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Complexity of ambulatory care across disciplines

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ABSTRACT

Background: Complexity of care has implications for quality of care, health costs, medical errors, and patient and physician satisfaction. The objective was to compare complexity of ambulatory care across 14 medical specialties.
Methods: This secondary analysis uses the 2010 National Ambulatory Medical Care Survey, which used a multistage probability design of primary sampling units throughout U.S. ambulatory practices across 14 specialties. Sampling weights enable results from 29,179 ambulatory visits to represent 878,653,561 visits. Data included symptoms, diagnoses, diagnostic procedures, and treatments provided. Measures of input, output and total encounter complexity and hourly complexity densities were computed.
Results: Internal Medicine leads in total input and total encounter complexity with Family Medicine second in total encounter complexity. When duration-of-visit is considered, Family Medicine is the most complex discipline while Internal Medicine is the second most complex. Pediatrics lacks the complexity of Family Medicine and General Internal Medicine, and OB/GYN bears little similarity to Family Medicine or General Internal Medicine.
Conclusions: Family Medicine and Internal Medicine encounters are the most complex overall, especially when duration-of-visit is considered.
Implications: Revaluing payments based on complexity could bring better balance to cognitive and procedural services, and better meet the needs of people receiving insurance under the ACA.
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1. Introduction

Complexity of care is increasing. From 1997 to 2005, the mean number of clinical items addressed during an office visit increased from 5.4 to 7.1.[1] From 1995 to 2005, the proportion of patients on medications increased from 21% to 44% while the proportion taking at least three drugs also increased.[2] From 2002 to 2010, medications prescribed to adults rose 22%.[3] From 1997 to 2005, office time spent per clinical item addressed declined.[1]

With health care reform, further change is anticipated. With the influx of newly-insured individuals, patient diversity and psychiatric comorbidity should increase. Increasing demands for documentation and electronic health records (EHR) use will not increase face-to-face durations-of-visit, but increase the time required to care for each patient. With increases in demand for care, physician shortages may become exaggerated, potentially shifting patients among existing specialties or decreasing durations-of-visit. Finally, primary care disciplines may uniquely experience increasing numbers of chronic medical problems, complexity of medication regimens, numbers of guideline-indicated services, demand for preventive services, and pressures for accountability and performance. Increased use of urgent care centers may leave primary care disciplines with even greater proportions of chronic care, multimorbidity visits.

Such increasing complexity could affect the quality of health care. When medical care becomes more complex, practice guidelines are less effective[4] and the rate of errors occurring rises.[5] The risk of errors increases with seeing multiple patients with multiple conditions, use of multiple medications, and implementation of complex procedures.[6] Complexity of care may partially explain why only 55% of adult patients receive recommended care.[7] Poor quality of care was especially noted for time-intensive activities, such as history-taking, counseling, and patient education[7] as well as screening and preventive medicine.[8] In addition, not only is complex care at risk for inefficiencies, but to cope with perceived complexity, physicians may increase testing or lower the threshold at which they refer patients to specialists, adding to the cost of care. Finally, complexity of care could impact patient and physician perceptions of time adequacy and satisfaction. This could explain a decline in perceived autonomy and career satisfaction,[9] with perceived autonomy poorer among primary care physicians.[10] Yet, we know little about the differences in complexity of

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ambulatory care across disciplines; such differences have implications for the cost of care and its payment.

Although previous work found that the complexity of ambulatory care in 2000 was the highest for Family Medicine compared with that of Cardiology and Psychiatry,[11] no recent analysis has been conduct or involved more than three medical specialties. The purpose of this study was to compare the complexity of patient care across 14 specialties using data from the 2010 National Ambulatory Medical Care Survey (NAMCS).

2. Materials and methods

Using a method designed to estimate complexity of ambulatory care derived from national databases,[12] relative complexity can be estimated (computational details are provided as supplementary material). This study analyzed data from the most recently-available NAMCS database (2010) for 14 medical specialties (Family Medicine, General Internal Medicine, Pediatrics, OBGYN, Cardiology, Dermatology, Neurology, Oncology, General Surgery, Orthopedics, Urology, Ophthalmology, Otorhinolaryngology (ENT), and Psychiatry). NAMCS used a multistage probability design of primary sampling units (PSUs) throughout the U.S., practices within PSUs, and patient visits within practices, designed specifically to be representative of all ambulatory visits in the United States. Trained physicians and office staff completed encounter data on patient visits selected, including patients' symptoms, physicians' diagnoses, diagnostic procedures, and treatments provided.

2.1. *Computation of complexity of each input/output (see Fig 1)*

If we define "complexity" of a system as the amount of information needed to describe it or its behavior,[5] then complexity (like error) is associated with volume, diversity, variability, and time limitations.[6] It includes "cognitive complexity" (focused on the content of information flowing) and "relational complexity" (focused on the interactions by which information flows among agents).[13] Cognitive complexity is measured in counts, while relational complexity is measured in variability. Any measure of complexity must reflect the range of problems and inputs seen by the physician.[14] However, because a specialty is not defined by a single encounter, 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 complexity of a specialty must include the diversity (range of characteristics seen) and variability of events across encounters. Thus, "complexity of care" should reflect the complexity of the typical encounter and the complexity across encounters.[15] Approaches such as case-mix measures, risk adjustment approaches, patient severity (or risk) measures, patient complexity estimates, and clinical problems per hour fail to measure complexity of care because they either equate severity with complexity, represent single patient measures, fail to capture all relevant dimensions, and/or assume linearity.[16]

Patient encounters and their components can be described by the quantity of information and services exchanged between patient and physician, by the visit-to-visit variability in quantity of these exchanges, and by their overall diversity.[12] "Quantification" of visits included the per-patient number of reasons for visit, diagnoses, body systems examined and tests ordered, medications prescribed, other therapies and procedures ordered. Whether patients were new to the practice was also recorded. "Variability" was measured across visits within discipline by computing the coefficient of variation (COV)—a unit-free measure—from the mean and standard deviation from quantities measured above. In addition, the COV of the age of patients seen was also computed. "Diversity" was defined as the proportion of categories needed to describe 95% of the visits for each specialty. The 95% proportion was chosen to minimize the impact of a rare or miscoded input/output. Finally, patient demographic diversity was assessed as the proportion of categories within a gender *X* race *X* ethnicity matrix used by NAMCS needed to describe 95% of patients seen.

The NAMCS databases provide a patient weight that allowed the 2010 sample of 31,229 visits to represent 1,008,802,005 visits that year in the United States.[17] This patient visit weight was applied to the dataset so that estimates of complexity parameters produced by re-sampling techniques would better conform to national patterns of patient encounters.

Visit input depended upon the reasons for visit, diagnoses, examination/testing, and patient characteristics. Visit output depended upon medications (including vaccines) and other therapies (including procedures, education, physical therapy, nutrition, etc.) prescribed, and visit disposition. In addition to the mean quantification for each variable, differences in discipline-specific duration-of-visit were used to determine an hourly complexity rate for each discipline. The complexity of each input/output was defined as the mean input/output quantity per clinical encounter weighted by its inter-encounter diversity and variability. To standardize the weightings and limit the impact of low diversity or variability on complexity, the weightings used were the *Z*-transformations of the diversity proportion and the COV, ranging between 0.5 and 1.0.

2.2. *Computation of total complexity (see Fig 1)*

Total input and output complexities were calculated by summing their component complexities. However, calculation of total complexity was not merely the sum of input and output complexities. A fundamental principle of complex systems is that a logarithmic relationship exists between input and output, such that, as the information in the input increases linearly, the complexity of the system increases exponentially. To calculate total encounter complexity, total output complexity was multiplied by "2" raised to the power of the input complexity. Thus, total system complexity depends more heavily upon the complexity of the input.[5]

2.3. *Complexity density (see Fig 1)*

The estimate of complexity of ambulatory care presented is a measure of the complexity of the typical clinical encounter. However, coping with complexity is time-dependent.[13] An hourly complexity density estimate was derived by dividing the total complexity estimates by the duration-of-visit and then multiplying by 60.

2.4. *Analysis*

The 95% confidence intervals were derived from bootstrap resampling procedures based on 500 samples, enabling comparisons across disciplines. Friedman's test was used with multiple comparison posthoc testing to seek significant differences of complexity estimates among disciplines. Cluster analysis of component measures was used to group disciplines. First, to identify the number of clusters, the *K*-means method was used with the visit components to examine 2-, 3-, and 4-cluster models. Based upon analysis-of-variance (ANOVA) results, the 3-cluster solution produced the most consistent clear-cut differences. Then, to assign disciplines to clusters, *Z*-scores were computed for each component measure. The squared Euclidean distance approach was used because it is sensitive to differences in the magnitude of

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