

# A Conceptual Model of the Role of Complexity in the Care of Patients With Multiple Chronic Conditions

David Grembowski, PhD,\* Judith Schaefer, MPH,† Karin E. Johnson, PhD,† Henry Fischer, MD,‡  
Susan L. Moore, PhD, MSPH,‡ Ming Tai-Seale, PhD, MPH,§ Richard Ricciardi, PhD, NP,||  
James R. Fraser, BA,† Donald Miller, ScD,¶ and Lisa LeRoy, MBA, PhD,#  
on behalf of the AHRQ MCC Research Network

**Background:** Effective healthcare for people with multiple chronic conditions (MCC) is a US priority, but the inherent complexity makes both research and delivery of care particularly challenging. As part of AHRQ Multiple Chronic Conditions Research Network (MCCRN) efforts, the Network developed a conceptual model to guide research in this area.

**Objective:** To synthesize methodological and topical issues relevant to MCC patient care into a framework that can improve the delivery of care and advance future research about caring for patients with MCC.

**Methods:** The Network synthesized essential constructs for MCC research identified from roundtable discussion, input from expert advisors, and previously published models.

**Results:** The AHRQ MCCRN conceptual model defines complexity as the gap between patient needs and healthcare services, taking into account both the multiple considerations that affect the needs of MCC patients, as well as the contextual factors that influence service delivery. The model reframes processes and outcomes to include not only clinical care quality and experience, but also patient health, well being, and quality of life. The single-condition

paradigm for treating needs one-by-one falls apart and highlights the need for care systems to address dynamic patient needs.

**Conclusions:** Defining complexity in terms of the misalignment between patient needs and services offers new insights in how to research and develop solutions to patient care needs.

**Key Words:** chronic disease, theoretical models, healthcare delivery

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As this special issue describes, effective healthcare for people with multiple chronic conditions (MCCs) is a growing worldwide challenge. Guided by a Strategic Framework on Multiple Chronic Conditions,<sup>1</sup> a range of federal and other efforts are promoting research about interventions and systems to benefit individuals with MCC, including the Agency for Healthcare Research and Quality MCC Research Network (AHRQ MCCRN<sup>2</sup>). The Strategic Framework defines a person with MCC as someone with 2 or more concurrent chronic conditions or problems such as substance abuse that require ongoing medical attention or limit activities of daily living.

MCC pose challenges for research because of their complexity. In treating MCC, medications prescribed for 1 condition may be contraindicated for another, or several medications may be needed to effectively treat a single condition. For people living with MCC—diabetes and arthritis to use a common example—the physical activity such as walking that is so beneficial to the diabetes management may be infeasible due to joint degeneration. The aging of the population, as well as the stresses inherent in creating and adhering to multifaceted treatment regimens, make managing MCC a complex problem for patients and their families, as well as for the clinicians and systems that serve them. For these reasons, meaningful research on MCC requires an epistemological shift from a reductionist single-condition paradigm to one that accounts for inherent complexity. Counts of chronic conditions and consideration of interaction effects between medications begin to define problems related to MCC. Complexity emerges when the persistence and progression of diseases and courses of treatments, as well as the many contextual factors inherent in both patients' lives and the delivery of effective and efficient healthcare are

From the \*Department of Health Services, University of Washington; †MacColl Center for Healthcare Innovation, Group Health Research Institute, Seattle, WA; ‡Denver Health and Hospital Authority, Denver, CO; §Palo Alto Medical Foundation Research Institute, Palo Alto, CA; ||Agency for Healthcare Research and Quality, Center for Primary Care, Prevention, and Clinical Partnerships, Rockville, MD; ¶Center for Health Quality, Outcomes, and Economic Research, Edith Nourse Rogers Memorial Veterans Hospital, Bedford; and #Abt Associates, Cambridge, MA.

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Reprints: Karin E. Johnson, PhD, MacColl Center for Healthcare Innovation, Group Health Research Institute, 1730 Minor Ave, Suite 1600, Seattle, WA 98101. E-mail: johnson.ke@ghc.org.

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considered. This complexity translates into critical gaps in the evidence base about how to best understand interactions between chronic conditions and their treatments; quality of life and caregiver burden; as well as how to organize, provide, and finance appropriate care.<sup>3-8</sup>

In light of this clinical and research need, the 45 MCCRN-associated research projects and a Learning and Technical Assistance Center were funded to generate research findings and infrastructure that improve understanding about effective interventions for MCC patients. The 2 purposes of this paper are to describe conceptual models in the literature that relate to MCC and to present the MCCRN model. A common language and model are important to guide future research because they enable comparisons and generate a coherent body of evidence.<sup>9</sup> Conceptual models serve to organize constructs and relationships and are especially helpful in complex or rapidly emerging fields.<sup>10</sup>

## METHODS

The MCCRN used the following methods to develop a conceptual model presenting a foundational definition of complexity in the care of patients with MCC. At several MCCRN in-person meetings, participants explored MCC definitions and concepts based on their research projects and clinical experience. They discussed salient themes, and incorporated them into an initial conceptual framework.

Thereafter, a working group (the authors) reviewed existing published conceptual models relevant to complex care or care for patients with MCC. We identified these based on suggestions from the MCCRN, through a literature search, and by reviewing the references of identified conceptual model papers. Other relevant models may exist; this analysis does not report the results of a systematic review, but rather the conceptual models already known by Network members and relevant to their research or identified through our literature review.

We compared the models in a structured manner (Table 1), participated in the February 2013 National Institutes of Health-sponsored "MCC In Context" meeting, and revised the framework. The MCCRN perceived there were missing dimensions not squarely addressed by other models, chiefly the lack of fit between patient needs and system capacities, and model building progressed in steps to address this lack of fit, which culminated in the current version. We mapped onto the model examples of MCCRN research projects to illustrate how it could frame patient and system factors where there was either lack of fit or congruence. This theoretical work did not involve human subjects, so no IRB review was required.

## RESULTS

### Critical Analysis of Existing Models

Below we describe each model identified by the MCCRN or through the literature review (Table 1 and Appendix, Supplemental Digital Content 1, <http://links.lww.com/MLR/A616>) and discuss its contribution to explaining MCC care.

Two models approach the problem of care delivery complexity from the perspective of a key or index condition. Piette and Kerr's<sup>11</sup> framework of the interplay between diabetes management and management of comorbid chronic conditions addresses the impact of comorbid conditions on diabetes care, but the concepts apply to other medical conditions. They recognize that not all comorbidities have the same impact on the treatment plan. They present a typology where they classify chronic conditions into dominant (so complex or serious that they eclipse the management of other conditions), concordant (with similar pathophysiological risk profile and disease management plan), and discordant (not directly related in either pathogenesis or management) conditions, and distinguish between symptomatic and asymptomatic conditions. These characteristics may influence how healthcare systems, clinicians, and patients approach their management relative to diabetes care.

The second model by Ismail-Beigi et al,<sup>12</sup> a framework to assist in determining glycemic treatment targets in patients with type 2 diabetes, addresses the difficulty of arriving at concrete goals of care and clinical decisions for an individual patient with diabetes. This model focuses on customizing glycemic targets. The framework parameters include psychosocial and economic considerations and comorbidities as well as complications. The intention of this model is to provide a clinical tool for complex patients. It is intended neither to guide research or policy decisions, nor does it capture why treatment decisions vary across patients.

Two of the identified models do not specifically address the problem of MCC, but instead consider quality of life, an outcome that Network participants identified as particularly important and relevant for MCC patients, given the inherent chronicity and treatment tradeoffs. Patrick's<sup>13</sup> model of health-related quality of life outcomes of healthcare organization and delivery utilizes the structure, process, and outcomes approach to guide theoretically informed research on how organizational structures, especially managed care, influence health-related quality of life. This model lays out a pathway by which structures and processes within the healthcare system, as well as determinants outside the healthcare system, lead to outcomes including quality of life.

Wilson and Cleary's<sup>14</sup> conceptual model of the relationships among measures of patient outcome and health-related quality of life indicates the pathways through which medical care influences the patient's quality of life. The pathways flow from biological and physiological factors, to symptoms, functioning (physical, psychological, social, and role function), to general health perceptions, to overall quality of life. The model notes the complex direct and indirect relationships between and among the concepts, for example, that health concepts in the pathway are influenced by individual, social, economic, and psychosocial factors. For MCC patients, 1 contribution of this model is a visual reminder that the relevant outcome of care is functioning and health-related quality life, rather than meeting specific metrics in quality-of-care guidelines.

Two models address complexity directly, both primarily from the perspective of patients. The Vector Model of Complexity<sup>15</sup> visually displays relative complexity between

**TABLE 1.** Synopsis of Published Chronic Disease Conceptual Models

Title and Author	Model Purpose	Complexity/MCC Components	How Health is Defined and Measured
The interplay between diabetes management and management of comorbid chronic conditions, Piette and Kerr <sup>11</sup>	Consider the ways in which comorbid chronic conditions can influence diabetic patients' medical care, self-management, and outcomes. Suggests points of intervention for improving systems of care.	Rising prevalence of multimorbidity. Inadequate health system support and little guidance on how to manage multimorbid patients. Patient ability to manage self-care, based on comorbidities, time, financial resources. Prevalent and incident comorbid chronic conditions classified into dominant, discordant, concordant. Also distinguishes between symptomatic and asymptomatic conditions.	Diabetes-specific and nondiabetes health
Framework to assist in determining glycemic treatment targets in patients with type 2 diabetes, Ismail-Beigi et al <sup>12</sup>	Set a glycemic target range for an individual patient in the outpatient setting.	A set of clinical characteristics (comorbid conditions, age, duration of DM, presence of macrovascular and microvascular disease, history of severe hypoglycemia), and psychosocioeconomic context (support systems, medication adverse effects, psychological and cognitive status, economic considerations, quality of life). Influence of the patient perspective referenced in text.	Glycemic target range for an individual patient
Health-related quality of life outcomes of healthcare organization and delivery, Patrick <sup>13</sup>	Model how structures and processes within the healthcare system (especially managed care), as well as determinants outside the healthcare system, especially managed care, influences health-related quality of life	Text delves into social theory and discusses power and dependency relations	Outcomes include quality of life divided into 5 categories. The model also highlights cost of care and equity as outcomes.
Relationships among measures of patient outcome in a health-related quality of life conceptual model, Wilson and Cleary <sup>14</sup>	Categorize measures of patient outcomes according to the underlying health concepts they represent and propose specific causal relationships between different health concept; integrate clinical and social science paradigms	Not specific to MCC, pathways flow from biological and physiological factors, to symptoms, functioning (physical, psychological, social, and role function), to general health perceptions, to overall quality of life. Complex direct and indirect relationships between and among the concepts at nonadjacent levels.	Quality of life "Implication and challenge for researchers is to measure these various outcomes and to develop statistical models that explicitly estimate the size of the effects specified in this model"
The vector model of complexity, Safford et al <sup>15</sup>	Vector portray the numerous influences that together make a patient more or less complex	Multiple chronic conditions, along with biological, socioeconomic, cultural, environmental, and behavioral forces	Congruence between doctor or healthcare system and patient, reflected in evidence and guidelines; quality measurement and performance profiling; and new research methods
Cumulative complexity model, Shippee et al <sup>16</sup>	Explores how clinical and social factors accumulate and interact to influence and shape the patient's health and influence healthcare	Person-centric approach to multimorbidity and chronic conditions in which the individual's personal, social, and clinical factors dictate the patient experience and function as complicating factors on health and health outcomes	The cumulative complexity model is posited as a framework for researchers and clinicians to develop diagnostic criteria and/or decision algorithms to improve the clinical management of patients with multiple comorbidities
Chronic care model, Wagner et al <sup>17</sup>	Organize the health system to improve outcomes for chronic illness care	Not specifically defined	Different components relate through productive interactions in a structural framework for effective chronic illness treatment/disease management

multiple sources in patients' lives—biological, socio-economic, cultural, environmental, and behavioral forces—as determinants of health. This conceptual approach to complex patient care promotes congruence between patient and provider to achieve maximally effective treatment plans, guide trade-off decisions, and assess quality. It shows the relationship between the patient and family domains in

support of making trade-off decisions in treatment beyond clinical indicators to tailor care to individual patients. The emphasis on congruence between clinician and patient around health goals may be particularly important for complex patient care.

Shippee et al's Cumulative Complexity Model<sup>16</sup> focuses on patient complexity, which they define as a dynamic

state in which personal, social, and clinical aspects of the patient experience define the complicating factors. They consider the balance between a patient’s daily living workload, including the self-management tasks incurred because of illness, and his or her capacity and resources. They also consider burden of treatment as a variable that is not always considered by clinicians and, if ignored, may increase burden of illness and reduce patients’ ability to manage their conditions effectively. The model also addresses the longitudinal nature of chronic illness, and how factors may interact over time, with the possibility of patients becoming overwhelmed or, alternately, developing a resilience that allows them to normalize the burden of illness, and develop successful management.

Although it does not address complexity directly, the Chronic Care Model describes an interactive approach to chronic disease management that explicitly addresses chronicity of conditions, and is informing care and research for patients with MCC.<sup>18–20</sup> It incorporates impact at multiple levels of a socioecologically focused approach: community, health system, patient, and care team. The model describes the components of chronic care as contextual factors such as community resources and policies; healthcare system domains including decision support tools, clinical information systems, and delivery system design that promotes effective, efficient, evidence-based, and culturally appropriate care by health teams; and self-management for patients. This model explicitly refers to productive interaction between patient and provider as a dynamic core point for producing positive outcomes.

These models provide foundational constructs for a model of care for patients with MCC, describing care from either the system or the patient perspective, but none capture the inherent mismatch of service to need that the MCCRN identified as the central problem in complex patient care.

Several essential constructs from these articles resonate with the MCCRN’s discussions about improving research and clinical care for patients with MCC. They point out that outcomes of any research need to be defined to include patient functional status and not just a particular clinical target, for example, blood pressure (BP); that patient needs correspond to various clinical and contextual factors that change over time; and that the healthcare system must be organized to provide services in a way that addresses multifaceted needs. Although 2 models specifically note the importance of the interaction between patients and providers as a dynamic, critical point of influence,<sup>16,17</sup> and all models address the presence of multiple influencing factors, either in the context of the impact of comorbid conditions and socioecological influences on the patient’s health or in relation to the organization of healthcare delivery, no model adequately captured the lack of alignment between patient needs and delivery system capacity as the nexus of complexity.

### The AHRQ MCCRN Conceptual Model

After reviewing the above models, the MCCRN developed the conceptual model of complexity and healthcare for patients with MCC (Fig. 1) with 3 goals in mind: (1) define the concept of complexity in patients with MCC; (2) describe patient, health system, and other contextual factors that influence complexity; and (3) review implications of the model for patient care, research, and health policy.

Figure 1 is an ecological model that emphasizes the interconnectedness of component elements. *At the center, we define “complexity” as the gap between the major system components: an individual’s needs and the capacity of healthcare services to support those needs.* Because this model focuses on healthcare, this relationship is the heart of the conceptual model. However, health and healthcare are always influenced by the broader context, for example, social

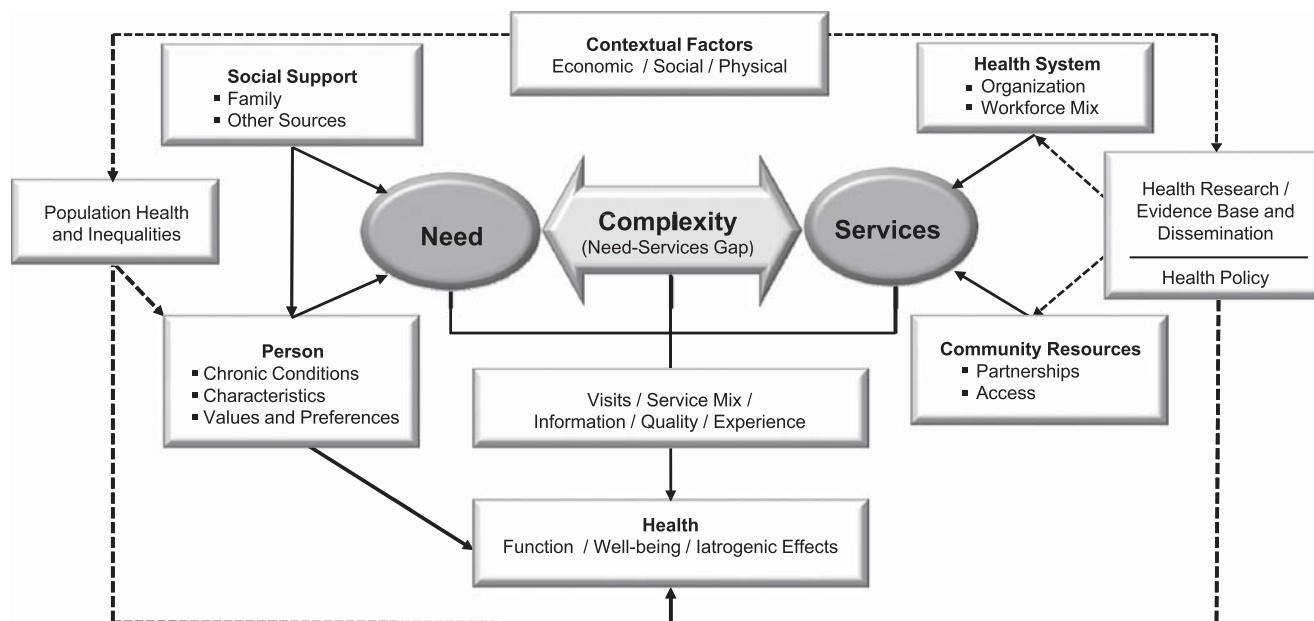


FIGURE 1. A conceptual model of the role of complexity in the care of patients with multiple chronic conditions.

determinants of health and healthcare policies that create economic incentives or disincentives. The model indicates these contextual factors and their influence in dashed line boxes and arrows.

On the basis of Figure 1, the size of the need-services gap is related to patient needs, system capacity, and the interaction between them. On the *person* and *social support* side (left side of Fig. 1), the number, severity, and duration of the person's chronic conditions affect the level of need, as well as whether conditions are concordant or discordant (as defined above).<sup>3,11</sup> Characteristics such as age, sex, socioeconomic status, race, ethnicity, values, and preferences, further influence need. Self-management is essential for optimal health outcomes in patients with MCC, and self-management often is compromised for individuals with inadequate social support, which may increase needs.<sup>3,11</sup> Prevalence of comorbidity is not distributed randomly but rather concentrated in older individuals, families, and communities based on social deprivation and race/ethnicity.<sup>4,21</sup> Lack of insurance may reduce access to healthcare, thereby increasing unmet needs.<sup>22</sup>

On the *service delivery* (right) side of Figure 1, several factors may influence system capacity. As noted earlier, national, state, and local health policies (such as availability of universal health insurance), the evidence base for treating patients with MCC, the availability and implementation of electronic health records and health information technology, and implementation of those clinical guidelines into primary care practice may influence systems' capacities to respond to patient needs. These contextual factors translate into the organization of the health system and the workforce mix, including the extent to which providers are trained to treat patients with MCC. Community context also influence service capacity to meet patient needs; partnerships beyond the health system may expand service availability as well as access.<sup>1,17,23</sup>

The implicit goal of service delivery systems is to identify an individual's needs and provide one or more services that are thought or known to address those needs. Figure 1 implies that the greater the complexity, or gap, the lower the quality of care and worse health outcomes. In other words, to produce the desired outcomes for patients with MCC, the system's services must have the capacity to do so.

Current US health system design lacks capacity to care for large populations with MCC.<sup>24</sup> The system works best for patients with a single condition (diagnosis code). However, "patients with multiple conditions are the rule rather than the exception in primary care."<sup>3</sup> Patients with MCCs may have more clinic visits, greater healthcare costs, more fragmented care, longer hospital stays, and wide variations in quality of care.<sup>3</sup> Because patients with MCC typically see multiple providers, greater or less care coordination may influence system capacity.<sup>25</sup> Patients with MCC tend to have worse health outcomes, such as higher mortality, decreased quality of life, greater depression, and psychological distress.<sup>3,4</sup> Clinicians struggle with how to best care for patients in the context of competing priorities, short office visits,<sup>21</sup> and an organizational context that provides limited support for multimorbidity.<sup>26</sup> In addition, the gap between needs and services can cause iatrogenic effects.<sup>27</sup> In sum, the model

helps to illustrate how the single-condition paradigm for linking treatment with needs falls apart in the case of MCC and causes complexity, or gaps, to emerge in the capacity of healthcare systems—and particularly primary care systems—to address patient needs.

## Application of the Model

In this section, we mapped onto the model 2 of the 45 AHRQ MCCRN studies to illustrate how the model could frame patient and system factors where there was either lack of fit or congruence.

### A Study of Trends in Obesity Progression Among Complex Patients

*Study overview:* Obesity, hypertension, and depression are common and costly chronic conditions that contribute to untimely mortality and reduce quality of life. This study used electronic medical records on up to 111,000 patients in a large community-based practice with various combinations of elevated weight [body mass index (BMI)], BP, or indicators of depression over an 8-year period. The study had 2 main aims: (1) to examine the effects of comorbidities on the probability that people with high BMI received a diagnosis for overweight/obesity and the probability that previously untreated patients with high BP would receive a hypertension diagnosis; and (2) to examine the trends in BMI and BP of people with MCC using multilevel modeling. Study findings are reported in a separate paper in this issue.<sup>28</sup> The findings suggest that patients with high BMI who were Asian, male, with insurance other than preferred provider organization or Medicare fee for service insurance, or had female physicians received an overweight/obesity diagnosis less often than non-Asian patients, female patients, and patients of male physicians. High BMI patients with HMO or Medicare Advantage plans, or who had internists as PCPs (compared with family medicine PCPs) were more likely to be diagnosed for overweight/obesity. Similarly, the contextual makeup of patient and physician characteristics significantly affected the probability of hypertension diagnosis among patients with high BP.<sup>28</sup> Patient and physician characteristics were also significantly associated with BP and BMI trajectories among these MCC patients.

*Application of the model:* The study illustrates the challenges of describing and explaining the myriad potential interrelationships between context, obesity, hypertension, and comorbid conditions over time, suggesting clinicians face equal, if not greater challenges, in matching services to patients' changing needs. From the patient need portion of the model, while the number of conditions played a significant role in patients' hypertension and obesity over time, the contextual makeup of their socioeconomic status, as well as race/ethnicity, sex, and insurance status, not only influenced whether they would receive clinical diagnoses for their conditions, but also influenced the trajectories of their BMI and BP, likely because many of them received neither diagnoses of their conditions nor treatments for them. From the service provision side of the model, as the study was conducted in 1 large medical group, there is limited variation in system level structure, but practice patterns related to

physicians' specialties, sex, and race, were significantly associated with both recognition of the conditions and the trajectories of BMI and BP, which may contribute to the complexity, or gap, between patient needs and services.

### Bridging the Between-Visit Gap Through a Mobile Health Infrastructure

*Study overview:* Underserved populations report high cell phone use and interest in utilizing mobile technology for healthcare; therefore, mobile technology may provide an opportunity to transform healthcare delivery to underserved patients with chronic diseases.<sup>29,30</sup> This pilot project expanded a mobile health infrastructure and assessed the feasibility of using it for automated, bidirectional text message communication to support diabetes self-management in an indigent population. The study demonstrated new system capabilities to: (i) prompt patients for home measurements and to electronically transfer the data to the clinical record and the point of care; and (ii) make automated queries to Denver Health's laboratory and database to trigger text message outreach for laboratory reminders. Focus groups with patients yielded the following themes: increased adherence to self-management skills; better awareness of chronic disease status; and multigenerational participation in chronic disease management within a given household.

*Application of the model:* This study applied new technology to create a healthcare *service* that supported a *need* for chronic disease management in underserved patients—potentially reducing the gap between patient needs and system services. From the patient perspective, a mobile health infrastructure allows for easy, frequent, and individualized engagement to better detect changes in disease status and receive chronic disease support outside of clinic visits. At the same time, the infrastructure addresses important healthcare system barriers that can increase complexity: clinical visit access issues; dependency on visit-bound care; insufficient time to support patients; poor integration of quality improvement programs into usual clinical care and clinical datasets; lack of an electronic health record and/or health information technology tools to track and identify at-risk patients; and insufficient capture of the patient perspective and desires.

### CONCLUSIONS

Defining complexity in terms of the misalignment between patient needs and services offers new insights in how to research and develop solutions to patient care needs. In particular, we can draw on methods from multiple disciplines in understanding and responding to complexity. Healthcare systems have been recognized by the Institute of Medicine as meeting the criteria for consideration as complex adaptive systems,<sup>31</sup> based on the number of components present even in small delivery systems, and on the continual process of quality improvement and adaptive learning that takes place among the providers and patients who are engaged in the shared purpose of achieving good healthcare and health outcomes. Complex adaptive systems are characterized by the presence of *interconnected* individual agents that engage in nonlinear, dynamic *interactions* based on simple internalized

rules, resulting in self-organized emergent behavior that is directed toward an “attractor,” otherwise known as a common goal.<sup>32–34</sup>

Complex adaptive systems have no single point of control, and efforts to exert strict regulation to influence behavior and outcomes often have unexpected results. An example is the impact that promoting adherence to a single-condition-specific, evidence-based guideline may have over another on the health of a patient who must find a way to reconcile contradictory recommended treatments for 2 or more comorbid conditions. Another is the unpredictability of the effectiveness of treatments across patients, such that what is learned in the last encounter may not be effective in the next due to differing contextual factors, trajectory of illness, or even genetic factors. A third example is the effect of current reimbursement structures, which prohibit billing for both mental and physical health services on the same day. This limits the care that can be provided for a patient with coexisting mental health and physical health needs, such as diabetes and depression, in a single clinic visit.

In contrast, establishing complexity itself as the defining factor for both the patient and the delivery system, and utilizing the self-ordering behavior of complex adaptive systems, may aid in achieving flexible balance at the critical point of interface between patient and provider. In defining complexity as the gap between needs and services, what research is needed, and what steps should healthcare systems take to close the gap? How can we learn from and build on current innovations such as patient-centered medical homes and complex care management?<sup>35,36</sup> What can be done upstream to reduce or prevent patient needs and improve evidence-based health service delivery? How does the gap between needs and services differ for different groups of patients, for example by age, sex, socioeconomic status, and race/ethnicity? What health policy or prevention activities should be undertaken to achieve the ultimate goal of reducing the accumulation of chronic conditions over the life course?

We encourage future researchers to use and refine this model to build on previous research. Quantitative and qualitative research is needed to assess how complexity varies across different systems. For example, future studies might analyze whether the same needs identified in epidemiological research (eg, discordant conditions) are addressed by healthcare services (eg, treatment guidelines for discordant conditions). The time interval and best methods to obtain the information in each domain could be part of future research and development of the model. Such research questions may inspire new research methods, addressing issues such as how to model many different parameters at once, or how to study phenomena on different levels, ranging from patient to community. Insights from other disciplines, including ecological modeling, may help inspire solutions to these methodological challenges.

The healthcare system can use this model to guide MCC care. It highlights that knowledge and understanding of all the domains is critical in providing the best care at the lowest cost. For example, a person who has well-controlled diabetes and depression can have a large need if they are dealing with challenging family issues that may exacerbate their depression and lead to uncontrolled diabetes. Patient-

centered access and care is a strategy that may be more effective in addressing the individualized and changing needs of patients with chronic conditions and comorbidity compared with primary care systems designed to address acute conditions.<sup>37–44</sup> Local systems where healthcare organizations partner with public health and social service organizations may offer a greater diversity of services, and therefore have greater capacity to address patient needs, and possibly reduce disparities in the gaps across social groups.<sup>45</sup>

Health policy makers can use this model to guide research agenda-setting. For example, data resources should be designed so that they can capture important conceptual elements and implementation studies should be designed to capture outcomes that are meaningful to patients.

The AHRQ MCCRN conceptual model was designed to capture a foundational definition of complexity as it pertains to patients with MCC that is applicable from the perspective of both a researcher and clinician. It is not designed to address every need, for example, a careful analysis of cross-cultural applicability, mathematical modeling, or how clinical status is influenced by a range of environmental, social, and genetic factors. We invite further testing, refinement, or expansion by others based on theoretical and empirical work to continually promote a research paradigm that incorporates the complexity of efforts to promote well-being in the face of rising prevalence of MCC.

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