Physician Practice Change I: A Critical Review and Description of an Integrated Systems Model
Mark Albanese, MA, PhD, George Mejicano, MS, MD, George Xakellis, MBA, MD, and Patricia Kokotailo, MD, MPH

Abstract
The long lag time between medical discovery and when Americans benefit from that discovery has a huge cost in terms of morbidity and mortality. Medicine needs more effective methods for moving discovery to practice. In this article, the authors first offer a critical review of the models of structure and change process gleaned from the physician change literature. Next, they describe the Integrated Systems Model (ISM) that they derive from this review. The ISM has four major components: superstructure, change motivators, change process, and functional interactions. The ISM considers the physician practice to operate as a complex adaptive system requiring diversion of resources from reserves to make a change. In the ISM, resource return is a function of improved quality of care and reimbursement for services. Changes decreasing the resources of the system (parasitic) will be harder to make than those that increase resources (symbiotic) because of resistance to resource loss. The authors extend the ISM to the individual level and describe the need to consider whether individuals within the practice have sufficient reserves to fulfill their part in making the change. Any given change is generally competing with other changes for adoption. Finally, the authors consider the strengths and weaknesses of their model, concluding that by keeping patient welfare, quality care, and finances in the forefront, the ISM provides a more complete picture of forces affecting medical practice change.

Editor’s Note: In a companion article in this issue (pages 1056–1065), the authors describe the implications of ISM for CME.

T
here is a “17-year time lag between discovery and when most Americans benefit from that discovery.”1 The failure to efficiently implement potentially lifesaving innovations has a huge cost in terms of morbidity and mortality in the U.S. population.2 However, why such a long lag-time exists is unclear. Medicine, of all the professions, has the infrastructure and culture that one would expect to be aggressive in implementing new advances. Physicians undergo rigorous education, testing, and assessment to obtain a medical license, and in most jurisdictions, they must complete continuing medical education (CME) each year in order to keep their medical licenses. The CME process is evolving to a maintenance of certification model that requires physicians to continuously upgrade their knowledge and skills in order to maintain their certification.3 In spite of the tremendous amount of resources spent on maintaining and upgrading physician skills, the effectiveness of CME in producing changes in practice has been mixed.

In this article we first provide a critical review of the literature on physician change from which we derived the Integrated Systems Model (ISM) as a framework for delineating the determinants of physician practice change. Then we describe the ISM and its implications, strengths, and weaknesses.

Analysis of the Impact of CME on Physician Change
Several authors have published reviews of the effectiveness of CME. The landmark 1995 study by David Davis and colleagues4 reviewed the clinical trials of the effectiveness of differing types of CME. These authors identified 99 studies that produced 160 different interventions. The most effective mechanisms for changing physician practice involved outreach such as academic detailing visits by pharmacists, standardized patients, study investigators, or nurse facilitators during which these members of the medical team personally reviewed the change process with all relevant staff. Davis and associates also found that, in general, relatively short formal CME events such as conferences were ineffective.

In a systematic review conducted using standards set by the Cochrane Collaboration, Marinopoulos and colleagues5 reviewed 136 articles and 9 systematic reviews of the effectiveness of CME. Their findings expanded on those of Davis and colleagues, examining the impact of CME on skills, practice behavior, and clinical outcomes. They found only 15 studies that included assessment of skill outcomes, leaving their conclusions tentative. Of 105 studies

Dr. Albanese is professor, Department of Population Health Sciences, University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin.

Dr. Mejicano is associate dean for continuing and professional development and associate professor, Department of Internal Medicine, University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin.

Dr. Xakellis is clinical lead physician for geriatrics and extended care, Tomah Veterans Affairs Medical Center, Tomah, Wisconsin.

Dr. Kokotailo is associate dean for faculty development and faculty affairs and professor, Department of Pediatrics, University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin.

Correspondence should be addressed to Dr. Albanese, Department of Population Health Sciences, University of Wisconsin-Madison School of Medicine and Public Health, 610 Walnut Street, 1007C WARF, Madison, WI 53726-2397; telephone: (608) 263-4714; fax: (608) 263-2820; e-mail: (maalban@wisc.edu).
evaluating the impact of CME on short- and long-term physician practice behavior, 61 studies (58%) met objectives (i.e., interventions aimed at health care outcomes produced a positive change), and slightly fewer than 50% (50/105) demonstrated that physicians maintained the changes for at least 30 days.\(^5\) Marinopoulos and associates found that across domains (knowledge, attitudes, skills, physician behavior, and clinical outcomes), print media seemed to be less effective than live media, and a multimedia approach generally seemed to be more effective than a single medium. In addition, interactive techniques seemed to be more effective than noninteractive ones, and multiple exposures to the CME activity seemed to be more effective than a single exposure. For clinical outcomes, 14 of 33 studies that measured long-term clinical outcomes demonstrated a positive effect resulting from the CME. Although the number of studies involved was quite small, Marinopoulos and his coauthors concluded that using multiple media was more effective than using a single medium and that multiple educational techniques were more effective than a single technique. Another of their conclusions was that “Future research on CME should be based on a sound conceptual model of what influences the effectiveness of CME” (p 8).

Grimshaw and colleagues\(^6\) cite anecdotal data that physicians have less than one hour per week to devote to reading the literature and limited skills in evaluating the quality of the research found therein. They considered this lack of time and these limited skills to be primary barriers to publications in journals as means of disseminating the evidence needed to produce practice change. In a summary of 44 review papers published before 1998, they reached five summary conclusions: (1) passive dissemination (e.g., mailings) are generally ineffective, (2) active approaches are generally more effective but more costly, (3) patient chart audits followed by expert feedback and use of local opinion leaders (physicians who are well-respected in the physician community) to promote change is variably effective, (4) educational outreach for prescribing behavior is generally effective, and (5) multifaceted interventions based on analysis of potential barriers to change are more effective than single interventions. A subsequent review (by the same authors) using a more rigorous methodology for combining studies yielded conflicting results. This led the authors to argue that “a major problem with current research is the lack of a theoretical base to support the choice and development of interventions as well as the interpretation of study results and that this should be an important focus for future research” (p 241).

Developing “a theoretical base” or “a sound conceptual model” is challenging because of the rather fragmented and widely dispersed nature of the underlying literature. The CME literature tends to be easily accessible, but it reflects only a small fraction of the CME research that is published. Almost every specialty of medicine has its own literature in which CME research can be located. For example, for their Cochrane review, Marinopoulos and colleagues\(^6\) pulled the 136 articles and 9 systematic reviews of the effectiveness of CME from not only the CME journals, but also *The Annals of Internal Medicine, Pediatrics, Journal of Family Practice, British Medical Journal, American Journal of Hospital Pharmacy, HMO Practice, Journal of Cancer Education, The Journal of the American Medical Association*, and others. This is an impossibly broad literature for physicians to follow.

### Models of Physician Change

The problem of investigating change is even more challenging because so many models of physician change have been proposed. A comprehensive review of the various models would be beyond the scope of this article (and perhaps any single article). Instead, we will use the skeleton of our ISM as an organizing framework and then limit attention to those models that we used in its creation.

Figure 1 shows the skeleton of the ISM and its four major components: superstructure, change motivators, change process, and functional interactions. The superstructure defines the key elements that contribute to physician (and health care system) performance. Change motivators are those factors, impetuses, and influences that create environments that promote changes in practice. The change process is generally considered to occur in a series of stages reflecting increasingly greater commitment. For our purposes, the functional interactions of the entire system operate in ways compatible with a complex adaptive system\(^6\) (CAS, described in detail below), in which the different components, themselves microsystems, can change themselves and operate from a small set of simple rules that in aggregate yield complex and often unpredictable system behavior.

#### Superstructure

We drew primarily on Stufflebeam’s Context-Input-Process-Products model (CIPP)\(^7\)–\(^10\) as well as elements of Karsh’s human factors model\(^11\) for the superstructure.

**CIPP model.** Stufflebeam developed the CIPP model (Figure 2) during the past 40
years in the context of educational program evaluation. Just as physicians use terms such as cardiovascular system and lymphatic system to help define key components of the human body that have elements in common, the CIPP model defines key components of educational programs that have elements in common (i.e., context—the larger environment in which the practice operates, input—the resources that power the system, process—the activities that are undertaken to achieve practice goals, and products—the result of the activities and their interaction with the larger environment). More recently, Moore offers the CIPP model as an approach for identifying and examining the factors that contribute to a successful CME activity (pp 268–269). Figure 2 shows an adapted CIPP model with its four components in terms of what they mean in the context of a health care practice. Figure 2 shows a version of the CIPP model in a linear relationship, but in more recent work, Stufflebeam represents the four components in the outer ring of a circle with the core values in the center and program components as intermediates where context is reflected in program goals, inputs are represented in plans, process translates to actions, and products are represented in outcomes. The linear form of the CIPP model with context as a surrounding environment provided a better fit for the ISM of physician practice change and also aligned the ISM with a CAS.

The context is the environment in which the health care practice resides. It reflects the ethnic and religious components, the socioeconomic factors, the physical environmental factors, and all the other characteristics of the community and its setting that have an impact on the health and well-being of the population. The patients that come to the practice are a function of the context as are the health care resources that serve for patient referral or hospitalization. Although the context is generally portrayed as the first component in a linear form like in Figure 2, the context can also be the larger environment in which all elements of the enterprise play out.

Inputs. Inputs are the resources that flow to support the practice, including money, technology, the physical plant, and human capital. The inputs determine the number and mix of health care providers (e.g., nurses, physicians assistants, laboratory technicians) supported by the practice as well as the support services (e.g., information systems, laboratory tests) that are available and how available they are (wait time). Inputs also include the types of patients that come to the practice as well as the availability of consultants, specialty services, and patient services.

Process. The process entails the activities of the physician(s), nonphysician clinicians, technicians, staff, and others who support the practice in order to provide health care for their patients and the community. It includes the data collected and recorded in the patient chart, examinations and diagnostic tests performed, interactions between patients and staff, prescriptions provided, therapies administered, procedures completed, referrals written, etc. For physicians, process incorporates all elements of the leadership they provide, the professional standards they promote and model, and the humanistic qualities they display to their staff, patients, other health care providers, and suppliers. The process also incorporates the qualities that make the practice behave as a CAS.

Products. The products are the outcomes resulting from the inputs and processes of the practice within the constraints of its context. These include the patient throughput (the number of patients seen per week) and the quality of care provided (a difficult entity to define but often considered to be at least partially reflected in patient satisfaction, the standards of care met or exceeded, the quality of life of patients, the resolutions of presenting problems, the quality index measures met, etc.). Quality of care and perceived quality of care are separately indicated for marketing purposes because in a competitive market perceptions of quality can be as important as the reality.

Input-Transformation-Output model from human factors engineering. Karsh and colleagues propose the Input-Transformation-Output model of health care professional performance shown in Figure 3. Karsh built his model in the context of human factors engineering to address patient safety issues. The model clearly includes the inputs, processes, and products (performance outputs)—of the CIPP model. The context box from the CIPP model is incorporated into the performance inputs in the external environment component. What is different about this model is the focus on the assessment of whether the outputs meet objectives and quality targets, potentially leading to system redesign. The other unique aspect of this model is the substructure within each of the three major boxes. The inputs are subdivided into four different types: (1) patient and provider factors, (2) work system/unit factors, (3) organization factors, and (4) external environment. The patient and provider factors are at the center of an interlocking system of relationships among the other types of inputs. This system includes the skill sets and training of the providers, but also transient characteristics, such as moods and illness. The patient and provider characteristics fit within the larger set of work system and unit factors that then fit within the organizational factors. The entire set then fits within the larger external environment or context, as the CIPP model would label it. The Karsh Input-Transformation-Output model divides the process component into physical, cognitive, and social/behavioral performances. The physical performance type comprises a broad range of different physical activities, including such low-level activities as walking and such high-level activities as performing the tactile tasks during a physical examination. The cognitive activities are similarly broad in scope, including at the lowest level, awareness, and at the highest.
level, problem solving and pattern matching. The social/behavorial performance is broad, but generally fairly sophisticated, including causal attribution, cost-benefit analysis, and motivation among other equally complex activities. According to this Input-Transformation-Output model, the outputs are either immediate or ultimate. The entire output of the system is evaluated against objectives and quality targets with the potential of system redesign if the objectives and quality targets are not met, and with maintenance if they are.

In addition to the CIPP and Karsh models we also used aspects of the Coordinated Implementation Model (CIM) and the Systems Engineering Initiative for Patient Safety (SEIPS) models to conceptualize and build the ISM.

CIM. Figure 4 shows Lomas’s13 proposed CIM. The CIM has the practitioner at the center with new information drawn from research and distilled by a credible agency that exists in the larger environment. The practitioner is embedded in a practice environment that contains components related to education, administration, economics, the community, and his or her personal life. The new information from discovery enters the practice environment through the educational window and is filtered through the physician’s awareness of the information, attitude toward the information, and preexisting knowledge. Pressures from administrative regulations, economic incentives, and the public also bombard physicians whose own personal catalysts (e.g., desire for providing quality health care) also drive them. All these factors influence physicians in their interactions with patients.

The CIM heavily involves consideration of the context of the practice in modeling change. It also considers economic factors to a greater degree than many of the other models.

SEIPS model. The SEIPS model developed by Carayon and colleagues14 (Figure 5) focuses on the issue of patient safety and how the individual (at the center) is influenced by the environment, the organization, technology, and the tasks expected of him or her. The superstructure of Carayon and associates’ model consists of the work system that influences the work processes that ultimately produces the outcomes (e.g., quality of care and patient safety) that interactively influence the employee and organizational outcomes.

These four models are only a small percentage of those that exist. Our intent in providing an overview of the aforementioned models is not only to give a sampling of those available but also to highlight those whose components influenced the development of the ISM.

For the superstructure of the ISM, we used the CIPP and Karsh models as the

Figure 3 Input-Transformation-Output Model of Healthcare Professional Performance (Karsh11), reprinted with permission from BMJ Publishing Group Ltd (2190371271638). This model provides a variation on the ISM superstructure.
basic form. The CIPP model is quite flexible and its relative similarity to the human factors model proposed by Karsh reinforces its utility. The finer granularity provided by Karsh is useful as it helps to define what the elements are within each of the boxes. The CIM (Lomas) influenced us to increase the importance of context in consideration of change while the SEIPS model (Carayon) emphasized the need to consider the individual in a more systematic manner.

Change motivators

The second major component of the ISM pertains to motivators of change. Change requires effort and sometimes cost. For change to happen, some type of motivating force must exist. The motivating force can be internal—driven by the physician who wants to provide the very best care to meet needs of self-satisfaction or peer esteem—or can be external—driven either by payors who value quality, safety, prevention, cost savings, or some other aspect of medical care or by patients unsatisfied with usual care.

**Behavior theory.** We drew the external change motivators in our model from Behavior Theory. According to Behavior Theory, four types of operant conditioning (operants are behaviors that act on the environment) motivate behavior: (1) positive reinforcement, (2) negative reinforcement, (3) punishment, and (4) extinction. In the following description, the desired behavior is providing patient education; payment is a desirable stimulus; and paperwork is a noxious stimulus. Positive reinforcement occurs when the intent is to increase the occurrence of desired behavior by administering a desired stimulus, such as if an insurer were to pay a physician a bonus for doing patient education (this is the basic principle of Pay for Performance). Negative reinforcement is intended to increase the occurrence of desired behavior by removal of a noxious stimulus when the desired behavior occurs, such as if an insurer required extensive paperwork for payment except when the physician provided patient education.

Punishment is intended to decrease the occurrence of undesirable behavior by the application of a noxious stimulus when the undesired behavior occurs, such as if an insurer required extensive justification for payment if the physician did not provide patient education. Extinction is the withdrawal of a desired stimulus when a specific behavior occurs, such as if an insurer were to quit paying for services that were not accompanied by patient education.

Payment is only one of many forms of motivators. Work flexibility, peer respect/recognition, and conforming to the vision of respected leaders as well as intrinsic rewards (e.g., altruism, self-satisfaction from a job well done, meeting a desire to perform at high levels of quality, and being at the cutting edge of health care delivery) are also all positive stimuli. Loss of income, embarrassment, ridicule, adverse patient care outcomes, and patient dissatisfaction are all negative stimuli. While people may be motivated...
by a host of different things, payment is probably the most universally accepted and the most easily administered at the systems level because metrics can be designed to measure desired behaviors and processes, and insurers or others can use direct reimbursement or other types of reinforcement as incentives to encourage these metrics and processes.

Pay-for-Performance model. The Pay-for-Performance model16–20 (P4P or sometimes P4Q-quality; Figure 6) is an application of positive reinforcement to change behavior. Its basic concept is to link reimbursement for health care services to meeting certain quality targets. Quality targets include increasing the rate of screening and reaching desirable targets for patients with elevated cholesterol levels or diabetes. Meterko and colleagues16 proposed the conceptual framework that pertains to programs that provide incentives to improve performance.

Meterko and associates’ conceptual framework depicts how various characteristics of the practice environment and provider interact with an incentive program containing quality targets buttressed by performance metrics in order to change practice behavior. This conceptual framework is important because it models how external incentives (e.g., physician reimbursement) coupled with performance metrics (e.g., prescribed immunizations for school-aged children) interact with a practice to effect changes in practice behavior. What sets it apart is the presence of incentives, quality targets, and performance measurements (i.e., metrics). These qualities align the framework with positive reinforcement in Behavior Theory in that a reward is administered when the desired behavior occurs.

Human factors engineers have addressed not only P4P, but patient safety in their models. The value of Meterko’s (P4P), Lomas’ (CIM) and Karsh’s human factors models is the inclusion of motivating forces in the model. Likewise, we have included motivating forces in the ISM.

Change process models
The third component of the ISM pertains to the change process. A number of physician change models that illustrate process of change have been proposed.
Pathman model. Pathman and colleagues21 examined a five-step model composed of (1) preawareness, (2) awareness, (3) agreement, (4) adoption, and (5) adherence. In the preawareness stage, the physician is at baseline in “blissful ignorance.” As the physician gains awareness, he or she evaluates the merits of the change. Ultimately, the physician decides whether he or she agrees with it or not. If so, he or she adopts the change. After adoption, adherence is the next step as the change is integrated into the ongoing practice.

Fox model. Fox22 also proposed a five-step model: (1) forces, (2) imagining, (3) assess learning needs, (4) learning, and (5) adoption. The physician first feels forces for change that may come from colleagues, learning of an innovation, financial concerns, or another source. Next, the physician imagines what practice would be like with the change. The third stage involves thinking about what he or she needs to learn in order to make the change. The fourth stage is a three-part process of achieving the learning followed by the fifth and last stage, implementation or adoption.

Innovation-Decision Process. For the change process component of the ISM, we drew heavily from the Innovation-Decision Process (IDP; List 1). The IDP is also a five-step sequence proposed by Rogers whereby a physician decides whether or not to adopt an innovation. The stages are (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation. Each stage has from three to five component parts. During the knowledge stage, the physician engages in recalling information, understanding messages, and gaining knowledge or skills for effective adoption. In the persuasion stage, the physician begins to like the innovation, discusses the new behavior with others, accepts the messages about the innovation, and forms a positive image of the message and the innovation, and marshals support for the innovative behavior from the system. In the decision stage, the physician intends to seek additional information about the innovation and to try it out. During the implementation stage, the physician acquires additional information about the innovation, uses the innovation on a regular basis, and continues to use the innovation. Finally in the confirmation stage, the physician recognizes the benefits of using the innovation, integrates the innovation into his or her ongoing routine, and promotes the innovation to others. Of course, if at any stage in the process the physician finds the innovation is either not effective or detrimental, the process of adoption will end.

Transtheoretical Stages of Change. Prochaska’s Transtheoretical Stages of Change (TSC; List 1) is one of the models from which we drew heavily for the ISM, also models transformation as a five-step sequence: (1) precontemplation, (2) contemplation, (3) preparation, (4) action, and (5) maintenance.24 The precontemplation stage occurs before making a change is seriously considered, and in this stage, the change may even be actively avoided. Change avoidance is especially difficult to overcome if earlier attempts to make changes have been unsuccessful. The contemplation stage occurs when the physician (or other health care provider) becomes aware that a particular change may have merit. It involves exploring the benefits that may be derived from the change as well as the costs and potential complications and side-effects. Preparation is the stage in which the physician has decided to make a change and is doing the ground work to make it happen. Physicians in this stage design a plan of action, such as either talking with staff about what such a change would mean in terms of how certain types of patients would be handled or discussing any potential costs that the change might involve with their business managers. Action is the stage in which the physician has completed all planning and now makes specific overt modifications to his or her practice behaviors. Finally, maintenance is the stage during which the physician works to prevent reversion to old practice behaviors. Old practice habits, perhaps learned in residency, die hard and at first require constant vigilance to avoid.

We ultimately adopted Rogers’ model for systems and Prochaska’s model for extensions of ISM to individual behavior for reasons of compatibility. In List 1, we compare Rogers’ IDP model to the five stages in Prochaska’s TSC. While Rogers’ model is more compatible in situations in which a physician is contemplating changes in his or her professional practice, Prochaska formulated his model to describe how individuals make difficult health behavior changes such as ceasing to use tobacco.

Functional interactions among the model components
The last major component of the ISM reflects the ways in which the different components of the model interrelate.

CASs. The Institute of Medicine report “Crossing the Quality Chasm” likened the health care system to a CAS, a “collection of individual agents that have the freedom to act in ways that are not always predictable and whose actions are interconnected such that one agent’s actions changes the context for other agents.”25 Individual clinics, hospitals, and health care practices (each a microsystem itself) are examples of the agents that are the component parts of the larger health care CAS. Whereas mechanical systems can be isolated into their elemental parts and their different functions predictably combined to produce a desired product, the components of a CAS interact in ways that often create novel and unpredictable outcomes. The eight key elements of a CAS are as follows:

1. Adaptable elements: The elements of the system can change themselves.
2. Simple rules: Complex outcomes can emerge from a few simple rules (e.g., safety first) that are locally applied.
3. Nonlinearity: Small changes can have large effects and vice versa.

List 1

Innovation-Decision Process (Rogers) and Transtheoretical Stages of Change (Prochaska) Models

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<tr>
<th>Innovation-Decision Process (IDP) Stages</th>
<th>Transtheoretical Stages of Change (TSC)</th>
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<td>A. Knowledge Stage</td>
<td>A. Precontemplation</td>
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<td>B. Persuasion Stage</td>
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<td>C. Decision Stage</td>
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<td>D. Implementation Stage</td>
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<td>E. Confirmation Stage</td>
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4. Emergent behavior, novelty: Continual creativity is a natural state of the system.

5. Not predictable in detail: Because the elements of a CAS are changeable, the relations nonlinear, and the behavior creative and emergent, the only way to know what a CAS will do is by observing it; forecasting CAS behavior is inherently inexact.

6. Inherent order: Order exists in a CAS though not through central control.

7. Context and embeddedness: Systems exist within systems and their interactions are critical to their behavior.

8. Coevolution: A CAS moves forward through constant tension and balance. The concept of CAS emerged from a number of different areas, including studies of biological organisms. The use of biological metaphors in application to organizations has yielded an interesting set of terms such as evolution in describing change in organizations over time and the butterfly effect to refer to how small perturbations can lead to large effects in complex systems.

The CAS framework served as a starting point for Chen and colleagues in their development of a mental model for physicians to conceptualize their world from a systems perspective. Their mental model contains seven characteristics: (1) purpose(s) or goal(s), (2) boundaries, (3) resources, (4) interactions, (5) outcomes, (6) effectiveness or efficiency in achieving outcomes, and (7) ability to evolve. In this model, the purpose(s) or goal(s) are not a top management decision but a reason for the system to exist, a shared vision or mission that enables the individual agents in the system to interact in functional ways because each understands his or her role and how it fits into the larger system. Boundary definition is important because individual agents in the system can be part of multiple systems that interact with one another in complex ways. The agent’s role can be quite distinct depending on which system he or she is part of in any given situation. Resources are the fuel that makes the system run, and they include technology, infrastructure, and people with different knowledge and skills. A system cannot achieve its goals without sufficient resources or if the resources are inappropriately aligned.

Interactions are a function of the system design, and they exist on a continuum from rigid to highly flexible. Although flexibility in the extreme can lead to a void in leadership that can complicate making a change, in lesser amounts flexibility can allow for innovative ways to address new and/or recurring problems. Outcomes are a result of the system's functions and can be either intended or unintended. Once identified, outcomes serve as the criteria to evaluate whether a system is fulfilling its purpose(s) and goal(s) and to what extent its resources and interactions are being deployed appropriately to achieve necessary levels of efficiency and effectiveness. Efficiency and effectiveness are critical components of a CAS because they provide the means by which the system can adapt to the changing environment. A CAS that is consuming all of its resources through inefficiencies or ineffective means of achieving its goal(s) and objective(s) will be unable to respond and adapt to its changing environment—in other words to evolve, the last element in Chen’s model. A CAS that is unable to evolve is heading toward extinction.

Moral, ethical and professional compasses. All individuals who participate in a health care system come with their own moral, ethical, and professional values. These are part of who they are and how they interact within the system. All professionals will have a certain number of these qualities instilled by their professional training and the obligations they feel to maintain the standards of their profession. There are other aspects of individuals (e.g., need to be needed, values, religious beliefs) that are intrinsic to who they are as people and how they view themselves and their roles in the system.

Leadership. Every human system has some type of leadership component. It may be top-down or a shared arrangement, but some mechanism sets the vision, goals, and objectives and makes resource allocation decisions that are critical to the health and well-being of the system. In a CAS, leadership is not just a function of the individual who may be in a leadership position. Decisions by each member of the system play a role in how the system responds to the larger environment and how it evolves. However, the formal leadership is most likely to be vested with the power to set the vision and goals of the organization; to decide who else is hired to be part of the system (in James Collins’ terminology “who is on the bus”??); and to determine how resources will be allocated. The example set by the leadership, both formally stated and demonstrated through their actions, is often the source of the simple rules that govern the interactions of the members of the system. Good leadership can inspire and engage all members in helping the system achieve greatness. Poor or constantly changing leadership can be tolerated for a short period by an effectively operating system, but it will eventually drag the system down.

Meeting needs. For a health care system to survive and thrive, it must meet the needs of both the environment (society) and the individuals within the system (staff, patients). Maslow classified needs into a hierarchy consisting of five levels: (1) physical, (2) safety, (3) love/belonging, (4) esteem, and (5) self-actualization. Higher needs in the hierarchy get attention only when those lower in the hierarchy are satisfied. Physical needs are the most basic and refer to oxygen, food, water, etc. Safety is the next most basic and includes physical safety and security of employment, property, etc. Love and belonging refer to friendship, family, and sexual intimacy. In the workplace, love and belonging are part of a positive, caring environment. Esteem refers to self-esteem, confidence, achievement, respect for others, respect of others, including patients and the other members of the health care system. Finally, self-actualization includes morality, creativity, problem solving, and the host of other qualities (e.g., compassion, sensitivity) that we strive for in our health care systems as well as in our individual lives. Although some have debated whether the needs are in fact a hierarchy and whether lower level needs must be met before higher-order needs can receive attention, few argue that people’s needs can influence their behavior. A system must meet the needs of those who are part of it in order for them to contribute constructively to its ongoing processes. Further, the system must meet the needs of the larger environment that supplies the resources and other elements (e.g., a healthy and productive workforce) that keep the system vital. For change to happen, it
must meet a felt need, such as the esteem of other health care providers, but not threaten a more basic need, such as job security. The needs of individuals and the system operate at all levels of the system and not just at the point where internal and external motivators for change are applied.

The ISM

Figure 1 shows the skeleton of the ISM that we propose. The superstructure is at the center because it is the fundamental enterprise that provides patient care. Change process constitutes the upper loop as it is something that is not yet part of the superstructure, but must be integrated within it. The change motivators are contained in the bottom loop as they reflect the return of resources to power the system. The arrows between the parts depict the manner in which the different parts functionally interact. Figure 7 contains the full model with the different specific models adapted for the different parts of the ISM skeleton.

The CIPP Model is the infrastructure at the center and shows the flow of the system. In recognition of Lomas’ argument for the importance of the system. In recognition of Lomas’ argument for the importance of the system. The CIPP Model is the infrastructure at the center and shows the flow of the system. The CIPP Model is the infrastructure at the center and shows the flow of the system. The CIPP Model is the infrastructure at the center and shows the flow of the system. The CIPP Model is the infrastructure at the center and shows the flow of the system. The CIPP Model is the infrastructure at the center and shows the flow of the system. The CIPP Model is the infrastructure at the center and shows the flow of the system. The CIPP Model is the infrastructure at the center and shows the flow of the system. The CIPP Model is the infrastructure at the center and shows the flow of the system. The CIPP Model is the infrastructure at the center and shows the flow of the system. The CIPP Model is the infrastructure at the center and shows the flow of the system. The CIPP Model is the infrastructure at the center and shows the flow of the system. The CIPP Model is the infrastructure at the center and shows the flow of the system. The CIPP Model is the infrastructure at the center and shows the flow of the system. The CIPP Model is the infrastructure at the center and shows the flow of the system.

The products are the outcomes of the processes, such as throughput, that create a healthier population and generate revenue and patient traffic that then flow back to contribute to the inputs that renew and drive the entire process forward.

The bottom of the diagram shows the motivating conditions in the boxes labeled metrics and incentives. The metrics (e.g., obtaining blood cultures in patients hospitalized for community acquired pneumonia before antibiotics are given) and incentives (e.g., quality of care resulting in less morbidity and mortality) are used to assay the outputs of the system and to direct where some of the resources returning to the system are expended. The metrics and incentives can yield supplemental resources to the system. For example, if the metric is to obtain blood cultures in patients hospitalized for community acquired pneumonia, insurers could reimburse the physician at a higher rate retrospectively for patients with community acquired pneumonia if the death rates and/or repeat visits for the same symptoms decline by 5% during a six-month period. A direct arrow connects the process to the metrics because some of the metrics and incentives are based on processes that occur rather than outcomes; for example, the insurer noted above could, as the metric, use instead of death rates and return visits, the ordering and interpretation of blood cultures, for reimbursing physicians at a higher rate in real time.

Note that the metrics and incentives boxes have portions with dashed lines. The dashed line parts of the boxes refer to external sources and the complete lines refer to sources that arise internal to the system. The internal metrics and incentives are designed to make the practice more effective through strategically allocating a portion of the inputs to desired activities. In the example of the pneumonia patient, the physician wishing to implement the change could set up a system of reminders to help in making these changes. One approach could be to have the nurse who does the intake flag the charts of patients whose presenting complaints are indicative of community acquired pneumonia. The physician would then be reminded to confirm the appropriateness of a blood culture before having blood drawn and the test run. The physician would have the rate at which the flags are applied appropriately (or not) tracked by the business manager and reinforce the nurses responsible as appropriate. The recognition could be through a compliment in a staff meeting, posting the accomplishment on a place of honor, and/or a monetary bonus.

The resources that accrue from the dashed portion of the metrics and incentives boxes are present only in systems with external incentives, such as the P4P system. These external metrics and incentives do not always exist, nor are they essential to make the system function. Not all systems have either explicit metrics or explicit incentives, although some type of incentives and an accompanying mechanism by which the incentives are allocated, are used in most practices. However, the system may not be overt nor systematically applied. Further, in a poorly functioning system incentives may be capriciously applied through cronyism or nepotism or some other approach that is viewed internally as unfair and that is ultimately detrimental to practice operations. If no metrics or incentives exist in the system, one or the other or both boxes in the...
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Symbiotic and parasitic changes

In Figure 7, an angle $\theta$ (theta–upper loop) indicates how the change aligns with the resources allocated to the ongoing inputs, processes, and products. The angle depicted is 90°, a value that is perpendicular to the flow of resources to the general system. This indicates that a change neither contributes nor detracts from the resources flowing to the general system. As a consequence, the cost of the change would be neutral to the system. Angles greater than 90° (Figure 8A) depict a symbiotic change, one that increases the net resources to the system by increasing the resource return from the reserves and supporting systems. Symbiotic changes require more resources from the reserves (e.g., Clinical relevance) boxes. Meterko’s Quality Target box is part of what is considered in the Products box.

Figure 8 Symbiotic and Parasitic Changes in the Integrated System Model. This depicts how the alignment of change with the ongoing processes of the practice affect the likelihood of adoption.
do not order tests that are not reimbursed to at least cover costs,” and “safety first” respectively) that guide interactions among the individuals in the microsystem. Other goals and rules will also likely guide interactions in a given microsystem, and these may vary among the different microsystems. These simple rules need further research regarding their nature, whether they are explicit or implicit, intrinsic or extrinsic, internal or external, how generalizable they are across different microsystems of the same type (e.g., doctors’ offices), and how individuals behave when the simple rules conflict (e.g., quality care threatens financial solvency). The ISM, like a CAS, needs reserves to evolve, and the ISM acknowledges the constant tension between different changes competing for adoption at a given time. The ISM also allows for the unpredictability of whether changes will be adopted and integrated into the system operations.

**Boundary definitions**

As noted by Chen,26 boundary definitions are important to the functioning of the CAS. In ISM this is also true because when boundaries are ambiguous, the simple rules that govern interactions become uncertain in their application and resources can be diverted from their intended use. For example, the prevailing concern about pharmaceutical payments to physicians for providing CME about pharmaceutical products breaches the boundary between practice and for-profit industry. The profit motive can put physicians in conflict with their practice imperative to provide quality care. A second example of boundary definitions is that between work and family. Unless clear boundaries are set, family concerns can interfere with a provider’s ability to provide timely, quality patient care in a manner respectful of resource limitations—and vice versa.

**The ISM leadership**

As a CAS, the ISM requires leadership for effective operations of the system. Although a CAS operates fairly autonomously at the individual provider level, the leadership defines the needs that the CAS must meet and provides the vision that sets the moral, ethical, and professional compass. These are critical to the operation of the CAS and provide the basis for establishing the simple rules that govern interactions. The leadership is also vital in establishing the will to change—the compulsion to carry on with making a change even when confronted by unanticipated obstacles. Constructively involving all agents—both those who are directly involved as well as those who are indirectly affected—in making the change is essential to actually realizing the change. The more agents in the practice that at least consider the ramifications of planned changes to their environment, the more likely that unexpected negative consequences can be avoided and the easier it will be to integrate the change into ongoing operations.

**The ISM and individuals**

Human factors engineering offers other insights into how the different components interact. Karsh and colleagues note that “any given system is part of a larger system and also contains subsystems.”11 These interactions have particular relevance for the ISM as it has an extension for each individual in the system (health care providers and patients).

Figure 9 shows the ISM adapted to the individual level. At the individual level, obligations outside of work as well as personal needs, interests, and obsessions interact to affect work performance. As a consequence, context contains both external and internal components. The external components reflect the larger environment in which the individual lives and works. The internal environment reflects the needs of family, friends, and self. The inputs reflect a similar dichotomy. Professional inputs reflect the skills, abilities, and experiences of individuals that are relevant to their jobs, and personal inputs are qualities such as dedication and interpersonal skills that contribute to making the workplace a positive (or negative) environment. These two components come together to produce the individual’s contributions to the workplace in terms of whether he or she is a team player, supports the decisions made by the system (including willingness to change), and discharges his or her specific professional services.

Just as in the larger system, having a reserve in the input box is essential for making a change. An individual without a reserve is unable to make a change, but is also at risk of committing errors from fatigue, overcommitment, and an inability to recharge, a condition that is or can lead to burnout.29,30 The current practice environment with reductions in reimbursements from many sources and shortages of health care providers is drawing down precariously on physician reserves even as the larger environment is putting stress on personal lives (decline of the traditional and extended family, two wage-earner households, divorce). Determining whether an individual is operating with inadequate reserves can be difficult because the problem may lie as much outside the work sphere as it does...
with the work-related stressors. Generally, studies of work performance have focused solely on work. Studies of physician burnout have also tended to focus on work and some have shown how the stress of a physician’s work is related to family stress such as divorce and alienation. The ISM argues that it works both ways. Because providers are agents in both the practice and their home CAS, factors in either can draw down their reserves to the detriment of both.

What makes predicting individual agent response to stress in the work place difficult is that what determines the reserves is not just that which draws from them, but that which replenishes them. Individuals draw strength from an almost limitless number of things. In fact, an individual who has a horribly lonely or dysfunctional home life could draw strength from the affiliation and respect received in his or her physician practice, even a resource-depleted practice.

Multiple change processes
A final point relative to how the different components interact is that at any give time, a physician may be considering the adoption of multiple innovations. A primary care physician could be considering changes in the care of patients with asthma at the same time he or she is considering changes in the management of patients with diabetes. Each of these changes could be at the same or a different stage in the innovation-decision process. While each innovation will proceed along the path to implementation with a relatively independent trajectory, the physician can devote only a finite amount of resources to each change. The amount in the reserve and the perceived quality of the resulting care provided govern the amount of resources devoted to change. Generally, innovations producing a more positive theta will win out. However, low-cost innovations that a physician can easily sustain with limited diversion of resources (e.g., change from one therapeutic agent to another one shown to have somewhat better outcomes) will sometimes have an advantage.

General ISM operating principles
The following statements, composites of CAS and human factors engineering principles relevant to components of ISM, summarize how the ISM operates.

- **Strong leadership with a clear vision and mission is needed to sustain a continued commitment to quality and system “self-actualization” in meeting the community and larger societal needs.**
- **The overall system model is an amalgamation of the mini-systems comprising each person integral to the change process.**
- **A change that any integral person perceives to be parasitic can stop the change from occurring.**
- **The resources and factors that motivate individual behavior can be more diverse than those that power the overall system and include power/control needs, insecurities/fears of failure, rivalries, addictions, personal crises, desires for respect or to feel needed, desires for excellence or to be a member of a high-quality organization, etc.**
- **A change that a critical mass of the system agents view as symbiotic can arise from within the system and take hold even without support from the leadership, especially in a reserve-depleted CAS.**
- **For change to occur, the system must have sufficient reserves to power the change and sustain it once it is in place.**
- **A system without adequate reserve resources to support change is in survival mode and will be driven disproportionately by financial considerations.**

**Strengths and weaknesses of the ISM**

The weaknesses of ISM generally lie in the uncertainty of how to quantify the relationships in the model. How to determine whether theta is symbiotic or parasitic is unclear, as is how to quantify perceptions of quality and the impact of a change on quality of care provided. Further, even the financial part of the model is challenging. Because of the complex web of variables in each box and the regenerative nature of the model, producing specific predictions of the impact of a change will be complex (CAS Rule #5). At this point, the model provides a conceptual model, a theoretical base for studying the interplay of financial and quality factors in the adoption of innovation. Additional research is needed for the ISM to provide more specific and predictive estimates of adoption of innovation.

Researchers have used many different models to characterize the factors involved in adopting innovations in health care. Each has its own strengths, and some tend to be more relevant than others depending on contextual factors. The relevant literature is vast and distributed among numerous disciplines and specialties making the ability to gain a comprehensive perspective on the issue difficult. The core features of the ISM have benefited from a multidisciplinary perspective. In addition, the finding that the model appears to be consistent with the large number of models we have encountered encourages us. An advantage of the ISM is that it considers financial as well as quality factors. It highlights the need for reserve resources to power change. Also, the concept of theta and symbiotic and parasitic changes provide a mechanism to discuss whether or not a change is going to support the system. The ISM also provides a mechanism for studying the features of a CAS and their relevance for physician practice. Because the ISM also models the behavior of individuals, it can help to analyze where obstacles to change are likely to occur at both the system and individual level. Finally, the implications of ISM for various components of the health care system would help to provide a clearer picture of the flexibility and generalizability of the model. In a companion article,31 we take the first step and describe the implications of ISM for one component that is considered to be important in helping physicians improve their care of patients: CME.

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**References**