation so that it suits the constraints of a particular practice context and (2) how to make changes to the existing practice context required to implement the innovation. For example, a new study may report on a successful web-based intervention to increase physical activity among individuals with multiple co-morbid conditions. However, the intervention may rely on the ability to communicate with a healthcare system's electronic medical record (EMR) to provide goal-setting data and self-monitoring support. Absent of an interoperable EMR, this promising intervention may be incompletely implemented. With an active knowledge management system, practitioners could seek advice and learn from others who have adapted the innovation under similar practice-level constraints. Studies in knowledge utilization, technology transfer, and implementation science point to this importance of *mutual adaptation* [23, 31].

Practicing in isolation, interested individuals innovate implementation strategies and learn about their value in that setting based on its success. But they cannot easily judge the generalizability of their strategies or determine which of the strategy's components determined its success or failure. Communication with fellow interested practitioners that is informed by data on the success of all their respective strategies provides a higher perspective on implementation issues. The aggregation of data reveals the natural experiment composed of their collective efforts across varied settings. The aggregation of expertise consolidates the intellectual capital that is focused on drawing conclusions about the generalizability and key components of effective strategies and on designing improved innovation.

The idea that change might be more effectively promoted through informal, trans-institutional virtual communities of practice (VCoPs) composed more of motivated individuals than led by formal management mechanisms has prompted many large organizations including IBM, Xerox, and The World Bank to devote significant resources to fostering and supporting them [32]. A large ethnographic study by Xerox concluded that information cascading downward through formal institutional channels was far less effective in helping people accommodate new practices into their work than information which moved laterally through informal channels of communication as colleagues shared practical tips and coached one another in trying out new strategies [55]. Communities of practice are increasingly popular in the healthcare sector [34]. One study by [48] found that an email network among 2,800 members of a networking service for evidence-based healthcare helped bridge research-practice gaps through the spontaneous generation of groups and larger communities.

Wenger [61] identified three essential characteristics of communities of practice:

- The domain, meaning that participants share an interest and thus a commitment to the domain
- The community, meaning that participants engage in joint activities and discussions, help each other with problems or challenges, and share information
- The practice, meaning that participants are practitioners of some type and among whom communication is facilitated by a shared repertoire of skills, experiences, tools, and paradigms

VCoPs are not all of one type. They differ by stage of development [62], and they can be more or less spontaneous or intentional in origination. [16] in a study of 18 VCoPs identified 21 characteristics which could be grouped into a few types. Clearly a key factor to operational success is participants' perceived trust and commitment to both the domain and to each other [17, 22, 35].

Taken together, multiple communities of practice that are each facilitated by a common infrastructure can constitute an implementation registry for health-care organizations. Each VCoP could tie together practitioners of a common type (cancer care coordinators, patient navigators, etc.) accessing and contributing to an online community. So an implementation registry supports each community of practice by embedding each community in a learning network in which employees of organizations voluntarily unite around a common purpose (e.g., improved transitions of care or medical home models) and interconnect to acquire, organize, and share their know-how. VCoPs are often moderated or facilitated by designated trained individuals or small teams of people, a function which seem important to their continued operation [18].

THE ROLE OF VCOPS IN INNOVATION DIFFUSION

We are convinced that an implementation registry that allowed for multiple VCoPs could accelerate knowledge sharing, adoption, trial, implementation, and sustained use of innovations. It is well-known that even strong evidence in favor of a practice change does not adequately motivate adoption [13, 36, 52]. An assumption to the contrary is a common error that leads to ineffective dissemination [12]. This is so even in the face of elaborate, multiple, and integrated dissemination systems to publicize public health and healthcare innovations at the national level [28]. Even with such a “push,” worthy innovations can take decades to spread while ineffective innovations sometimes diffuse rapidly and sustain. This is in part due to relational trust and, especially, the reliance by individuals on informal means of learning of and gauging trusted others’ opinions of innovations [47]. The advice-seeking networks that are responsible for much diffusion can be expected to operate well within VCoPs where participants come to know each other, depend on each other for examples and information, and both seek and give advice based on their experiential knowledge with innovations.

The knowledge that is most critical for reproducing effective results, the communication of tacit information about the actions taken to implement a new practice, can be the most difficult to communicate [43]. Likewise, use of information technology, while important, is typically only part of the answer to the challenges of organizational learning [24]. Organizations can easily lose track of past mistakes (e.g., the conditions under which opioid dosing errors occur, readmissions associated with failure to appropriately manage transitions in care) and the lessons learned [5], a source of knowledge as valuable as the successful solutions to problems. Lessons learned will be incomplete without knowledge of failures. Failure is the most common outcome of any implementation endeavor, and documentation offers an important means of mini-

mizing repeating the same failure. Engaging providers and managers to report failures and mistakes will require some degree of anonymity and other means to protect against risks so that the benefits of participation substantially outweigh threats. Organizing and “trading” on-the-job experiences through a networked community could address these challenges by concentrating and organizing the activities of individual practitioners and subjecting rapid cycle improvement testing to a form of collective intelligence both for analysis of patterns (i.e., identified problems and opportunities and solutions and outcomes) and for diffusion back through the registry and to stakeholders. We posit that an implementation registry could prompt more adoption decisions and more effective implementation at the nested levels of systems, organizations, teams, and individual providers.

NOT KNOWLEDGE FOR KNOWLEDGE’S SAKE

Sustainable systems to support continued improvement efforts in organizations such as an implementation registry are assets that can address gaps in employees’ understanding of why conditions may have improved, which is critical to sustaining the improvement itself. Transfer of information and knowledge about what works and why, upward and downward, and horizontally within organizations is a well-known competitive advantage [2]. The persistence of improvements requires that organizations—not just the individuals within them—learn. *Organizational learning* is represented by the ability to continually expand the capacity to create desirable results both through the acquisition and repetition of “what works” as well as through the identification and correction of error [50]. The anthropomorphic notion that organizations “learn” is important. While actions are the product of individual behaviors, alignment of behaviors occurs in diverse ways (e.g., in pairs, small informal groups, standing goal-directed teams) and within and among organizational units (e.g., department, organization, and higher still as an association, federation, or network of organizations). Employees and clients respond to and usually align with the formalized organizational images, structures, and processes that form a culture. Thus, efforts at organizational improvement through learning can usefully be thought of as occurring at different levels [3]. Organizational learning is precisely what sustainable systems that embed and manage knowledge and resources support. Knowledge management means that organizations are less dependent on any one individual and specifically recognizes a frail quality to organizational learning. Individuals come and go. Moreover, knowledge management offers a bridge across levels within organizations and across organizations [51].

How do leaders and staff in healthcare organizations think and talk about organizational improvement? People in organizations who are involved in

efforts to improve some aspect of performance do so by consciously or unconsciously moving back and forth between (1) exploring new ways to improve conditions and (2) seeking to exploit existing knowledge within the organization that is relevant to a newly emerging problem [10, 38]. Exploring and exploiting may be extrinsically motivated by recognition of a problem, or the intrinsic desire for ongoing “self improvement” that may or may not be motivated by the organizational culture.

Exploration involves directed information seeking beyond the borders of the organization by looking to professional associations, government, and published literature. Healthcare is a unique context insofar as the practitioner may literally be making life-or-death decisions. Thus, the effect of *not* learning and the consequences of using a given treatment choice are so critical and significant that professionals continually explore new technologies, procedures, and protocols of intervention to meet patient needs [14]. When these professionals “feed forward” what they learn into the organization about what may improve performance, they are engaging in explorative learning.

Exploitation involves finding out what has happened within other units in the organization and seeking to replicate or (commonly) adapt the prior intervention in the new organizational context. Exploitation is a form of feedback in a somewhat closed recursive loop. Whereas exploration is a process of applying research-based evidence in the organization, exploitation is a concomitant process of applying practice-based knowledge—often informally or partially assessed—from the organization to the organization.

An implementation registry can facilitate both exploration and exploitation. We illustrate this partly by describing how such a system might be grafted onto an existing network and so illustrate how exploratory and exploitative learning might be facilitated by communicating what works and under which conditions among practitioners and, perhaps, between practitioners and researchers. Tapping into an existing network, even one created and operating for avowedly different purposes, would present both opportunities and challenges for an implementation registry.

CASE IN POINT: THE CANCER RESEARCH NETWORK

The Cancer Research Network (CRN) is a consortium of 14 research centers based in healthcare delivery organizations nationwide. Supported by the National Cancer Institute since 1999, investigators in the CRN have conducted a range of research projects about cancer prevention, detection, treatment, survivorship, and related cancer control topics, several of which have directly affected practice at their home institutions. The unique embedded position of the research centers in healthcare organizations which, collectively, provide

healthcare to 4% of the US population affords CRN scientists the opportunity to surface and study important questions about care, service, and affordability in relation to the organization of cancer care. The CRN includes a Principal Investigator’s Office, Executive and Steering Committees, Academic Liaison Committee, and Administrative Committees for issues of communication, collaboration, proposals, publications, and data resources, along with its series of research projects most of which involve investigators at multiple CRN sites. About 45 funded CRN studies are active at any one time [19]. The CRN is noteworthy among networks. Over the 12-year history of its evolution, the CRN has dealt with and in some cases resolved a number of difficult obstacles to network structure and purpose, including privacy and confidentiality, institutional review board agreements, financing, network leadership, and data collection in the face of increasing diversity of the provider systems that partly comprise these healthcare delivery organizations [58].

Each CRN researcher exists in several “communities,” including a borderless health science community, their proximate healthcare organization community, and the CRN community in between that spans their discipline with their organization. The goals of learning and improvement are congruent in all three of these domains even while the approaches to knowledge translation in each setting may be quite divergent.

So the CRN ties together cancer researchers across healthcare organizations. However, it does little to weave together researchers with practitioners and operations leaders in the same healthcare organizations. Inter-institutional research is facilitated by a network. But for all the strengths of the CRN, its members can struggle with all the same translational issues that face researchers who are not members of such a network. The primary interests and focus of the researchers may not be attuned to the needs of the practice system or the novel efforts within their own organization to improve cancer care, nor are the research interests necessarily aligned with their organization’s strategic improvement agenda.

An implementation registry could add a new purpose to a successful network like the CRN. It could tie together practitioners in pursuit of quality improvement and join practitioners with researchers in finding evidence-based practices and documenting intervention effects. In other instances, such a registry could help researchers learn about practice innovations that warrant attention (e.g., conduct observational studies of quality improvement or organizational change). A system like the CRN already provides a laboratory for experimentation and versatility, adding an implementation registry in essence offers to bring the CRN into a “new market” for its knowledge by expanding into practice, but with practitioners in the lead, where knowledge for

improvement's sake is the dominant driver. Notably, the number of cancer care practitioners in these 14 healthcare organizations far exceeds the number of cancer researchers.

OTHER FORMS OF COMMUNITIES

Patients Like Me and Cure Together are path-breaking knowledge collection and sharing applications that have embraced the realization that micro-communities can quickly produce relevant, credible information, born of shared experiences with a particular condition or particular medication. These examples tap into a latent demand with a centrally facilitated but peripherally populated knowledge management system.

Each of these web communities are designed to harness the power of the "crowd" to share quantifiable information that is mined for insights about how diseases, symptoms, and treatments affect individuals and groups and harnesses social networking as a way to capture and aggregate knowledge. The benefit of participating is that knowledge is made available to researchers and industries seeking tacit knowledge as well as systematically gathered knowledge.

In healthcare and elsewhere, the appropriate balance between these new approaches to decision support and strictly local knowledge is still being sought. In an increasingly networked world, more and more routine decisions are informed by individually tailored context-sensitive recommendations. Internet applications such as Trip Advisor or iTunes recommend hotels in Venice, Italy, based on the user's taste in music and the reactions of people with similar taste to various hotels. But the many patients seen by the physician in the past and our own prior experiences in Venice are the framework used to make sense of and integrate new information and will retain their inherent credibility.

PRINCIPLES FOR FOUNDING AN IMPLEMENTATION REGISTRY

We have enumerated several challenges pertaining to knowledge management and ventured to describe how an implementation registry might begin to address these challenges. For a new IT-based sharing resource to be successful for practitioners across the CRN, in particular, it will need to fulfill a set of common goals which may include helping users explore and exploit current knowledge, serving the search and implementation support functions of daily clinical care, and making it almost intuitive for over-burdened practitioners to find the information they are seeking in rapid fashion, so as not to detract from the pursuit of care and communication that is patient-centered [25]. Given the complexities of cancer prevention and care—not to mention the rest of healthcare delivery—this is a tall order.

We suggest that several principles should guide the planning and development of an implementation registry:

Principle 1. *Organize existing data so that it is easily accessible.* Implementation of a medical service that addresses the intricacies of modern, evidence-based care delivery consists of devising a strategy for achieving a common goal by breaking down each step toward achieving that goal into a series of routine tasks. Many of the routine tasks involved in delivering healthcare are complex and time-sensitive. These performance demands create a natural and formidable barrier against any method of measuring implementation which adds new steps to routine tasks. It is possible, though, to measure variation in implementation approaches using the data that are collected and captured by IT in support of these routine tasks.

An early objective in developing an implementation registry, therefore, would be to leverage the information that is already captured for other reasons. IT systems are used to coordinate the activities performed by groups of individuals seeking to achieve a common goal such as the administration of chemotherapy. IT systems in place at multiple institutions that capture what is done, by whom, and in what sequence could link variability in implementation to treatment success. Measured consistently over time and across institutions, such a registry would provide a rich set of metrics that would reveal many natural experiments and suggest many hypotheses. Ideas about innovations arise naturally from viewing how successful a variety of implementation approaches have been. When monitored over time, consistent associations between high or low success would point to the implementation strategies that deserve to be spread more widely.

IT can also facilitate communication among practitioners who would use the registry to identify successful implementation strategies and the components of those strategies that lead to success. The implementation registry we envision would not only warehouse the data but maximize its value to practitioners by supporting intuitive data modeling and data visualization tools to identify patterns in the registry, and group communication and presen-

tation tools to sustain an ongoing forum for the discussion, analysis, and planning of implementation strategies.

Principle 2. *The basis for participation should be trust and asynchronous reciprocity.* As we envision it, “community” members participate voluntarily to access and share informal know-how, but on a scale not currently possible either within or across CRN institutions. Such a network is predicated on cooperation among individuals, units, and organizations that may simultaneously be competitors for political advantage, resources, and clients [45]. In the business sector, cooperation among rivals can occur when the organizational leaders perceive strategic advantages. Inter-organization networks take the form of formal governance structures, strategic alliances, partnerships, coalitions, research consortia, etc. In contrast, a voluntary association-based network operates on trust and reciprocity and a shared belief that participants are working together toward a greater good and accomplishing something as a collective that they could not achieve independently. In terms of know-how trading, this means the asynchronous sharing of problems and solutions as they arise in the course of a participant’s serve as a form of social capital: The unspecified social obligation of exchange or “trading” is implicit as a norm among participants [4], [8]. Similarly trained professionals and engineers employed by rival companies have been shown to engage in informal interpersonal know-how trading even when the helping behaviors run counter to the preferences of their employers [6]. In the minds of Silicon Valley engineers, for example, accruing advantages and benefits for the engineering community is more important than only doing so for one’s company [49].

Can personal motivation to engage in such problem-solution sharing be realized through an online resource that ties together practitioners across healthcare organizations? Empirical research from organizational studies suggests that continued interaction and helping behaviors in networks occurs as a result of trust: the predictability of the goodwill of others. The open source software community suggests that such a collective “do good” model can work in that sector, although healthcare has the added complexities of highly heteroge-

neous observations, misaligned regulatory and financial overlays, and dependence on social interactions that support therapeutic relationships. If a shared expectation that the unobligated but normative contributions of others in a network will continue not for the benefit of a department or an organization but for the larger dispersed community of practitioners, then such a network could be informally self-managed [45, 46].

Principle 3. *Expectations should be high and objectives measurable.* Creating a trans-institutional network, especially one that must meet the needs of multiple different end-users, will require careful delineation of expected inputs and outputs, along with intensive process mapping and workflow examination to ensure that the resultant system can be readily integrated into daily work of the practitioners. Understanding the various actors, how they will use the system (will they create, store, and access knowledge?), their roles, and also the ecology of the practice environment is critical. Will the implementation registry be used as an adjunct or a primary utility in day-to-day clinical decisions? Will the registry need to integrate into other IT systems at each organization (e.g., electronic health record (EHR) systems) or can it tie into established trans-institutional IT systems of the CRN (such as the CRN’s Virtual Data Warehouse)? Alternatively, can an implementation registry stand on its own and serve useful purposes of storing knowledge about who’s doing what and how, providing access to other practitioners with solutions, engaging those practitioners with solutions through minimal but targeted know-how trading (the provision of tailored advice), and providing a safe space for honest explorations of how to improve aspects of cancer prevention and care?

In developing any system, the issue of playing to the “lowest common denominator,” that is, the organization or agent with the least-developed capability, may arise. It is tempting to devise the system around this entity for ease of implementation and the expectation that more sophisticated entities or users will adapt to the more rudimentary. This assumption, however, is inherently risky since it may preclude users from leveraging the system to its full potential. Imagine a system that could machine–learn–auto-

matically conducting extract–transfer–load from the EHR or data warehouse into the implementation registry, which would aid the predictive modeling capabilities of the system with little or no effort on the part of the user. If a system were built to stand alone, in service to a lowest common denominator site that could not access EHR data, the incredible learning opportunities would be lost.

Principle 4. *Engage the workforce.* Employees are the source of innovation and the target for engaging in organizational level innovation enterprises. Nurses and physicians will engage in quality improvement efforts [59, 63]. Providers will use online communication technologies for purposes of care improvement [15]. To be successful, an implementation registry must link to a diversity of employees, and there are likely to be regional differences. For example, in some regions, labor unions play prominent roles in agreeing to and obstructing change initiatives, especially in relation to nurses. A current example of labor unions joining together with healthcare organizations for organizational improvement is Kaiser Permanente’s national Performance Improvement effort, based on ideas of Accelerating Implementation Methodology, Continuous Quality Improvement, and Plan Do Study Act. Kaiser’s performance improvement initiative has spread throughout the organization partly because key parts of the workforce have integrated the objectives and processes into their own Unit-Based Teams initiative, which provides structured help for front-line staff to formulate problems, hypothesize solutions, explore similar work of others, and then exploit what the team learns through iterative testing. In the case of the Kaiser workforce, union sponsorship allows members to take a change initiative seriously, to suspend their disbelief or skepticism, and try it for themselves. We expect, along with Rangachari [44], that information needs of system users would change depending on where they are in Plan Do Study Act improvement cycles.

Principle 5. *Gain the commitment of “lead users” as featured participants.* A trans-institutional network will not begin at full throttle with a maximum of participants actively engaged. A lure will be needed to convince potential users of a registry

that it may be worth their time and effort. Lead users are well-known, well-connected members of a social system who are considered especially credible by their colleagues and near-peers [21]. They are not only early adopters of innovations but more specifically informal opinion leaders whose advice is sought by others [12]. Lead users are frequently “lead rejecters” of change initiatives, too, so communicating early with them about the new resource, its purpose and function, and sharing prototype versions for their input is important for in turn being able to convince them to be featured personalities on the registry as users and contributors to the system. When the participation of lead users is communicated to other potential follower–users, more trial adoptions typically occur. Appeals to lead users to become early participants for others to see and behaviorally model should be normative, for the improvement of the larger community of practitioners (such as oncology nurses, or oncology care coordinators), since informal opinion leaders typically value and attend to the norms of the social systems which accord them informal status. Learning who is and who is not an informal opinion leader can be accomplished through social network analysis [9] or informant snowball interviewing. For example, in 2009, Kaiser’s Colorado region conducted a social network analysis of advice-seeking behavior for care, service, and affordability improvement of all 6,500 of its employees which resulted in the identification of 275 informal opinion leaders. More such data collection is underway elsewhere in Kaiser.

Principle 6. *Use techniques of cognitive science, medical cognition, and medical informatics to understand the user experience.* The IT-enabled implementation registry described here is fundamentally a human system. The system will fail without users. Thus, the user interface design is a paramount consideration, especially for a novel implementation registry that may be unfamiliar to many. Design of this system wisely should entail ethnographic observations of the eventual end-users, cognitive interviews as the user interface is developed and tested, and other qualitative and quantitative data such as para-data about how each page, screen, or function is used [29, 30]. Collectively, these observations

characterize ease of use, navigability, and functionality. The iPhone and similar devices are the products of intensive urban anthropology studies to understand how people interact with technology. The success of these products is not accidental. Too often, though, computerized healthcare resources lack serious formative evaluation of cognition and informatics [42].

Principle 7. *An implementation registry is about the patient, too.* While the target audience of users and contributors for a practitioner network is an audience segment of practitioners such as oncology staff in CRN healthcare organizations, many healthcare providers come to work because of their patients. Especially among nurses due to their self-selection into the field and to their holistic training which is centered around the patient and the patient experience, appealing to normative beliefs of theirs is important for convincing them to try the new system. The practical necessities of their work and office constraints will also affect their perceptions (“What will I get out of this? Is it easy to use? Can I use the registry in real-time?”), but a normative appeal to the importance of patient care will be a key driver of the adoption decision for many practitioners [47].

Principle 8. *Quality matters.* Designers of an implementation registry will need to creatively explore the ways in which quality of the practices and changes portrayed can be assessed for cancer care [51]. Can collective intelligence of the participant-users of a system contribute to evaluation of the innovations and improvement efforts that are portrayed and discussed? Might collective “star” ratings systems work, in which contributors assess how well a given approach or practice works in their clinic? Online users rely on others to make credibility assessments through use of such group-based tools [40]. Could enough tacit knowledge about variations and adaptations and customizations made during implementation be communicated to viewers to result in valid ratings? As users explore to learn what others have done in response to a given problem or objective, would vivid narrative and visual accounts of what a clinic is doing in relation to cancer care and how they made the new practice work after

several missteps be enough information to allow viewers to make a careful reasoned judgment about external validity to their clinic? Certainly the range of Plan Do Study Act rapid cycle tests does involve the collection and monitoring of data. Would the sharing of these data be adequate to provide trend assessments for changes in quality, service, and affordability at the level of a clinic, perhaps paired with narrative accounts of how those results were achieved? Real-world healthcare practice does not wait for research; practitioners change and adjust what they do in relation to patients to take advantage of what they see as immediate opportunities for immediate improvement. Researchers need to bend their standards of proof—deemphasizing internal validity and emphasizing external validity—to help practitioner systems such as the one described here achieve “good enough” evidence of effectiveness since practitioners are going ahead with inventive and re-inventive work anyway.

SUMMARY AND CONCLUSIONS

We will never put the genie back in the bottle as far as the exponential increase in the amount of scientific knowledge. Nor will the infinite variations that a patient can present decrease in the future. The need for practical knowledge management solutions will only grow. We need to cultivate a culture of impatience, one that mirrors what patients with cancer experience. Many of our healthcare providers already feel this impatience. But we must find ways to act on this sense through agility and disruptive innovation if we are to demonstrate a rapid learning health system [1, 7, 26].

The design of an implementation registry that could link together practitioners with common challenges is an enormous undertaking requiring a progressive vision. Ideally, an implementation registry would collectively anticipate “what’s next” for health and healthcare through the postings, new data, and real-time observations of its users, a form of meta-volition. If a biomarker was discovered tomorrow that could contribute to both prediction of the likelihood of disease and guide treatment, would the implementation registry have the capacity to collect and make accessible the information that makes this biomarker clinically useful? To what extent can a registry fuse guideline content, Up-to-Date (an online repository of clinical information summarized from peer-reviewed literature), National Library of Medicine databases, and Baye-

sian networks to broaden and integrate the use of health information technologies [37]?

We have suggested that leveraging an extant and mature network like the CRN offers the possibility of exploring the barriers and facilitators to using a registry to capture, store, and share knowledge among practitioners. Such a new system could augment an existing network like the CRN by better integrating research with practice, perhaps by identifying and linking together those with experience with particular interventions with other people who are faced with challenges of implementation. An implementation registry could function to facilitate interactive problem solving and support through the exchange of know-how [53].

Since the CRN was first formed, its researchers have published nearly 200 articles, many about strategies to improve the effectiveness of cancer control interventions. Could a means of drawing together the cancer-related practitioners across different but similar healthcare organizations prove as effective? The empirical evidence about the sources and places of innovation in complex organizations suggests to us that practitioners have much to teach each other and much to teach researchers, too.

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