American Academy of Family Physicians
Need for Dedicated Evaluation and Management Codes
Position Paper

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Introduction and Summary

There is broad agreement in the U.S. that the annual rise in healthcare costs is unsustainable and that the quality of care delivered to patients can be much improved. In response, public and private healthcare payers have launched innovative healthcare delivery and payment models that are designed to shift payment incentives to reward value rather than volume. Across these models, primary care plays a central role. Despite the growing importance of primary care services in the U.S., payment for primary care physicians lags behind that of most specialists.[1] Over time, primary care visits have grown more complex, as the number and variety of preventive services delivered has increased, the demographic diversity of patients has expanded, and medications and other treatments commonly used have changed.[2] As these trends continue, primary care encounters are expected to continue to grow more complex in the future.[3] While all medical care delivery is becoming more complex, the trend is more pronounced in primary care, given the growing scope of responsibility of primary care physicians and the relatively shorter amount of time per unit that can reasonably be allotted to a primary care visit.

The dominant basis of payments for patient visits to physicians and certain non-physician providers is the Current Procedural Terminology (CPT®) system. The CPT® coding system includes a series of evaluation and management (E/M) codes that describe provider-patient cognitive encounters, such as office and hospital visits. These E/M codes are applied without regard to specialty or type of provider. A major limitation of the E/M coding series is that the physician's scope of responsibilities, complexity of patient problems, and care coordination activities that primary care physicians must routinely undertake relative to specialists are not captured.

The current coding and valuation system does not account for the variation in intensity when E/M services are rendered by different specialists. The same number of relative value units (RVUs) is assigned to a single E/M visit, regardless of the specialist rendering the service. The Resource Based Relative Value Scale (RBRVS) system establishes physician payment based on three components: physician work, practice expense, and professional liability insurance. On average, physician work accounts for 48% of the total RVUs for each service.[4] Physician work is assessed based on a number of criteria, including, "the time it takes to perform the service, the technical skill and physical effort, the required mental effort and judgment, and stress due to the potential risk to the patient."[5] Physician work is also based on relativity to similar services. The current RBRVS system has difficulties, similar to but distinct from those in the E/M coding system, in the lack of recognition of different levels of "complexity" of work performed by different types of physicians. The physician work (or RVW component) of the RBRVS system recognizes "intensity" of physician effort most often in terms of the intra-service work per unit of time (IWPUT). IWPUT is often used as a criterion for establishing relativity amongst services within the RBRVS system by the American Medical Association (AMA)/Specialty Society Relative Value Scale Update Committee (RUC) as well as Centers for Medicare & Medicaid Services (CMS). For purposes of this paper, the IWPUT determination process, coupled with its multiplication by time, is considered a means of measuring the complexity of physician work and influences current valuation of services.

The various techniques, other than direct measurement, that have been used to value E/M code "intensity" and "complexity" leave room for greater accuracy. Over time, the updates to E/M code valuation and, thus, IWPUT have recognized some but not all of the inherent shortcomings of original and subsequent valuation methods. These updates have been of general benefit to primary care physicians because of their relative use of the E/M codes; however, more refined specialty specific methodologies are needed.

For procedure-based services, some have argued that having a single IWPUT is correct; the intensity and complexity involved in a procedure likely varies little between the specialties that perform the procedure.[6] The IWPUT does vary between patients; however, for an "average" physician performing the procedure, that physician will likely treat an appropriate mix of high and low complexity patients. However, within the E/M codes, the intensity and complexity varies widely between specialties, so having a single IWPUT for a given service is inappropriate.

The limitations of both the E/M and RBRVS systems yield an inherent disadvantage for primary care physicians relative to specialists. This disadvantage is amplified by primary care physicians' relatively greater use of the E/M codes in describing and billing for their services. Whereas office-based E/M services represent 55% of total RVU-based Medicare payments to family physicians, these services represent only 17% of total Medicare payments to specialists.[7]

In the quest for improved methods to measure physician work complexity and intensity, researchers have developed numerous frameworks and completed many studies. Some of these have been more concrete, such as attempts to modify E/M IWPUT calculation methods. Others are more theoretical in nature, adding to the knowledge base, if not offering direct solutions to the measurement problem. Significant contributions to the subject will be reviewed in this paper, along with caveats as to their limitations. Most of the limitations are related to the studies' inability to support their theses with rigorous quantitative analytics. Finally, a model advanced in both theoretical and quantitative analytics developed by Katerndahl, Wood, and Jaén (2011)[8] will be highlighted for consideration. The authors introduce a pioneering method to measure the relative complexity per unit of time (the "complexity/density" index) of physician visits by specialty type using combinatory analytics borrowed from systems theory. Using data from the National Ambulatory Medical Care Survey (NAMCS), Katerndahl *et al*. found the relative complexity/density index to be higher for primary care physicians than for the other types of physician specialists studied.

CMS should further the work begun by Katerndahl *et al.* to validate the researchers' findings across different sub-specialties. CMS would gain much from a better understanding of the role of complexity and intensity in physician services and be better equipped to ensure that physicians, particularly family physicians, are appropriately reimbursed. To do so, CMS should create interim E/M codes unique to these providers in order to support family physicians rendering the majority of primary care services. CMS has recognized that the current code set is not appropriately meeting the needs of physicians, particularly family physicians. Interim codes will provide immediate relief to these providers while CMS conducts additional research regarding intensity and complexity, as well as awaiting results from various payment and delivery demonstrations.

Resourced Based Relative Value Scale (RBRVS)-Based Payment

In 1992, the Centers for Medicare & Medicaid Services (CMS) established a standardized physician payment scheme based on a RBRVS. Medicare pioneered the system that it uses directly, and most other payers use in a derivative form, to determine payment levels for physician services, including those described by the evaluation and management (E/M) codes.

In the RBRVS system, payments for services are, ideally, determined by the resource costs needed to provide them. CMS divides the cost of providing each service into three components. The components and the percentage of total relative value units (RVUs) that each represented in 2013 is as follows: physician work (48.3%), practice expense (47.4%), and professional liability insurance (4.3%).[9] CMS calculates payments by multiplying the combined RVUs of a service by a conversion factor (a monetary amount determined by CMS annually) and adjusts payments for geographical differences in resource costs. The system is based on relative magnitude estimation, a technique that ranks a variable (such as physician work) in relation to a reference using a ratio scale.

The initial physician work components (RVWs) were based on the results of a Harvard University study.[10] Four factors are used to determine physician work, including the:

- Time to perform the service;
- Intensity, as measured by:
  - » Technical skill and physical effort;
  - » Required mental effort and judgment; and
  - » Psychological stress due to the potential risk to the patient.

The Harvard team found that although the strongest predictor of physician work is time, the other three non-temporal dimensions of physician work, collectively called "intensity", are critically important in determining the relative value of work across the spectrum of all physician services. The RVW is computed as:

$$RVW = Time \times Intensity.$$

The RVW can be further divided into three phases: pre-service work, intra-service work, and post-service work. The Harvard team also determined that the intra-service work proved to be the most variable of the three as far as intensity of physician work. The RVW and physician time data can be manipulated to yield another metric that represents “intensity”, the intra-service work per unit of time (IWPUT), which is calculated in simplest terms as:

IWPUT = Intra-service work / Intra-service Time.

IWPUT is one of the key metrics used by CMS to assess intensity or complexity of a service. It is a tool utilized to assess relativity amongst services as well as identify rank order anomalies within families of codes.

When the 1993 Medicare Physician Fee Schedule (MPFS) was published, CMS announced that the RVWs for E/M services should increase in a linear fashion so that the IWPUT would be the same for every code within a given family of E/M services, regardless of the duration of the visit.[11] This conclusion is generally consistent with the findings of the Harvard study. The E/M RVWs were adjusted by multiplying the IWPUT for each family of E/M codes by the typical (face-to-face) time for each code to determine an intra-service work value (RVW-intra). The values for pre- and post-service work, determined to be a percentage of the intra-service work, were added to the RVW-intra to calculate a total RVW for each E/M service.

The MPFS began with a study of magnitude estimation of physician work for a very limited number of services. However, the Harvard research team, and in turn, CMS and the Specialty Society Relative Value Scale Update Committee (RUC), have used a variety of techniques to produce a fee schedule for all services over time. As to specific valuation methods, IWPUT can be: (1) estimated, (2) assigned, or (3) calculated. Estimation and assignment have traditionally and infrequently been used to generate *de novo* values, while calculation of IWPUT has often been used to check and validate the appropriateness of RVW values within and between families of codes, such as the E/M series. In turn, there are three established methods for estimating and assigning the RVW: (1) survey, (2) consensus panel, or (3) paired-comparison study.[12] Recommendations for improvement have been made for all the valuation techniques. The calculation method, in particular, is criticized as imprecise because it often comes as the product of subtracting pre- and post-service activity from an assigned or estimated total relative value unit (RVU) value.

Over time, it became clear to the Harvard team that magnitude estimation for total work is not precise and that the most accurate comparison of physician work between specialties occurs when the comparison is divided into pre-, intra-, and post-service intervals and measured directly.[13]

Other observers noted that in contrast to the straightforward calculations for pre-service and post-service RVWs, the calculation for the intra-service RVW is more complicated because the IWPUT of physician work between services *within* specialties and *between* specialties (as in primary and specialty care) can vary widely. However, the observers go on to note that differences in IWPUT for seemingly similar services can become a marker or clue that a particular service is not valued correctly. A representative of at least one professional society cites that use of IWPUT has been instrumental for the society in determining correct payment for undervalued procedures. Mabry *et al.* argues that this is a powerful method to measure RVW across specialties and to solve reimbursement, compensation, and practice management problems facing physicians. They recommend the use of IWPUT in concert with large national databases that provide additional data on visits to generate more accurate RVWs.[14]

The increasing intensity of all physician care can be seen in the increases in RVWs and total RVUs per Medicare (and likely all) patients over time. In the two decades between 1992 and 2012 the total RVUs per Medicare beneficiary grew by roughly 82%.[15,16] In the first decade of this time period, family practice RVU increases of all types were: (1) smaller and (2) proportionately more accounted for by upward revisions in values for existing codes. Use of new (generally non-E/M) codes and quantity and mix of services figured less into RVU changes for family practice physicians than for physicians in aggregate.[17]

In summary, the RBRVS system has difficulties similar to, but distinct from, those in the E/M coding system in its lack of recognition of different levels of "complexity" of work performed by different types of physicians. The physician work (or RVW component) of the RBRVS system recognizes physician effort in terms of the IWPUT. For purposes of this paper, the IWPUT determination process, coupled with time, is considered a means of measuring the complexity of physician work. The basic inputs on which the RBRVS system are based are imprecisely defined and too few in number to reflect the complexities of primary care. The inputs build toward IWPUT assignment in a linear fashion that further lacks room for sufficient specialty-specific variation. For procedure-based services, some have argued that having a single IWPUT is correct; the intensity and complexity involved in a procedure likely varies little between the specialties that perform the procedure.[18] The IWPUT does vary between patients, but for an "average" physician performing the procedure, that physician will likely treat an appropriate mix of high and low complexity patients. However, within the E/M codes, the intensity and complexity likely varies widely between the specialties, so having a single IWPUT is inappropriate.

Background on E/M Codes

The E/M series within the CPT® system is a set of 152 five-digit codes that describe provider-patient encounters for the assessment and management of healthcare. The E/M codes are broadly organized by visit type, reflecting temporal aspects of service (e.g., initial, subsequent), place of service (e.g., physician office, hospital), and patient status (e.g., new, established). Most E/M codes are billed using codes that define what has been characterized as the “complexity” of level of service.[19] Each visit type has three to five E/M codes, with higher level codes intended to represent more complex visits.[20]

Within the CPT® system, the complexity level of an E/M service is determined based on seven components.[21] Three of these components are considered *key* to determining the appropriate level of E/M code (i.e., patient history, physical examination, and medical decision making). Another three components are considered *contributory* factors (counseling, coordination of care, and the nature of the presenting problem) and can be used as guidance but are not required for every patient visit. Visits that consist primarily of counseling and/or coordination of care are an exception to this rule.[22] For these visits, time is the key or controlling factor to qualify for a particular level of E/M services.[23]

Providers use these elements in a stepwise, linear fashion in order to determine the appropriate E/M code. In addition, the definitions of the elements are qualitative rather than quantitative, vary in the precision of their qualitative descriptors and have not been updated since CMS published the 1995 and 1997 E/M documentation guidelines.[24] The small number of elements considered and the fact that certain elements are key and some elements are contributory has been criticized. As importantly, the linearity of the components and how they are assembled fails to capture the work required by primary care physicians, and is a significant limitation of the CPT® E/M coding system. The current E/M structure is based on a paradigm in which a single illness is diagnosed and treated. In reality, primary care is much more complex, with the physician addressing multiple problems during a single visit.[25] The E/M system as presently configured does not sufficiently capture the natural range of variations that exists in the evaluation and management of patients. The American Medical Association (AMA), without mention of specialty-specific shortcomings, recognizes E/M codes' general limitation in comments made to CMS on proposed audits.[26]

Of particular concern is the fact that the E/M coding system under-represents the variations found in primary care. One group of authors, whose novel research will be highlighted in a subsequent section of this paper, has shown that the variations found in primary care are greater on every parameter measured.[27]

The shortcomings of the CPT® E/M coding system carry through to physician payment. Most payers use some version of the Medicare RBRVS to pay physicians. If the CPT® E/M system does not adequately capture primary care work complexity, a payment system that is based on a "one payment amount per code" principle also does not appropriately reflect that complexity in payments to primary care physicians.

Last E/M Update

Since the creation of RBRVS there have been minimal valuation changes to the RVWs of E/M codes. The most recent changes to the E/M codes were implemented in 2007 as part of the Third Five-Year Review. During this process, CMS reviewed 35 E/M codes.

CMS made adjustments to selected E/M codes to recognize increased intensity of physician work therein. Specifically, CMS responded positively to a set of AMA RUC recommendations to increase the relative value for E/M office visit codes 99204-99205 (new patient) and 99213-99215 (established patient). Because of primary care physicians' greater use of these codes, the adjustment has had relatively greater positive impact for primary care than specialty physicians. In the final rule language on the changes, CMS fully accepts the notion that greater complexities necessitate better payment, but expresses uncertainty about the methods of computation and equitableness of results.

> ... There has been a change in the complexity of the patient population resulting in more diagnoses per encounter and more ambitious management goals.... As to the comments regarding the IWPUTs of the E/M services, we are not yet convinced about the validity of the IWPUT analysis when applied to such 'cognitive' services ... If there might be merit to the contention

> that the RUC recommendations will cause some rank order anomalies, we do not have the information that would be needed to rectify this.[28]

E/M codes were identified as potentially misvalued codes in the MPFS 2012 Proposed Rule. CMS noted that primary care is evolving due to increased focus on preventative medicine and managing chronic diseases and suggested the E/M codes be reviewed to reflect these changes. However, in the final rule, CMS decided not to have these codes reviewed "given the significant concern expressed by the majority of commenters over the possible inadequacies of the current E/M coding and documentation structure."[29]

The various techniques other than direct measurement that have been used to value E/M code IWPUT also leave ample room for greater accuracy. Over time, the updates to E/M code IWPUT have recognized some, but not all, of the inherent shortcomings of original and amended valuation methods. These have been of benefit to primary care physicians, but many argue more refined methodologies are needed.

The Challenge of Defining Complexity

Much has been written about the growing complexity of healthcare.[30,31,32] Changes in the healthcare system are also having a pronounced impact on the scope of care provided by primary care physicians. Primary care physicians report that the medical conditions they are treating have increased in complexity and severity.[33] This self-perceived complexity has been validated in data that show primary care physicians are the locus of care for patients with the greatest comorbidities. In the case of common conditions, even individuals with high levels of comorbidity see primary care physicians more often than specialists.[34] At the same time, there is growing appreciation for the profound influences that environmental and behavioral factors have on a patient's health. As the frontline of care, primary care physicians must ensure that medical care is congruent with these social determinants of health.

In the quest for improved methods to measure physician work complexity, researchers have developed numerous frameworks and completed many studies. Some studies have been more concrete, such as attempts to modify the E/M IWPUT described in the prior section of this paper.

Other studies are more theoretical in nature. These studies add to the knowledge base; although they do not offer direct solutions to the complexity measurement problem. Significant contributions to the subject will be reviewed in the next sections with appropriate caveats as to their limitations -- most of the limitations are related to the studies' inability to support their theses with rigorous quantitative analytics. The limitations lay the groundwork for the presentation of a model advanced in both theoretical and quantitative analytics developed by Katerndahl, Wood, and Jaén (2011).[35] The study presents a pioneering method to measure the relative complexity per unit of time (the "complexity/density" index) of physician visits by specialty type. The study uses concepts found in familiar models, such as the IWPUT calculation, and data from the National Ambulatory Medical Care Survey (NAMCS); however, the combinatory approach to analytics is borrowed from sophisticated systems theory. Katerndahl *et al*. find the relative complexity/density index to be higher for primary care than for the other types of physician specialists studied.

Provider Perceptions

In surveys, family physicians have reported recognizing an increase in the complexity of care they provide.[36] As far back as 1996-1997, 24% of primary care physicians reported that the scope of care they were expected to provide was more than it should be and 30% believed that it had increased in the prior two years.[37] Natural adaptation to self-perceived increases in complexity in family medicine encounters is thought to explain the variation between doctors in a laboratory simulation in which physicians meet the same patient more than once over time.[38]

All physicians report increased complexity of patients and their care over time. However, the manifestation of a relatively greater practice burden than other types of physicians, coupled with other aspects of practice, have many experts disproportionately anxious about the future of primary care. The lower income of primary care physicians is a major factor leading U.S. medical students to reject primary care careers.[39,40] The percentage of U.S. medical graduates choosing family medicine decreased from 14% in 2000 to 8% in 2005 and has declined slightly since.[41] Seventy-five percent of internal medicine residents eventually become subspecialists or hospitalists rather than general internists.[42] Because office visit fees are relatively low, primary care physicians schedule many short, rushed visits to keep afloat financially, potentially compromising patient outcomes[43] and fostering the unsustainable physician work- life imbalance that contributes to students' avoidance of primary care careers.[44] With high debt burdens relative to earning prospects, medical students are further discouraged from choosing careers in primary care because of the noncompetitive income.[45]

Increasing Co-Morbidity and Adherence to Practice Standards

One of the more commonly held reasons for the increase in the complexity of primary care encounters is the increase in visits to primary care physicians made by patients with co-morbidities. Data from large public and private datasets on patient visits to primary care physicians and specialists have consistently shown over time the importance of primary care physicians in caring for patients with certain conditions, such as hypertension, lipid disorders, diabetes, and congestive heart failure. These studies have also increasingly shown the importance of a primary care physician in the care of all conditions, except those that are highly complex or rare.[46,47] For instance, primary care physicians provide about 80% of visits for conditions such as diabetes and hypertension,[48] two of the most common co-morbidities found in adult populations. It should be noted that most researchers have used claims data as the source of their work on co-morbidities. Given the limitations on information about co-morbidities in many claims datasets, including and particularly the often-used Medicare Standard Analytic files, it is likely that the trends observed in these studies are understated.

Østbye *et al.* (2005)[49] and Yarnell *et al.* (2009)[50] examined the notion of co-morbidities from a different perspective. The teams of researchers took two successive looks at the clinical practice guidelines associated with the care of conditions most often seen by primary care physicians. For a primary care physician to provide guideline-adherent care for an average panel of patients with only these conditions, the provider would have to work in excess of 21 hours per day.[51]

Non-Clinical Factors

Other models have sought to look more explicitly at socioeconomic, cultural, environmental, and behavioral factors as contributors to complexity of medical care. The Vector Model of complexity conceptualizes these and other forces as having formal relationships that exert influence on health that can lead to a complex patient. At any given time, a particular vector, or factor, may exert a force increasing complexity, or alternatively, lessening complexity. In the Vector Model, overall complexity is determined by summing these multiple components.[52]

At least two models described in the literature use the concepts contained in the Vector Model. Zubialde, Shannon, and Devenger (2005)[53] at Dartmouth and Peek and Baird (2008)[54] at the University of Minnesota have proposed models for resource allocation that explicitly account for variables that may only be implied (or not contained at all) within the E/M code or RVU methods of measuring complexity. At its simplest, the Dartmouth model envisions care as falling within four modules, based on combinations of two types of patient illness (acute and chronic) and two categories of provider decision-making (straightforward or complicated). The University of Minnesota model ultimately assigns visit complexity and "action needed" to four levels based on the "state of affairs" as determined by eight variable categories. The eight categories include psychosocial domains of patient reaction to symptoms; readiness for treatment/change; and home and social network status. These are in addition to the more traditional domains of symptom severity and diagnostic challenge. The final two domains pertain to patient-medical care system interaction, i.e., organization of care, and patient-provider relationship. The Zubialde *et al.* and Peek and Baird models use novel quantitative methods to translate socio-demographic variables into systems to organize primary care work in the clinic. As such, they lay the groundwork for more purposefully integrated models of care to emerge. Their work comes in contrast to newer examples of specialty care management, in which the organizing principles tend to be disease-focused rather than patient-focused. These include models that stress increasingly narrower aspects of body systems, disease entities, or diagnostic or therapeutic areas rather than patient characteristics.

Building on Systems Theory to Measure Medical Care Complexity

Some experts perceive the fundamental challenge to recognizing and measuring complexity in medical care to be the fact that the current healthcare system is built on a linear, cause-and-effect view of illness.[55,56] Various researchers have argued that this system works well in very ill hospitalized patients whose illnesses tend to display linear dynamics with their predictability,[57] diagnostic tests have greater specificity,[58]and patient behavior is controlled. In the inpatient setting of care researchers argue that diagnosis and management are relatively straightforward. In contrast, in ambulatory, and particularly primary care, settings patient behavior is more variable; more and different players (such as family members and caregivers) are involved; patients have multiple and often less well-defined illnesses; and diagnostic activity is often less straightforward. These factors result in greater unpredictability that manifests in chaotic or random dynamics. Or, as some have put it, no longer is the system simply the sum of its parts.[59,60,61]

Measuring complexity is acknowledged as a conceptually and methodologically difficult subject.[62] However, methods exist for estimating the complexity of other systems. From these models it is possible to derive a means of characterizing complexity in medical care. One starts with a base definition of the complexity of a system as the amount of information needed to describe the system or its behavior.[63] With advances in systems theory, estimation techniques have been developed that not only delineate the components of the system but also consider all of the possible states of the components.

Organizational theorists Boisot and Child[64] suggest that complexity includes both cognitive complexity and relational complexity. Cognitive complexity focuses on the quantity and content of information flows. Relational complexity focuses on the interactions by which the information flows between agents. Cognitive complexity is measured in counts, while relational complexity is measured in the variability of counts across information transactions. Translated to the medical setting of E/M services, to gauge the complexity of a type of care, the following are needed: a count of how many elements in the universe of care are used to evaluate and manage a patient, the variability that is seen in the arrangement of the elements, and the diversity of the relationships among elements.

Increasingly, theorists argue that relationships are relatively more important to the complexity of a system than the components themselves and are most often missing in many "standardized" attempts to measure the complexity of medical care[65] such as the E/M CPT® coding system and the Medicare RBRVS payment system. The relationship aspects undergird the works of Safford *et al*. with their Vector model[66] and Peek and Baird[67] and Zubialde *et al.*[68] in their resource allocation models.

In the medical complexity measurement model, the clinical encounter is the focus of the measure of complexity because it represents the nexus of information transfer.[69] However, because a specialty is not defined by a single encounter, and because complexity in relationships often reflects the frequency with which change occurs, the measure of complexity needs to include inter-encounter variation as well. Whereas the complexity of an encounter includes the number of events occurring and the amount of information transferred, the measurement of complexity of a specialty needs to include the diversity and variability of events across encounters. Just as the complexity of a situation is the sum of the complexity of the event and the average complexity encountered,[70,71] a comprehensive measure of complexity should reflect the complexity of the typical encounter and the complexity across encounters. In other words, as noted above, to gauge medical care complexity, the following information is needed: how many of the possible elements of care are involved in an encounter; how these elements vary among encounters; and how many combinations of elements describe the majority of encounters in a particular specialty of medical practice.

Three inherent challenges arise in estimating complexity that make the quantification of medical care complexity especially challenging and the results imperfect. The first is the difficulty in counting all of the possible states of all of the relevant components. The second is the fact that lack of knowledge of the full behavior of the system or ability to capture it will result in an underestimation of its complexity. The third is that the framework underpinning measurement must be appropriate for the behavior.

Because of these limitations, the value to quantitative estimation of complexity may not lie so much in the accuracy of a particular estimate, but rather in the estimation of the relative complexities of two or more medical care systems using the same techniques (the same philosophical tenet on which the RBRVS system is based). This general concept translates to estimating the relative complexity of care as practiced by family physicians to that practiced by specialists.

The Katerndahl Complexity/Density Model

The Katerndahl *et al.*[72] "complexity/density" model demonstrates a method for calculating the relative complexity of ambulatory clinical encounters that offers novel ways to address the inherent problems with estimating medical care complexity. The authors use complex systems theory as their framework, arguing complex systems theory is more appropriate to the study of medical care than the linear frameworks of the past. The authors acknowledge that they will not know all possible elements or states of the medical care they will be studying. However, they borrow from complexity theory to define, quantitatively, the "universe" of care that can be measured using data from the NAMCS and using combinatory methods not heretofore used in medical care complexity measurement along with the relative proportions of that universe that are used by physicians of different specialties. In a final step, the authors compute a new measure, complexity per unit of time, or a "complexity/density" index, that measures the relative work effort involved, on average, per medical specialty. Here again is a similarity to an RBRVS system concept, specifically IWPUT; however, the “complexity/density” index is measured on the basis of more well defined inputs and outputs and quantified using sophisticated combinatory methods. Katerndahl *et al.*’s method consists of five steps, as shown in simplified form below.

1	Count the average number of inputs and outputs of physician-patient encounters typically used in a specialty
2	Compute how much variability there is in the input/output combinations across encounters
3	Compute diversity, or proportion of all possible input/output combinations that a physician uses in all encounters in practice
4	Calculate complexity using the products of Steps 1, 2, and 3, using a computational method borrowed from systems theory
5	Compute a complexity per unit of time or "complexity/density" index

The first three steps reflect the authors' beliefs that measures of complexity should reflect: (1) the absolute content of the typical encounter, (2) the "variability" of the content among encounters, and (3) "diversity" in the content of medical care across encounters that represents the majority of a physician's work. Using methods taken from systems theory, the authors take the products of Steps (1), (2) and (3) to compute a "complexity index" in Step (4). In Step (5) they perform what they consider to be their most important (and differentiating) calculation by dividing the product of Step (4) by units of time to arrive at a "complexity/density" index. This index is based on the view that complexity per unit of time or "complexity/density" is the most accurate representation of physician effort available to date. In other words, how much information has to be processed and put into actionable form per hour for the average patient to receive care is the truest gauge of physician work effort. Katerndahl *et al.* compare this index across three specialties: family medicine, cardiology, and psychiatry.

Appendix A includes a more detailed description of the steps in the methodology and results of calculations and **Appendix B** includes technical information on the computations used to produce results and the theoretical underpinnings of the model.

Results

Using the 2000 NAMCS database, Katerndahl *et al.* calculated input and output complexities for three specialties. They affirm the validity of their construct by comparing the relative rankings of complexity against relative rankings using other complexity-related measures.

Katerndahl *et al.* found that there is minimal difference in the unadjusted input and total encounter "complexity" of general/family medicine (44.04 ± SE 0.002) and cardiology (42.78 ± SE 0.004), while psychiatry's index is less (17.49 ± SE 0.001). Cardiology encounters involved more input quantitatively, but the diversity of general/family medicine input eliminated the difference. Cardiology also involved more complex output.

However, differences arise when time is a factor. Family medicine has a greater complexity/density per hour (167.33 ± 0.0095 SE) index than either cardiology (125.4 ± 0.0117 SE) or psychiatry (31.21 ± 0.0027 SE). Implied in the calculations is that family physicians had, on average, the equivalent of less than 16 minutes per encounter to care for an average patient, while cardiologists had approximately 20, and psychiatrists an average of 34. When the duration of visit is factored in, the complexity of care provided per hour (or complexity/density) in general/family medicine is 33% more relative to cardiology and 5 times more relative to psychiatry.

Exhibit 1 ties the elements in the RVW and the E/M coding use rationales to elements in the NAMCS, the basis for the work of Katerndahl *et al*. Using methods borrowed from systems theory, the authors find the complexity per hour or what they deem to be the "complexity/ density index" to be higher for primary care than for the index specialty, which in this case is cardiology. On every parameter that could potentially be used in the award of the same E/M code or RVW, a relatively higher complexity/density index is shown for primary care than for the index specialty. The NAMCS includes greater specificity on all inputs to the RVW and the required and contributory elements within the E/M structure. That being said, the use of the fields within NAMCS is still likely to result in underestimation of a complexity index, given the limited number and type of fields available in that database.

Exhibit 1

Comparison of Complexity per Hour - General/Family Practice versus Index Specialty - in Context of E/M, RBRVS, and NAMCS-Based Scheme

RBRVS Scheme		E/M Scheme*	Katerndahl Research (Based on NAMCS)**		
				Complexity Per Hour In Comparison to Index Specialty ***	Complexity Per Hour Index Specialty***
				General/Family Practice (n = 198,577,765)****	Cardiology (n = 21,598,184)****
Inputs		**Inputs**	**Inputs**		
Psycho-logical Stress	Technical Skill and Physical Effort/ Mental Effort and Judgment	History (R)/ Nature of problem (C)	Reasons for visit	166%	100%
		History (R)	Patient characteristics	138%	100%
		Exam (R)	Examination/ testing	121%	100%
		Medical decision making (R)	Diagnoses	136%	100%
			Total Inputs	**138%**	**100%**
			Outputs		
		Medical decision making (R)	Medications	93%	100%
			Procedures	600%	100%
			Other therapies	150%	100%
		Counseling/ Coordination (C)	Disposition	130%	100%
			Total Outputs	**112%**	**100%**
Time***		Timing (C)	Timing- Factored into every variable***		
			Total encounter	**133%**	**100%**

Key:
*(R) = required in code assignment scheme; (C) = contributory in code assignment scheme
*** Source: Katerndahl D, Wood R, Jaén C. Family Medicine Outpatient Encounters are More Complex than those of Cardiology and Psychiatry, *J Am Board Fam Med*. 2011 Jan-Feb;24(1):6-15.
*** All numbers reflect values per unit of time
****n= number of weighted visits

The authors conclude that such estimates could have broad use for inter-physician (such as primary versus specialty care) comparisons as well as longitudinal applications, meaning that differences in physician work over time could be mapped and adjustments made for changes in practice.

Limitations and Their Implications

There are limitations to Katerndahl *et al.*'s work. The authors have only looked at three specialties: family medicine, cardiology, and psychiatry. It is unknown how their findings will hold across all specialties. The authors' work is bounded due to the limited data fields in the NAMCS. The authors presume that the relative difference in the complexity/density of primary versus specialty care would be even more pronounced if a database with more input and output fields were available for analysis. This opens up the possibility for analysis using a more comprehensive database, such as one drawn from, for instance, the greater number of fields found in an electronic health record or like instrument rather than a survey such as NAMCS or a claims database. Finally, the indices arrived at by Katerndahl et al. are just that. They represent the relative complexity/density of family medicine versus two types of specialty care. If universality of the initial Katerndahl et al. findings is demonstrated, work will need to be done to translate indices into a new E/M coding and payment system that appropriately captures this relative complexity/density.

Recommendations

If primary care is a complex, nonlinear, dynamic system as Katerndahl *et al.* propose, the underpinnings of existing measurements based on linear models should be re-examined. Policies based on measures derived from linear models will have an unintended, unexpected, and likely adverse, impact on the care of patients. One impact is that linear model–derived measures will make "partialist" care appear better and fail to capture the overall outcomes improvement of complex, generalist care.[73]

Researchers recognize that a key methodological challenge is demonstrating that the use of complex systems models can describe phenomena in primary care that are not adequately captured by linear models.[74] Truly rigorous demonstrations of complex nonlinear dynamics would require larger data sets than exist now, with thousands of observations of the same individual system elements over time. At least one author has remarked that despite this challenge, measurement efforts based on relatively sophisticated assumptions about complexity grounded in available "interim" data are at least as reasonable as traditional linear-based measures and are important to consider.[75]

As such, CMS should further the work begun by Katerndahl *et al.* to validate the authors' findings across different sub-specialties. CMS would benefit from a better understanding of the role of complexity and intensity in physician E/M services to ensure that physicians, particularly family physicians, are appropriately reimbursed. To do so, CMS should create interim E/M codes unique to these providers in order to support family physicians rendering the majority of primary care services. CMS has recognized that the current code set is not appropriately meeting the needs of physicians, particularly family physicians. Interim codes will provide immediate relief to these providers while CMS conducts additional research regarding intensity and complexity, as well as, awaiting results from various payment and delivery demonstrations.

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[14] Mabry, op cit

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[16] Avalere Health Analysis of 2011 Physician/Supplier Procedure Summary File

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Appendix A. Steps and Results of Katerndahl *et al*. Analysis[1]

Steps in the Katerndahl Complexity/Density Model

1	Count the average number of inputs and outputs of physician-patient encounters typically used in a specialty
2	Compute how much variability there is in the input/output combinations across encounters
3	Compute diversity, or proportion of all possible input/output combinations that a physician uses in all encounters in practice
4	Calculate complexity using the products of Steps 1, 2, and 3, using a computational method borrowed from systems theory
5	Compute a complexity per unit of time or "complexity/density" index

More Detailed Description of Steps with Results

Step 1: Quantify the Content of the Encounter

Katerndahl *et al.* characterize ambulatory physician encounters as the products of inputs and outputs. While recognizing that there are many additional inputs and outputs, the authors confine their analysis to those represented in the NAMCS. Inputs and outputs and the possible categories of each within the NAMCS are shown in the table below.

Components Groups	Individual Components of Encounter (Taken from NAMCS)	Possible Categories (n)
Inputs	Reasons for visit	355
	Diagnosis	491
	Body systems examined/tests ordered	96
	Patient characteristics (sex, race, ethnicity)	16
	Total Inputs	
Outputs	Medications	113
	Procedures	37
	Other therapies	46
	Patient Disposition	5
	Total Outputs	
Total Encounter	***Total Inputs + Total Outputs***	

The first calculation step is to determine the mean quantity of individual components (inputs/outputs) per encounter by discipline of physician.

[1]Katerndahl D, Wood R, Jaen C, Family medicine outpatient encounters are more complex than those of cardiology and psychiatry, J Am Board Fam Med. 2011 Jan-Feb;24(1):6-15.

Table A1. Quantification of Ambulatory Care Provided across Disciplines

Variable	General/Family Practice (n = 3344)	Cardiology (n = 1650)	Psychiatry (n = 1567)
Input (mean per visit)			
Reasons for visit	1.61 (0.00001)	1.44 (0.00001)	1.57 (0.00001)
Diagnoses	1.70 (0.00001)	1.97 (0.00001)	1.39 (0.00001)
Examination/testing	1.68 (0.00002)	1.97 (0.00002)	0.14 (0.00001)
Patient characteristics			
Proportion of new patients	0.08 (0.000003)	0.13 (0.000006)	0.11 (0.000005)
Output (mean per visit)			
Medications prescribed	1.80 (0.00002)	2.94 (0.00004)	1.60 (0.00002)
Procedures	0.03 (0.00000)	0.01 (0.00000)	0
Other therapies	0.61 (0.00001)	0.59 (0.00001)	1.52 (0.00002)

Values provided as weighted mean (SE). n=number of visits.

Step 2: Compute the Variability among Encounters

Katerndahl *et al.* define variability as how much variance there is in the input/output combinations seen across encounters within a specialty. The authors calculate the "variability" of encounters by physician discipline using the weighted coefficient of variance (COV) from the mean and standard deviation of the quantities in Step 1. A COV for patient age was computed as well.

Table A2. Variability of Ambulatory Care Provided across Disciplines

Variable	General/Family Practice (n = 3344)	Cardiology (n = 1650)	Psychiatry (n = 1567)
Input			
Reasons for visit	0.49 (0.00000)	0.52 (0.00000)	0.52 (0.00000)
Diagnoses	0.50 (0.00000)	0.45 (0.00001)	0.50 (0.00000)
Examination/testing	1.01 (0.00001)	0.76 (0.00001)	3.05 (0.00007)
Patient characteristics (age)	0.53 (0.00000)	0.22 (0.00000)	0.44 (0.00001)
Output			
Medications prescribed	0.94 (0.00001)	0.78 (0.00001)	0.81 (0.00001)
Procedures	6.35 (0.0002)	14.67 (0.0018)	—
Other therapies	1.68 (0.00002)	1.56 (0.00003)	0.70 (0.00001)

Values provided as weighted coefficient of variation (SE). n=number of visits.

Step 3: Compute the Diversity in the Elements of Encounters that Represent the Majority of Physician Work

The third step in the model is to compute "diversity," or proportion of all possible inputs/outputs that a physician uses in all encounters in their practice. For each variable, the entire database was used to determine how many categories out of all possible categories were needed to describe 95% of the visits in the specialty. The procedure is repeated for each discipline, and the diversity computed as the proportion of possible categories that were needed to describe 95% of visits within that discipline.

Table A3. Diversity of Ambulatory Care Provided across Disciplines

Variable	Possible Categories (n)	General/Family Practice (n = 3344)	Cardiology (n = 1650)	Psychiatry (n = 1567)
Input				
Reasons for visit	355	0.50 (0.00002)	0.24 (0.00001)	0.11 (0.00002)
Diagnoses	491	0.47 (0.00003)	0.19 (0.00003)	0.06 (0.00001)
Examination/testing	96	0.22 (0.00006)	0.21 (0.00008)	0.28 (0.0009)
Patient characteristics				
Demographic diversity†	16	0.62 (0.00042)	0.63 (0.00000)	0.62 (0.00048)
Output				
Medications prescribed	113	0.50 (0.00002)	0.33 (0.0001)	0.09 (0.00005)
Procedures	37	0.65 (0.00014)	0.16 (0.00008)	—
Other therapies	46	0.37 (0.00047)	0.20 (0.00098)	0.23 (0.00038)
Disposition	5	0.60 (0.00000)	0.60 (0.00000)	0.40 (0.00000)

Values provided as weighted proportion (SE). *Proportion of possible categories needed to include 95% of patients; n, number of visits. †Proportion of categories (sex X race X ethnicity).

Step 4: Calculate Complexity of Encounters

The fourth step in the model is to calculate the "complexity" of encounters using a 3-part method:

- Weight the quantity (Step 1) by the variability (Step 2) and the diversity (Step 3) for all components of encounter;
- Sum the component complexities to determine total input and output complexities; and
- Compute the total complexity per encounter by multiplying the output complexity times 2 raised to the power of the input complexity.

This method of measuring complexity is derived from the complex systems theories of Bar-Yam.[2]

[2] Concept adapted from Bar-Yam Y. Dynamics of complex systems. Reading, MA: Perseus Books; 1977:716. To reflect the logarithmic relationship between input and outputs.

Table A4. Complexity per Visit across Disciplines

	General/Family Practice (n = 198,577,765)	Cardiology (n = 21,598,184)	Psychiatry (n = 28,864,201)
Category	**Complexity Per Visit**	**Complexity Per Visit**	**Complexity Per Visit**
Input			
Reasons for visit	0.77 (0.00001)	0.60 (0.00001)	0.59 (0.00001)
Diagnoses	0.80 (0.00001)	0.76 (0.00002)	0.50 (0.00000)
Examination/testing	0.83 (0.00004)	0.89 (0.00005)	0.09 (0.00000)
Patient characteristics	1.97 (0.00000)	1.85 (0.00000)	1.93 (0.00000)
Total	4.35 (0.00004)	4.10 (0.00005)	3.12 (0.00001)
Output			
Medications	1.03 (0.00001)	1.44 (0.00008)	0.68 (0.00002)
Procedures	0.019 (0.00000)	0.004 (0.00000)	0
Other therapies	0.37 (0.0001)	0.32 (0.00021)	0.68 (0.00017)
Disposition	0.73 (0.00000)	0.73 (0.00000)	0.66 (0.00000)
Total	2.15 (0.0001)	2.49 (0.00022)	2.02 (0.00017)
Total encounter	44.04 (0.002)	42.78(0.004)	17.49 (0.001)

Values provided as weighted mean (SE). *Adjusted for duration of visit. n=number of weighted visits.

Step 5: Compute Complexity/Density

Step 5 is to compute a complexity per unit of time or "complexity/density" index. This is a relative measure of how many inputs and outputs have to occur per unit of time for the physician, on average, to successfully complete his/her work. Put another way, the "complexity/density" index is how much information has to be processed and put into actionable form per hour for the average patient to receive care.

Table A5. Complexity per Hour across Disciplines

	General/Family Practice (n = 198,577,765)	Cardiology (n = 21,598,184)	Psychiatry (n = 28,864,201)
Category	**Complexity Per Hour***	**Complexity Per Hour***	**Complexity Per Hour***
Input			
Reasons for visit	2.925 (0.00003)	1.759 (0.00002)	1.053 (0.00002)
Diagnoses	3.039 (0.00005)	2.228 (0.00005)	0.892 (0.00001)
Examination/testing	3.153 (0.00019)	2.609 (0.00018)	0.161 (0.00001)
Patient characteristics	7.484 (0.00004)	5.423 (0.00004)	3.443 (0.00003)
Total	16.526 (0.00021)	12.018 (0.00021)	5.566 (0.00005)
Output			
Medications	3.913 (0.00005)	4.221 (0.00027)	1.213 (0.00003)
Procedures	0.072 (0.00001)	0.012 (0.00000)	0
Other therapies	1.406 (0.00040)	0.938 (0.00056)	1.213 (0.00018)
Disposition	2.773 (0.00001)	2.140 (0.00002)	1.177 (0.00001)
Total	8.168 (0.00041)	7.300 (0.00062)	3.604 (0.00018)
Total encounter	167.3 (0.009)	125.4 (0.012)	31.2 (0.003)

Values provided as weighted mean (SE). *Adjusted for duration of visit. n=number of weighted visits.

Appendix B. Katerndahl *et al.* Computation of Complexity

Taken from Katerndahl DA, Wood R, Jaén CR. Supplemental Appendix of A Method for Estimating Relative Complexity of Ambulatory Care. Accessed at: http://www.annfammed.org/cgi/content/full/8/4/341/DC1on January 30, 2013.

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Computation of Complexity of Each Input/Output

We used the National Ambulatory Medical Care Survey (NAMCS) for calculations. The NAMCS is an annual national probability sample survey of visits to the offices of physicians classified by the American Medical Association (AMA) and American Osteopathic Association (AOA) as ‘‘office-based, patient care. ‘The complexity of each input/output is defined as the mean input/output per clinical encounter weighted by its inter-encounter diversity and variability. The mean of the input/output was chosen because it is the most unbiased estimator of central tendency,[1] and because the median and mode could be zero in meaningful but uncommon input/output measures, underestimating complexity. Thus, the complexity of diagnoses seen in family medicine (coded as “General/family practice” in the NAMCS database) would bathe product of the mean number of diagnoses seen in family medicine encounters, the inter-encounter diversity of diagnoses weighting, and the inter-encounter variability of diagnoses weighting. Information theory also supports the weighting of information.[2] The NAMCS 2000 data set provides a patient weight that allows the sample of 27,369 visits to be “inflated” to represent the total of 832,541,999 visits that yearn the United States. This patient visit weight was applied to the data set so that estimates of complexity parameters produced by re sampling techniques would better conform to national patterns of patient encounters.[3]

The diversity of an input/output is defined as the proportion of the number of categories needed to include 95% of the input/output reported out of the total possible categories. The 95% proportion was chosen to minimize the impact of a rare or miscoded input/output. The variability was defined as the coefficient of variation (COV) of the input/output, which is calculated as the standard deviation divided by the mean. The COV was chosen over other measures of variation because it is a unit-free measure.[4] Thus, diversity will and variability should typically range between 0 and 1. To standardize the weightings and limit the impact of low diversity or variability on complexity, the weightings used are the Z- transformations of the diversity proportion and the COV, and range between 0.5 and 1.0.

Using the 2000 NAMCS database[2], the diversity of 95% of the diagnoses seen is 0.47 and the COV of diagnoses seen is 0.50. These Z-transform into weights of 0.68 and 0.69 respectively.

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[1]Sokal RR, Rohlf FJ. *Introduction To Biostatistics.* 2nd ed. New York, NY: W. H. Freeman & Company; 1987.
[2]Reza FM. *Introduction To Information Theory.* New York, NY: Dover Publications, Inc; 1994.
[3] National Center for Health Statistics. National Ambulatory Medical Care Survey. Hyattsville, MD: US Department of Health and Human Services; 2000.
[4]Armitage P, Berry G. *Statistical Methods In Medical Research.* 2nd ed. Boston, MA: Blackwell Scientific Publications; 1987.

Thus, the complexity of family medicine diagnoses is:

Mean Diagnoses per Encounter	x	Diversity Weighting	x	Variability Weighting	=	Complexity
1.70	x	0.68	x	0.69	=	0.80

Severity of illness was not included in this formula. First, severity of illness is distinct from complexity.[5] Second, a primary reason for including severity of illness when assessing complexity would-be its impact on testing and outputs. Because these measures are already included, using severity of illness in the calculations would over-emphasize its impact on complexity. Similarly, the acuteness of illness was not included. Although it has been suggested that acute problems may represent higher complexity states due to their lack of equilibrium,[6] the fact that many are self-limited would suggest lower complexity across encounters. Thus, acuteness of illness was not included.

Because some inputs/outputs (i.e., patient characteristics, patient disposition) could not be represented in this manner, those variables were handled in a different but analogous way. For these variables, Z-transformations were performed on each component. Thus, patient characteristics are represented by 3 components (sex and race/ethnicity, age variability, and proportion of patients previously unknown to the physician). Sex and race/ethnicity were combined in a 2-way table. As with diversity, this combined sex-race/ethnicity is the proportion of possible categories that represents 95% of the patients seen. Similarly, age variability is measured as the COV for the ages of the patients seen. Finally, the proportion of patients previously unknown to the physician is also assessed. Previous work suggests that previously unknown patients represent situations of higher complexity.[7] Once these 3 components are represented by their proportions or COV, Z-transformation is performed to convert them to scores ranging from 0.5 to 1.0 and these scores are then summed to provide an estimate of patient characteristics complexity. Using the 2000 NAMCS data, this results in a patient characteristics complexity for family medicine as follows:

Component	Proportion/COV	Z-Transformation
Sex-race/ethnicity	0.63	0.74
Age variability	0.52	0.70
Previously unknown patients	0.09	0.53
Patient Characteristics Complexity		**1.97**

COV = coefficient of variation

The number of components used in assessing patient characteristics complexity could be fewer or greater. Three components are used in this example so that the maximum possible patient characteristics complexity matches the maximum possible complexity of the other input

[5]Horn SD, Buckle JM, Carver CM. Ambulatory severity index: development of an ambulatory case mix system. *J Ambul Care Manage.* 1988;11(4):53-62.
[6]Bar-Yam Y. *Dynamics of Complex Systems*. Reading, MA: Perseus Books; 1997.
[7]Fraser SW, Greenhalgh T. Coping with complexity: educating for capability. *BMJ*. 2001;323(7316):799-803.

components, such as diagnoses, thus providing similar weight across components when computing total input complexity. In a similar manner, patient disposition is measured as the Z-transformation of the proportion of possible patient disposition categories that represents 95% of the encounters. For family medicine, of the 5 possible patient disposition categories in the 2000 NAMCS data, 3 were used in 95% of the encounters(proportion = 0.60); this corresponds to a Z-transformation of 0.73.

Computation of Total Complexity

Once the complexity of each component has been calculated, the total input and total output complexities are calculated by summing the component complexities.[6] However, calculation of the total specialty complexity is not merely the sum of the input and output complexities. A fundamental principle of complex systems is that there is a logarithmic relationship between input and output, so that, as the information in the input increases linearly, the complexity of the system increases exponentially. Thus, for binary data, the total system complexity is determined by the following formula[6]:

$$\text{System Complexity} = \text{Output Complexity} \times 2^{(\text{Input Complexity})}$$

In this case, we accept the assumption of binary data for 2 reasons. First, the components used generally represent the presence or absence of an entity (i.e., a particular diagnosis, a particular medication). Second, biological systems behave as if they are binary no matter what system we examine.[8] Thus, total system complexity depends heavily upon the complexity of the input.

Table 1 [of Katerndahl D, Wood R, Jaén C. Family Medicine Outpatient Encounters are More Complex than those of Cardiology and Psychiatry, *J Am Board Fam Med*. 2011 Jan-Feb;24(1):6-15.] presents the complexity of family medicine using the 2000 NAMCS data. The total input complexity is the sum of the complexities of reasons-for-visit (0.77), diagnoses (0.80), examination/testing (0.83), and patient characteristics (1.97). Using the formula presented above, we calculate the total specialty complexity as:

System Complexity	=	Output Complexity	x	$2^{(\text{input Complexity})}$
44.04	=	2.15	x	$2^{(4.36)}$

For the purposes of this study, we used the above procedure to estimate complexity of ambulatory care for family medicine, cardiology, and psychiatry.

Limitations

The process of estimating complexity has several limitations. In addition to the difficulty in counting events, the lack of knowledge about the full behavior of the system, and the appropriateness of the framework of estimation[6], these measures have no gold standard. Units in this complexity measure are purely abstract, without any concrete meaning. This method is only useful in comparisons. In addition, if we could account for the full range of decision-making strategies, the gap between generalist and specialist relative perceived complexity may be even greater. Finally, the database used for any such estimate will almost certainly be limited. For example, NAMCS only allowed physicians to report a maximum of 3 problems per visit; previous

[8] Kauffman SA. Origins of Order. New York, NY: Oxford University Press; 1993.

work suggests that the average number of problems address in a brief visit to a family physician is 3-4.[9,10] Hence, such estimates will tend to underestimate complexity. Their value in relative comparisons lies in the unbiased limitations of measurement across specialties.

[9] Beasley JW, Hankey TH, Erickson R, *et al.*. How many problems do family physicians manage at each encounter? AWReN study. *Ann Fam Med.* 2004;2(5):405-410.

[10] Flocke SA, Frank SH, Wenger DA. Addressing multiple problems in the family practice office visit. J Fam Pract. 2001;50(3):211-216.

Appendix A. Identifying Primary Care Providers: Memo for the Physician Payment Taskforce of the AAFP

Prepared by the Robert Graham Center

Studies have shown a significant income gap between primary care physicians and non-primary care physicians. This discrepancy negatively affects medical student choice of primary care as a profession and threatens the primary care workforce. Altarum demonstrated that primary care physicians income would need to increase to 70-80% of specialty income to positively change student interest in primary care. For family physicians, this readjustment of income discrepancy could be achieved with a 32% increase in the median income.

The definition of primary care in this country varies in different contexts but it consistently encompasses certain core values including first contact of care, continuity of care, comprehensiveness, and coordination of care (Table 1). In order to appropriately identify primary care physicians, we must use a working definition that reflects the core definitional elements. Physician specialty does not necessarily define a primary care physician as many internal medicine and family physicians work as hospitalists or in emergency rooms. The Affordable Care Act (ACA) defines primary care physicians by specialty combined with use of certain CPT codes which reflect common primary care services.

We propose the following measures that incorporate first contact, comprehensiveness, and continuity using Medicare claims data to identify primary care physicians as an alternative to the definition provided in the ACA. We include a measure of coordination of care in our analysis but this measure was so low using claims that it may not be sufficient to measure this function of primary care at this time.We feel that utilizing key definitional elements of primary care will result in rewarding the appropriate physicians with additional payments for providing primary care. Table 1 provides a summary of the measurement of each element. We could not find a claims-based way to measure community/family functions of primary care.

Table 1: Core Definitional Elements of Primary Care

Primary Care Definitional Elements	How to measure and use for payment
first contact care	Family medicine, general internal medicine, general pediatrics (claims-based or NPI)
continuity of care	Patients who see this physician/clinic get the plurality of their care there (claims-based)
comprehensive care	Breadth and depth of ICD-9 codes used by physicians in Medicare claims
coordinated care	Patients who see more than 3 physicians are seen by a PCP or PC practice at least every 6 months
Bridges personal, family, and community	Undetermined

Comprehensiveness:

Comprehensiveness is a central element of most definitions of primary care. As the point of first contact, primary care providers must diagnose and often treat a wide range of medical conditions. While there is little disagreement on this point, there is not a widely used measure of comprehensive care.

The following lays out a simple approach to characterizing the extent to which an individual physician provides comprehensive care. The basic idea is that over a certain periods of time, physicians will treat patients with a number of conditions identified by ICD-9 codes. Physicians providing more comprehensive care will generally treat a larger number of conditions. A simple count of the number of different conditions treated is a misleading measure as even sub-specialists such as cardiologists or neurologists who focus their practice on a narrow set of conditions will still treat patients with a wide range of additional, co-morbid conditions. A simple count measure is also sensitive to the total number of patients treated over a period of time.

Below is a measure that takes into account the overall distribution of conditions treated and is relatively insensitive to the number of patients treated. The approach has three steps: 1) for each physician, create a frequency distribution of all of the conditions treated in the course of a year, 2) rank order these conditions from the most frequent to the least frequent and calculate cumulative frequencies, 3) set threshold of the cumulative frequencies 80% to cut off the long tail of codes that appear infrequently, and then count the ICD-9 codes that account for distribution below the threshold value. The rank-ordered distribution for each physician is unique. Distributions that are flatter indicate more comprehensive care, while those skewed to left indicate less comprehensive care. The appropriate threshold is a matter of judgment, and approaching a 100% threshold will include more of the low-frequency conditions.

Table 2: Cumulative frequencies of ICD-9 codes as a measure of comprehensiveness

Specialty	Number of claims	Average number of ICD9 codes	Threshold percentage for minimum 12 ICD-9 codes
Family Medicine	1891	46	91
Internal Medicine	2759	39	85
Geriatrics	2887	52	95
General Practitioner	1897	38	80

Table 2 demonstrates 91% of family physicians billed for 12 or more ICD-9 codes for 80% of their practice and hence would be included as primary care through this definition. A slightly higher number of general internists and general practitioners would be excluded using this threshold. Geriatricians show more robust comprehensiveness using this measure due to the fact that the population they are treating is older with comorbid conditions. This difference does not negatively affect family physicians.

Continuity:
Continuity of care can be reflected in consistency of provider for multiple physician visits.

The approach to capture provider continuity of care involves 1) examining primary care physician visits in cases where the patient had 2 or more visits in that year 2) determine if visit was with same provider.

Table 3 demonstrates that 57% of primary care visits by the same captures 90% of family physicians, and nearly 90% of all four specialties (Table 5).

Coordination of care:
Primary care should involve coordination of other health services and visits with other physicians. A measure of regular visits at least every 6 months with primary care physician for patients who saw at least 3 physicians would reflect a physician's coordination of patients' care. This could reflect patients being referred to specialists or other care settings and then coming back to primary care. It does require that a patient see at least 2 other physicians which does not apply to most patients given that this pattern of care is only 16.7% of family medicine patients. For this reason it may not be an accurate measure of coordination—or may not be applicable for a sufficiently large enough pool of primary care patients to warrant use. Task Force Members should decide.

Table 3. Values for the three functions of primary care that capture 90% of family physicians

	Captures 90% of Family Physicians				
Specialty	Comprehensiveness	Continuity	Coordination	Physicians in Sample	Weighted
General practice	5	51.2%	9.3%	600	6,339
Family practice	12	57.1%	16.7%	4,975	46,161
Internal medicine	7	55.2%	18.0%	4,749	52,467
Geriatric medicine	17	68.9%	25.0%	66	695
Note: Data are weighted. The 10th Decile for Family Practice was used to create overall primary care inclusion measure					

Excluding hospitalists:
As mentioned early, traditional primary care specialties are practicing as hospitalists and emergency physicians. A primary care incentive payment or bonus would not be best allocated to these physicians who are already being reimbursed at higher rates. It is useful, then, to have a measure that excludes those physicians for whom a disproportionate amount of their billing is from hospital or emergency room visits.

Table 4: Primary care physicians for whom the majority of claims are from hospital-based care

Specialty	% physicians who bill >80% charges as hospital codes	% of allowed charges are hospital codes?
Family Medicine	10.7	20.9
Internal Medicine	23.0	38.3
Geriatrics	16.6	33.5
General Practitioner	7.67	13.1

Table 4 demonstrates that you would exclude 10% of family physicians using a threshold of 80% as the maximum amount of hospital billing codes. This threshold would reasonably rule out those practicing predominantly in hospital settings without excluding too many physicians. Other specialties are affected differently, which is logical as more internal medicine physicians practice as hospitalists relative to family physicians.

Applying all primary care definitional elements:
When these three definitional or functional filters, created using Medicare data, are applied to primary care physicians, more than 75% of family physicians would be captured (Table 5). Only geriatricians are captured at a higher rate (90%). Slightly more family physicians would be captured without the coordination criteria. Rural physicians do slightly better than urban physicians (76.7% of urban FPs vs. 79.2% of rural FPs) owing to higher levels of comprehensiveness and continuity.

Conclusion:
Applying the above filters using Medicare claims data allows us identify physicians who are providing care consistent with core elemental components of primary care. This approach is the first to attempt to define and identify primary care physicians in this way. Moving forward, with legislation geared to promote primary care and efforts underway to improve primary care physician incomes, it is essential to be able to appropriately identify those physicians providing primary care consistent with its most basic tenents. This approach is as complex as the nuances of the definition of primary care, but as simple as recognizing core values we should expect from primary care. It is offered as an alternative to the definition set out in the ACA, and we have demonstrated that it captures a more functional definition of primary care.

Table 5: Application of all three primary are function filters to physician eligibility

	Percent of Physicians Meeting Threshold					
	Comprehensiveness	Continuity	Coordination	All Criteria	Physicians in Sample	Weighted
1. All Primary Care (PC) Physicians						
General practice	79.6%	87.7%	80.1%	59.2%	600	6,339
Family practice	90.7%	90.1%	89.3%	76.7%	4,975	46,161
Internal medicine	85.1%	89.1%	90.9%	71.7%	4,749	52,467
Geriatric medicine	94.6%	99.4%	95.6%	89.9%	66	695
2. Non-Hospitalist PC						
General practice	79.4%	88.1%	80.2%	59.4%	551	5,853
Family practice	92.2%	91.7%	90.5%	79.7%	4,348	41,232
Internal medicine	85.7%	93.5%	92.7%	77.4%	3,541	40,389
Geriatric medicine	93.6%	99.7%	94.7%	88.3%	55	580
2.a Urban						
General practice	79.9%	89.5%	76.6%	57.2%	293	3,730
Family practice	91.3%	92.6%	89.7%	79.2%	2,926	31,579
Internal medicine	84.6%	94.0%	92.5%	77.0%	2,840	34,853
Geriatric medicine	96.5%	99.6%	94.3%	90.7%	49	532
2.b Rural						
General practice	89.2%	83.4%	88.7%	72.5%	155	1,093
Family practice	95.4%	88.3%	93.1%	81.3%	1,393	9,363
Internal medicine	94.1%	89.8%	94.2%	80.9%	635	4,876
Geriatric medicine	61.5%	100.0%	100.0%	61.5%	6	48