UNIVERSITY OF CALIFORNIA UC Health

Center For Health Quality And Innovation

Calculating Primary Care Panel Size

January 2017

Coleen Kivlahan, MD, MSPH

Kristen Pellegrino, MD

Kevin Grumbach, MD

Samuel A. Skootsky, MD

Naveen Raja, DO

Reshma Gupta, MD

Robin Clarke, MD

Thomas Balsbaugh, MD

Tyson Ikeda, MD

Lawrence Friedman, MD

Lisa Gibbs, MD

Erin Todoki, MPA

Calculating Primary Care Panel Size

Introduction

Increased demands for quality, population-based health care and advancements in technology mandate that academic medical centers design their care in order to meet these challenges as well as stay true to their three-part mission of clinical care, research and education.

The University of California (UC) Center for Health Quality and Innovation (CHQI) was created in 2010 to promote, support, and nurture health care innovations at UC medical center campuses. Specifically, the goals of CHQI are to support innovations that help achieve the Triple Aim of Healthcare: to improve the patient experience, improve the health of the population, and reduce cost. CHQI has been successful in sharing best practices across the leadership of UC Health at UC Davis, UC Irvine, UC Los Angeles, UC San Diego, and UC San Francisco, the nation's largest statewide health sciences training program.

In this collaboration, the primary care leadership of the five medical centers sought best practices to meet primary care access needs of the future. This paper addresses the foundation of primary care: linking patients to a health care home, a process known as empanelment. Recognizing that new payment models incorporate panel attribution as a way to measure access and the health of a defined population, the UC collaborative recognized that there was no national standard to guide the process of empaneling patients. The following questions guided the identification of best practices:

Question 1:
How should patients be attributed to a primary care clinician's panel?

Question 2:
What is the "right-sized" panel?

Question 3:
How can practice panels be adjusted for patient and population risk?

Question 4:
What are the best ways to right-size panels?

Background

The landscape of primary care in the U.S. has seen both growing demand for primary care access and increased accountability for population management, making determination of the "right sized" panel for primary care clinicians ever more important. A primary care panel refers to the number of patients cared for by a single clinician. The "right sized" panel is one that allows the clinician and associated care team to work to their fullest capacity, while meeting the population's needs for access, quality of care and patient experience. As the demands for primary care in the U.S. continue to climb, it is critical for all primary care physicians to work to their full capacity. The Affordable Care Act (ACA) has benefited 20 million of the 47 million uninsured Americans, providing improved access to primary care.[1] In addition, primary care visits are expected to increase by 15-25 million per year by 2019, primarily due to the aging population.[2,3]

As incentives in primary care shift from volume to value, it is critical for primary care physicians to understand the population to whom they are accountable. Recent federal policies are designed to reward value and care coordination – rather than volume and care duplication, creating payment system changes to (1) increase accountability for both quality and total cost of care and (2) develop a greater focus on population health management as opposed to payment for specific services.[4] Primary care providers are in a strategically important position to meet these goals deploying a defined and achievable panel size.

What is empanelment?

Empanelment refers to the process of attributing individual patients to a clinician's care team and is the first step in effective population health management. Empanelment not only serves to determine accountability for population health, it is the basis of a therapeutic continuity relationship between a primary care clinician/team and patient. Empanelment is one of the ten building blocks of primary care.[5] Through a consistent relationship between the primary care team and patient, benefits accrue to patient experience, provider satisfaction, clinical outcomes, and cost.[6] Fortunately, technology has increased our ability to care for panels of patients, with electronic health records (EHR) able to identify a provider's panel size and composition over time. Many primary care practices have grown due to expanded coverage, making it essential to determine the right sized panel, in which the demand for services are matched to the full capacity of the clinical team. The capacity of each clinician's team is signified by panel size, recognizing variation in team composition (e.g. work delegation) and in the patient population served. Efforts are then required to match demand with the supply, such that the actual panel size equates to the right-sized panel goal.

What are the consequences when the actual panel size does not equal the right sized panel?

Empanelment is an enabler of high-performing, high continuity primary care. However, a panel size that is too large or too small may result in problems in quality, access, clinician/patient satisfaction, and clinician burn out. A number of published studies have shown correlations between panel size and quality. Larger panel sizes have been associated with poor diabetes control[7] and decreased rates of cancer screening.[8] Clinicians who are over-empaneled are likely to have difficulty providing access for established patients. Patients may have to wait weeks to months for an appointment, which increases the risk of missed appointments. The patients of these clinicians are likely to see other clinicians, reducing continuity and increasing cost. Over-empaneled clinicians are also at risk for burn-out due to increased work load of direct patient care, as well as additional asynchronous work that is not generally recognized through traditional reimbursement. A recent study found that physicians spent 27% of their time on direct clinical face time with patients and 49% of their time on EHR and desk work. While in the exam room, physicians spent 53% of the time on direct clinical face time, and 37% on EHR and desk work. Over-empaneled clinician are at tremendous risk for excessive after-hours work in order to manage test results, refills and asynchronous patient communication.[9]

On the other side of the spectrum, while decreasing panel size can reduce burn-out[10], a panel size that is too small may indicate poor clinician engagement and care quality concerns, and create financial instability for the practice. Clinicians who are under-empaneled are often seen by colleagues, or may see themselves as not fully contributing practice members.

This can reduce engagement and physician retention. There are a variety of clinician-specific reasons for low panel size, such as clinical performance concerns, perceived low quality, poor communication skills, and limited clinician engagement. Alternatively, the under-empaneled clinician may have a higher than average patient annual visit rate because of clinician or patient driven reasons such as highly complex adult patients or very young pediatric patients.

Panel size also has significant implications for the primary care workforce shortage. One model identifies a shortage of 33,000 primary care doctors in 2035.[11] Decreasing panel size by 10% would result in an increased shortage to 60,000 physicians. Increasing panel size by 10% decreased the shortage to 6,000. This highlights the dilemma of reducing panel size. Smaller panel sizes may improve quality and reduce burnout, but may worsen access to primary care for the population as a whole. In light of the increasing demands for primary care due to increased health care coverage and population size, it is prudent to maintain access and value of care while utilizing our primary care workforce to its fullest capacity through identification of the right-sized panel.

QUESTION 1

HOW SHOULD PATIENTS BE ATTRIBUTED TO A PRIMARY CARE CLINICIAN'S PANEL?

Introduction

The concept of "empanelment" is a key conceptual framework for population health management. Particularly in the context of advanced primary care, empanelment assumes that the care of that panel is team-based, and built upon a medical home model. It is self-evident that any particular physician and health care team cannot endlessly expand their panel. Therefore, answering, "Who are our patients?" is fundamental to managing a population. The appropriate and precise identification of patients truly affiliated with the practice is necessary to optimize the use of the team's resources and provide effective care.

Many primary care practices do not have a systematic way to identify the patients who should be considered for inclusion in their panel. Patients who are cared for through a capitation payment model are prospectively assigned to a primary care provider (PCP). However in the fee for service (FFS) payment model, the patient is not formally tied to a PCP by a prospective payment. The FFS model thus demands a process for attribution so that the PCP and care team can be accountable for the attributed patients and the total panel size can be identified. Often, the patients are attributed to a PCP based on the physician listed on the PCP banner in the EHR, which is often incorrect, outdated or lists a specialist as the PCP. In today's PPO environment, many patients can receive care at multiple practices of their choosing; thus new attribution methods are needed to incorporate these complexities. Patients sort themselves according to their needs for acute, emergent, preventive or chronic care, and may seek care at several sites that change as they age or develop significant illnesses. Practices who are serious about managing a population's health must have a large enough population base to scale resources and can no longer rely on only those patients who make frequent office visits. Practices struggle with questions such as: are patients who make only one visit in three years part of the practice? Is that status reserved only for those with chronic conditions who have many visits and non-visit contacts? The UC primary care collaborative proposes a step-wise approach to addressing who should be considered for inclusion in a panel, the process called "attribution." Only after developing clear approaches to this first step can other steps in empanelment be completed, the ultimate goal of which is a right-sized panel size that is maintained by active management.

Problem statement

Patient attribution to clinical teams is the first step in patient empanelment, yet no consensus exists on how to attribute patients in fee-for-service payment models. Attribution involves two major steps: attribution of the patient to the practice, followed by attribution of the patient to a specific PCP. In order to operationalize attribution, several concepts must be defined:

1) the look back period
2) the number and type of visits or contacts required to be "in the practice"
3) the frequency of the attribution assignments

Finally, clinicians must view the result as reasonable based upon their own knowledge of the patients in their practice.

Conceptual approach

Clinicians may perform many types of services in multiple locations, both physical and virtual or asynchronous. Although alternative approaches to care provision are expected to grow over time, face-to-face encounters currently predominate. Attribution is how health insurance and other payers determine which PCP is responsible for a patient's care when prospective patient selection is not performed under a capitated payment model. Retrospective attribution is assessed based on patient behavior and health care utilization occurring over a defined prior period. The goal of attribution is to accurately reflect the correct patient-provider relationship.

Many attribution models using various types of metrics have been described[1]. To some extent, the variations depend upon an accurate understanding of patients' interactions with the entire health care system. A recent review identified 84 sources describing 171 unique attribution models[1]. Health plans with access to complete claim datasets may be able to attribute patients across health systems by various means such as visit or episodes of care history. Similarly, provider groups that accept patient assignment with a capitation model also may have complete datasets. Providers also have the ability to include clinical data such as virtual or asynchronous interactions into attribution models.[1] However, for patients in fee for service systems allowing for freedom of choice, the provider will always have only partial information. Fundamentally though, primary care providers within a particular health system are primarily interested in which patients should have their focused resources. The selection of the attribution method should be calibrated to the intended purpose of the attribution--for the purposes of this paper, attribution is used as the first step in empanelment in ambulatory or hospital outpatient primary care practices.

The look back period is the time period for evaluating utilization patterns for attribution purposes. There is no clear consensus in the literature on the duration of the look back period. Indeed, the CMMI CPC and Safety-Net Medical Home Demonstration Projects give only general guidance.[2,3] A short look back period (< 12 months) risks missing healthier patients whose health care use is limited to preventive services, even though they may consider the subject practice their "usual source of care." If the period is too long (> 3 years), patients who have relocated or decided to seek care elsewhere may be included in the panel. Sources have used 18-36 months as an appropriate look back period.[2] The CMMI CPC and Safety-Net Medical Home Demonstration Project suggest that 24-36 months is appropriate.[2,3] Across the UC Health systems, look back conventions vary between 18 and 36 months.

There is somewhat greater consensus regarding the number of visits or contacts required to be included in a practice or clinician's panel. In the CMMI CPC and Safety-Net Medical Home Demonstration Project two visits were specified, but other methods have used a single visit or contact.[3]

There is no consensus about how often the attribution analysis should be reviewed. While daily analysis is possible, it is not a practical goal for most organizations. In the literature, active panel management is based upon monthly reports, thus a monthly update seems reasonable.[3]

Finally, some patients will be prospectively assigned to practices or physicians by their health plan (e.g., under commercial or governmental capitation contracts). This population, which may have zero visits or contacts in a look back period despite being formally empaneled with the practice, also needs to be considered in panel size measurement, and thus in the attribution model.

The Safety-Net Medical Home initiative outlined the "Four-Cut Methodology" for attribution to a specific PCP.[3]

1st cut: Patients who have seen only one provider in the past year. (Assigned to that sole provider).

2nd cut: Patients who have seen multiple providers, but see one provider for the majority of services in the past year. (Assigned to majority provider).

3rd cut: Patients who have seen two or more providers equally in the past year (no majority provider can be determined). (Assigned to the provider who performed the last physical exam).

4th cut: Patients who have seen multiple providers with no majority of visits with a single provider. (Assigned to last provider seen).

UCLA's attribution approach has similarities to the Four Cut Methodology and other sources[4], and has been informed by clinician feedback in a large multispecialty academic environment.

Stepwise Approach for Attribution

We outline three steps:

1. Define the overall primary care population base for all practices and all primary care providers
   - A. ≥ 2 PCP in-person ambulatory office visits in the past 36 months defined by E&M codes 99201-99215, 99381-99397, or G0438/G0439; or
   - B. ≥ 1 PCP in-person ambulatory office visit with preventive service E&M codes (99381-99397 or G0438/G0439) in past 1 year, and
   - C. All health plan assigned (e.g. HMO) patients even if no visits

This is a hybrid approach; the default is a 2-visit model with a three year look back with the purpose of capturing patients who may visit infrequently and to exclude one-time visits that may not represent a relationship with the practice. This rule also recognizes that the use of the preventive services code or the annual Medicare Wellness code in a particular year indicates that the provider is assuming a special role with that patient, even if there has been only a single visit. Urgent care center visits may count for one but not both of the inclusion visits.

2. Assign patients from this population to specific active PCPs
   - A. If preventive service (99381-99397 or G0438/G0439) is present in the past 12 months, assign to the physician with the most recent of these visits
   - B. Using general E&M services (99201-99215), but excluding urgent care visits, assign to the physician with the most visits. If there is a tie, assign to the physician with the most recent visit
   - C. Attribution of health plan assigned (e.g. HMO) population with no visits to the health plan assigned physician in the look back period
3. Run and disseminate analysis monthly

Table 1. Attribution Model Tradeoffs

Pros	Cons
1. Reduces physician administrative burden	1. Creates a source of truth outside of the workflow of the EHR.
2. Mirrors the visit method (E&M codes from administrative data) used by plans to define ACO populations (Medicare, Anthem and other commercial ACO)	2. Some loss of validity. There is some lag (esp. new patients) due to billing cycle framework. But as visits take place, eventually correct attribution will occur but it is not real time.
3. Overcomes the errors seen in EHR PCP field related to dynamic patient choices (changing PCP), specialist use of field, and when PCPs leave practice.	
4. There is reliability. Attribution that "self –corrects" based upon patient visit behavior due to automated analysis of visit data. Does not require additional work by staff or physicians	
5. Physicians agree that the result is correct	

An analysis of EHR accuracy at UCLA in 2015 demonstrated the following:

A. 92.5% specificity for patients in attributed Primary Care Population being 'active' UCLA patients

B. The PCP field in the EHR did not accurately capture the attributed population in the panel

1. About 20% of patients in the attributed Population have no PCP listed in the EHR
2. About 13% of attributed patients have a specialist (non-PCP) listed in the PCP field
3. About 2% of attributed patients have a PCP who has left UCLA in the PCP field

As the above data from UCLA demonstrates, maintaining the correct PCP linkage to the patient using the EHR PCP field may be difficult. Maintaining the accuracy of the PCP field requires constant manual update activities by staff or clinicians. The UCLA automated attribution model is used to mitigate these problems likely to be prevalent in most health systems with enterprise EHR systems.

Environments with Resident Trainees as PCPs

A modification of the above process is made when trainees have their own panels. Patients of resident trainees are included in Step 1, so that resident patients are included in the overall defined primary care population of the practice. However, at UCLA when patients are then attributed to individual faculty physicians, patients known to have trainees as their PCP are excluded (executed prior to Step 2A of the assignment to individual PCP). The exact method will depend upon how trainees designate their panels. At UCLA, the EHR PCP field is used to identify patients with an Internal Medicine or Family Medicine resident as the PCP. Excluding resident's primary care patients in the panels attributed to faculty has led to much greater acceptance by both trainees and the supervisory physicians, who otherwise would be attributed some residents' patients as the billing physician for a patient's visit.

Attribution models across the UC primary care enterprise

There is variation in the attribution approach across UC Health. All five medical centers incorporate office visits in their method. Three (UCLA, UCSD, UCSF) use or plan to use a 36 month look back period. The other two campuses each use a 12 (UCI) and 18 (UCD) month look back period. Four academic medical centers (UCD, UCI, UCSD, UCSF) incorporate the EHR PCP field, but no health system relies on that exclusively. One (UCLA) uses office visits exclusively. Three health systems incorporate non face-to-face encounters into the framework (UCD, UCSD, UCSF). Three campuses (UCD, UCI, UCLA) utilize capitated health plan PCP assignment data into their overall model.

Table 2. Major Attribution Components by UC Health Campus

	UC Davis	**UC Irvine**	**UC Los Angeles**	**UC San Diego** (new model)	**UC San Francisco** (new model)
Look Back	18 months	12 months	36 months	36 months (new model)	36 months (new model)
Framework	Office visits, patient portal, EHR PCP field	Authored documents, EHR PCP field	Office visits	Office visits, patient portal encounters, refill, telephone encounters, EHR PCP field	Office visits, patient portal encounters, refill, telephone encounters, EHR PCP field
Health Plan PCP assignment used for patients in capitated plans with no visits	Yes	Yes	Yes	No	No

Conclusions and Recommendations

The UCLA attribution method is an active approach that confers great importance to patient behaviors, as reflected in office visits. For example, if a patient decides to change their primary care physician, the next preventive services code will override all other visit history and attribute that patient to the "new" primary care physician. A monthly analysis is recommended to ensure that patient choice, as reflected in visit behavior, is incorporated into panel methodology without undue delay.

UCLA has used this attribution method since 2014, with approximately 320,000 patients attributed to primary care clinicians. They have found that it is robust enough for practices of various characteristics, but is also constructed to function in a complex multispecialty environment. The method is based on feedback from PCPs and practices, given that a reasonably inclusive definition of the look back period is used, while acceptably low resources are being used on patients who have moved to other primary providers.

The attribution method defined above could be used when the EHR PCP field is blank, to define the primary care base, used for quality metrics reports and compensation calculations. The UCLA method assumes that even heavy users of non face-to-face services will have at least enough visits for attribution through their model. As care delivery and payment are redesigned, the approaches to attribution should evolve. Empanelment models must take into consideration the actual clinician time required to manage a particular panel; this active management must consider all clinical work, direct and asynchronous care, in determining the size of the panel that can be sustainably managed in an exemplary manner.

QUESTION 2

WHAT IS THE RIGHT SIZED PANEL?

How Is Panel Size Calculated?

Primary care providers need well-defined, appropriately sized panels to achieve effective population health management. The literature demonstrates some accepted and novel methods for establishing the right-sized panel. Non face-to-face care, risk adjustment, and the effectiveness of the practice team must be considered in establishing a targeted panel size.

1. Visit Based Method

One method of calculating panel size or demand is to calculate the panel based strictly on office visit supply, such that demand equals supply. Mark Murray described the method that compares the demand for visits to the practice's capacity to provide those visits.[1] He quantifies this relationship in what has become known as the "Murray equation":

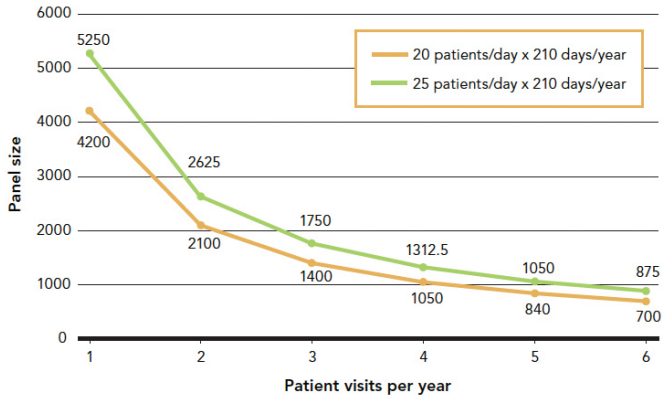
Panel size × average visits per patient per year (demand) = PCP's available visits per day × PCP work days per year (supply). Calculation of the right sized panel based strictly on visit capacity is computed from this equation as: (PCP schedule visits per day × PCP work days per year) ÷ average visits per patient per year = right sized panel size based on visit capacity.

To illustrate this computation, a physician might have four days of clinic per week and work 47 weeks per year, for 188 clinic days per year, and see an average of 20 patients per day in clinic for a capacity of 3,760 visits per year. If their patients on average had 2.5 visits per year, the right panel size would be 1,504.

This approach requires careful definitions of both demand and supply variables. The demand for visits (i.e., average number of visits per patient per year) is usually defined by measuring historical utilization data on patients in the practice. The supply of visits has a number of important determinants. The term Clinical Full-Time Equivalent (CFTE) refers to the percentage of time a provider is designated to provide (and actually provides) patient care. Depending on the actual work schedule of a physician, this percentage could affect the provider visits per day or the provider days per year. To accurately calculate the supply of visits, a practice must precisely define how many sessions a provider actually works per year to produce the CFTE. The calculation also depends on a standardized schedule template with a consistent number of appointments.

The following graphic shows the relationship between panel size and average patient visits per year as well as the effect of reducing appointment length to provide more visits per day. Both a reduction in appointment length and an increase in the number of visits per day will increase the targeted panel size based on the Murray equation.

Table 3. Variables that Affect Panel Size



Panel size can be influenced by the number of patients seen per day, the number of days per provider is available per year and the average number of visits per patient per year. For example, a provider who sees 20 patients per day, 210 days per year, with an average of three visits per patient per year, could manage a panel of 1,400 patients. By increasing capacity to 25 patients per day, the provider could manage a panel of 1,750 patients.

Murray M, Davies M, Boushon B. Panel size: how many patients can one doctor manage? Fam Pract Manag 2007;14:44 –51. *Reprinted with permission*

The Murray model has been widely used to measure a panel size that matches demand and supply for face-to-face visits. Unfortunately, panel size estimates using the Murray approach do not account for many of the activities of today's primary care physician that occur outside of a face-to-face clinic visit including patient e-mail, telephone/virtual visits, and panel management activities in the era of value based payment. Many studies have documented the extensive amount of work required for asynchronous clinical activity. Arndt surveyed primary care physicians about their perceptions of non face-to-face work,[2] asking physicians to describe their workload using relative values for face-to-face vs. non face-to-face work. All activities were compared relative to the work of a Level 3 established patient visit. Across all levels of patient complexity, physicians identified a greater workload for non face-to-face tasks than for tasks conducted during actual clinic visits. Sinsky sought to explore the same question of non face-to-face activity but she directly measured physician activities using a time-motion study,[3] finding that nearly 50% of practice time during the day included completion of desk and EHR work, in addition to a mean of 1.5 after hours work at home.

Clinicians anticipated that asynchronous work could reduce the demand for office visits and telephone calls. In a 2012 retrospective cohort study, Palen examined the utilization of services at Kaiser Permanente before and after the initiation of an online patient portal.[4] The study actually identified increased use of office, telephone and acute care services. Non face-to-face work is an increasing expectation in primary care practice that is unaccounted for in panel size calculations based purely on visit capacity, and by most payment systems.

2. Time-based method

An alternative to a visit-based methodology for determining the right-sized panel is to attempt to estimate the overall PCP work effort required to deliver comprehensive care using time as the unit of measurement. There is no well-accepted method for this approach. Altschuler et al.[5] adapted estimates of work effort for primary care tasks developed by a research team at Duke[6-8] to compute panel size targets. The right-sized panel calculation was based on the work hours per year for a PCP (measured from national survey data) and the estimated time a PCP needs to spend to deliver evidence-based preventive, chronic, and acute care to a population of patients of the typical age and gender distribution in a family medicine practice. The authors determined that a PCP could only effectively manage 983 patients under a conventional practice model whereby the PCP alone directly delivers these services. The authors then modeled scenarios for delegating different amounts of routine preventive and chronic care to other members of the primary care team. Under the most highly delegated model, a right sized panel for a family physician with a typical age-gender patient distribution would be 1,947. Few primary care practices currently operate with the level of staffing support and workflow redesign needed for this highly delegated model.

Table 4. Estimated Panel Sizes Under Different Models of Physician Task Delegation to Nonphysician Team Members

	Nondelegated Model (Panel = 983)		Delegated Model 1 (Panel = 1,947)		Delegated Model 2 (Panel = 1,523)		Delegated Model 3 (Panel = 1,387)	
Type of Care	Time Delegated %	Hours per Patient/Year	Time Delegated %	Hours per Patient/Year	Time Delegated %	Hours per Patient/Year	Time Delegated %	Hours per Patient/Year
Preventive	0	0.71	77	0.16	60	0.28	50	0.35
Chronic	0	0.99	47	0.53	30	0.70	25	0.75
Acute	0	0.36	0	0.36	0	0.36	0	0.36
Total	–	2.06	–	1.04	–	1.33	–	1.46

Altschuler J, Margoulis D, Bodenheimer T, Grumbach K. Estimating a Reasonable Patient Panel Size for Primary Care Physicians With Team-Based Task Delegation. Ann Fam Med 2012;10:396-400. doi:10.1370/afm.1400. *Reprinted with permission*

This study explores an important shift away from calculating panel size strictly by the capacity for visits. It develops the concept of calculating total hours of care per patient per year. It also highlights another important factor in determining the right-sized panel: the effectiveness of the practice team. In a team-based panel, in which non-physicians are delegated tasks to help promote the health of the panel, PCPs are able to effectively manage larger sized panels. Such a model can be utilized to determine the right- sized panel of a practice depending on the percent of work delegated to non-physician team members.

3. Normative benchmarks

The visit and time based approaches use formulas and empiric data on input variables to compute the right-sized panel. Another approach is to simply look at existing panel sizes in different health care settings and consider these as normative benchmarks. Many studies have published average panel size for primary care practices, but panel metric definitions are not standardized, and some do not specify if the panel size is CFTE adjusted. The American Board of Family Medicine sought to understand the current state of physician panel size. In a 2015 study, they included a survey about panel size during the board recertification process.[9] Nearly two-thirds of the physicians who responded could not estimate the size of their patient panel. For the physicians who were able to make an estimate, there was significant variation in reported panel size. The percentage of time providing direct patient care varied significantly, so few conclusions could be made about an "average panel" size. A study in the Journal of *General Internal Medicine* found that 463 non-concierge physicians surveyed across the nation had an average panel size of 2,303 patients.[10] The type of team model or CFTE was not specified. As is illustrated in Table 5 below, there is lack of consistency in average panel sizes across medical organizations and countries.

Table 5. Literature support for right sized PCP panels

	University of Wisconsin 2016[11]	Mayo Clinic 2014[1]	Ohio Kaiser 2008[6]	Veterans' Administration[12]	Canada 2010[7]	Denmark 2012[8]	England 2006[12]
Family Medicine	1797	2959					
Internal Medicine	1741						
Pediatrics	1664						
Composite			2650	1266	1400	1600	2033

Because of the increase in demand for primary care for older adults, the UC primary care collaborative also evaluated the panel size for its geriatrics primary care practices. The Stanford Longevity Center estimates that the California population over age 65 will double over the next twenty years from 4.3 million in 2010 to 8.4 million in 2030.[13] Health systems increasingly recognize that panel size adjustments are necessary for physicians who specialize in the primary care of older adults. Geriatricians are trained in complex problem analysis required for the care of the sickest and most frail patients, and often serve primary care practices.[14] The methods used to determine geriatric patient panel size are the subject of considerable debate. To date, there is no standard benchmark panel size. Clinical geriatric experts on the American Geriatric Society Forum provided estimates of panel sizes that ranged from 600 to 1000 patients per CFTE.[15] An editorial in the Journal of the American Geriatric Society notes that "the VA experience indicates that each geriatrician can manage a patient panel of, on average, 700 of the VA's most-complex older patients (compared with an average panel of 1,200 older adults managed by primary care providers)."[16] At UC Health, geriatrician panel sizes range from 800-1200. Panel size for older adults must be adjusted to account for the complex case mix of the population and the availability of team based care.

Conclusions

Determining the right sized panel is critical for the success of primary care practice, especially in the changing landscape of increased demand and greater value placed on high-quality population health management. Non face-to-face activity is an important element of healthcare demand. While these alternatives to in-person visits are popular with patients, they create new demand on clinician's work time. Patient complexity should be considered when assessing demand for services and the right-size for a panel, and is discussed in the next section. Team-based care, with greater time delegated to non-physician team members, can be used to expand panel capacity, while further research is needed to identify the best practice for delegation of asynchronous, preventive and chronic disease care.

QUESTION 3

HOW CAN PRACTICE PANELS BE ADJUSTED FOR PATIENT AND POPULATION RISK?

Introduction

Once the methodology of an attribution model and determination of the right sized panel are established, decisions must be made about how to adjust the size of the attributed panel to account for variation across panels in patient factors such as age, gender, and morbidities that may affect the workload of PCPs. Adjusting for patient complexity allows for equity in panel size measurement across clinicians and their unique patient populations. One of the main methods to adjust the size of the attributed panel size is by patient characteristics. Patient demographic information like age, sex, payer, and language preference certainly affects patient complexity. Centers for Medicare and Medicaid Services use the Hierarchical Condition Category (HCC) for Medicare and the Chronic Illness & Disability Payment System (CDPS) + Medicaid Rx MRx for Medicaid populations to risk adjust patient populations. The HCC uses age, sex and diagnoses generated from claims data to predict a patient's health care utilization and related costs.[1] Certain patient demographic characteristics can increase physician workload without necessarily increasing the number of encounters. For example, a telephone call to a non-English speaking patient using a telephone interpreter could take 2-3 times longer than anticipated. As noted above in the prior sections of this paper, asynchronous work is a major driver of PCP workload. A potential downside of these demographic/diagnosis-based models is the reliance on established diagnoses. Oftentimes in primary care, patients will present with multiple symptoms and return frequently for ongoing symptoms without a clear, identifiable diagnosis. In this example, the diagnosis-based risk models may not take into account the work and cost in caring for such patients. In addition, cost of care does not always correlate with primary care physician workload. For example, a patient could be diagnosed with cancer and begin chemotherapy. While this patient may be generating numerous office visits and non-visit encounters these may not be directed at the PCP. In addition to demographics and diagnoses, risk adjustment models evolved to incorporate pharmacy information as a way to predict risk using medication utilization as a marker for patient disease burden.[2] Pharmacy-based risk models have the advantages of rapid analysis speed and correlation with disease severity; the limitation is the variation in prescribing practices by PCPs.

Table 6. Measuring Physician Workload at UCSD

Non-Clinical Factors to Consider in Measuring Physician Workload
Measure non face-to-face activities appearing in the EHR • Telephone calls • Refill requests • Patient and consultant electronic messages
Measure physician log in time in the EHR • Total log in time • EHR log in time outside of direct patient care hours

An alternative approach to panel size adjustment using established patient demographics, diagnoses and medications is to directly measure PCP workload. In the Murray equation for computing panel size, the "visits per patient per year" metric functions to adjust for complexity but to only a limited degree. Complex patients tend to have a higher average number of visits/patient/year. However, some PCPs and some patients experience a higher visit rate per year, yet have no other objective increase in medical complexity. Thus, we cannot rely solely on the Murray equation to adjust panel size for patient/physician workload.

Health systems have demonstrated that measuring the non face-to-face workload of PCPs can be facilitated using EHRs. One methodology involves counting the frequency of non face-to-face visits in the EHR directed at the PCP. This study shows that with healthy patients the ratio of PCP face-to-face time with non face-to-face time is about 1:1. When patients develop chronic disease in three or more major organs the ratio of face-to-face with non face-to-face changes to 1:3.[3]

UC San Diego Health has developed a physician workload index to make adjustments to the raw attributed panel patient counts for individual physicians using a similar methodology to Arndt et al.[4] This workload index includes measurement of office visits, but also includes measurement of non face-to-face PCP activities such as telephone encounters, refill encounters, and electronic messages. The EHR is used as the source of data on these activities for each patient. Each encounter activity type is assigned workload points based on the average input of the group's physicians. The relative points assigned to each activity type were developed by surveying the faculty compensation committee ago about the relative workload associated with each of these activities.

Table 7. UCSD physician workload index points

Encounter Type	Points
Prenatal Visit	1
Office visit	1
Telephone	0.25
Electronic Message	0.1
Letter	0.1
Refill	0.05

Each physician's average workload points per patient per year can be calculated. This average is then compared to the group's average to calculate a relative workload index for each physician. The raw attributed patient count is then multiplied by the relative workload index to compute a workload adjusted panel size.

Table 8. Example of Workload Adjusted Panel Size

Workload Adjusted Panel Size					
Physician	Patient Count	Workload Points	Workload Points/Patient	Workload Index	Workload Adjusted Panel
A	500	4400	8.8	1.10	550
B	1000	6400	6.4	0.80	800
C	1500	10800	7.2	0.90	1350
D	2300	20800	9.0	1.13	2600
Total	5300	42400	8.0	1.00	5300

UCSD's model is an example of how the asynchronous work involved in caring for a patient panel can be used to adjust the attributed panel size to account for variation in patient complexity. Asynchronous work is becoming a large part of the PCP's day and must be considered in the equation of panel size adjustments.

UCSF has also developed a panel adjustment method based on asynchronous activity recorded in the EHR that is conceptually similar to the UCSD approach. The UCSF method uses a more complex statistical model involving machine learning and "big data" analytics to generate a complexity weight for each patient.[5] Utilization phenotypes, in addition to age-sex and primary payer variables, were used to predict future primary care utilization. These phenotypes were then used to weight panels. UCSF has implemented this method to generate monthly reports of weighted panel sizes for each PCP. Figure 1 displays how four populations at each primary clinic at UCSF are distinct and show different results for the weighted panels. The geriatric clinic for example has 41% of patients in the high work cluster, which equated to a weighted panel that was nearly double the raw panel.

Figure 1. Primary Care Work Across Specialties

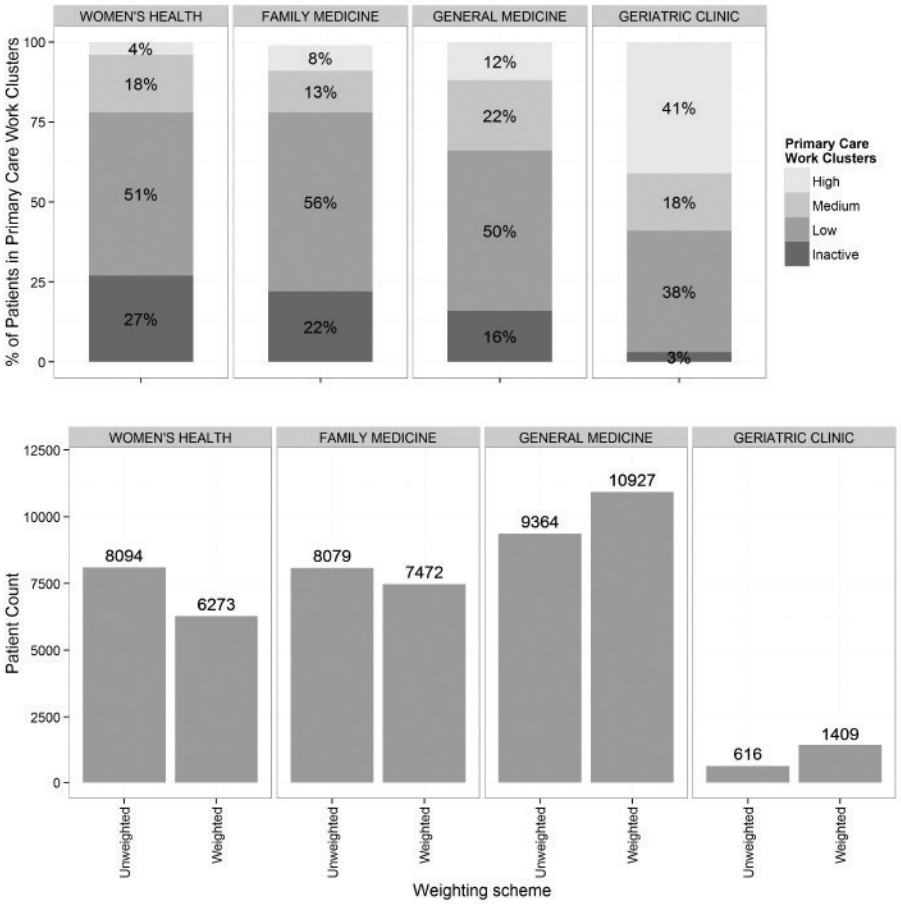


Figure 1: Rajkomar A, Yim JWL, Grumbach K, Parekh A. Weighting Primary Care Patient Panel Size: A Novel Electronic Health Record-Derived Measure Using Machine Learning. JMIR Med Inform 2016;4(4):e29

Conclusions

There are many methods that assess risk or complexity using patient characteristics, including demographic information, diagnoses, encounter utilization and pharmacologic activity. While these methods can deduct how ill a patient is, they are limited in estimating how much work is required in caring for a patient. The population risk burden does not adequately represent the "work" and "complexity" burden, even when using metrics such as age, Charlson Score, Optum Scores, or HCC scores.[4] The newer methods of predicting risk incorporate the comprehensive workload involved in patient care; thus recognizing the large degree of asynchronous work that comes in caring for some patients who do not have a complex diagnosis or medication list. There is not one standard risk adjustment method, however our recommendation is to utilize a methodology that incorporates PCP workload measurement.

QUESTION 4

WHAT ARE THE BEST WAYS TO RIGHT SIZE PANELS?

UCSF: Strategies to Improve Access

Once patients have been attributed to PCP panels to determine actual panel sizes and a right-sized panel target is established, it is possible to compare a weighted (i.e., complexity adjusted) panel size for a PCP to the target panel size goal. At this point, one can determine whether a PCP has a panel that is "right sized," or if the PCP is under- or over-empaneled relative to the target. This section will address the interventions needed to maintain the right size panel for primary care physicians (PCPs) when demand or supply change and result in under or over-sized panels. Our recommended approach to address imbalanced panels includes regular monitoring of panel size and step-wise interventions for over-empaneled and under-empaneled PCPs by a practice panel manager. The Safety Net Medical Home Initiative Implementation Guide provides a robust framework for interventions when demand and supply are imbalanced.[1] Our recommendations have been adapted from this framework and are presented in a stepwise approach. We are also assuming that the following steps have already taken place:

1. Patients have been accurately attributed to PCPs and the panel attribution refreshed on a regular basis.

2. The target PCP panel size has been determined by the practice or health system.

3. PCP panel sizes have been adjusted by factors such as age, gender, payor mix, morbidities, and asynchronous work to account for variation in patient complexity and workload demand.

Steps for the Over-empaneled PCP

1. Assess if the panel size is problematic for the empaneled patients or PCP

The first step is an assessment to better understand how the large panel size impacts the empaneled patients and PCP. Data to better understand how a large panel size impacts patients include reports on access, patient experience, and quality. Access reports, specifically the third next available appointment and continuity reports, are helpful in determining if the large panel is creating long waits or preventing patients from seeing their PCP. Patient experience reports can also shed light on long waits and impaired continuity, in addition to signs of poor communication that may be due to rushed visits or PCP burnout. Quality reports, such as chronic disease and cancer screening metrics, can add to the picture of whether this PCP can meet the preventive care demands of the large panel. Data to better understand how the panel size is affecting the PCP should include burnout scores, total time spent in EHR with delineation of time spent with after-hours documentation, and chart closure rates.

2. Panel reduction plan

If there is evidence of a problematic panel size after step one, a plan to reduce the panel size should be considered. Patients who have not visited the practice for some period (18-36 months), yet desire to remain an active patient in the practice, could be offered to transfer to a PCP with a smaller panel, thus achieving better access. Gaining both receiving and over-empaneled PCP buy-in on this approach can be challenging; an incentive for the PCP to participate in this model could include incentives to increase the panel, but cap the upper limit of panel size.

3. Expand the care team

If a reduction in the panel size is not feasible or desired, then that PCP's care team could be expanded. Additional support staff such as health coaches, medical assistants, scribes and behavior/social support team members can enhance the ability of the primary care team to effectively manage a larger panel size. When preventive and chronic care services are delegated to non-physician team members, PCPs can then accommodate larger panel sizes.[2] Additionally, or alternatively, a nurse practitioner or physician assistant could be added to the care team to share the panel with the physician in a co-management approach.

4. Close panel temporarily

Lastly, the physician's panel can be closed to new patients for a set period of time until attrition and other interventions take effect.

Steps for the Under-empaneled PCP

1. Assess if the panel size is problematic for the empaneled patients, PCP, or practice

Similar to the over-empaneled PCP, the first step of assessment with the under-empaneled PCP is to better understand if the current panel size is a problem, and to whom. Data that should be reviewed to better understand how the patients are being impacted includes patient satisfaction scores and quality reports. For example, patient satisfaction data may reveal unmet patient needs that result in more frequent and perhaps unnecessary visits. Data to better understand the well-being and efficiency of the physician includes burnout scores, total time and after-hours time spent on EHR, and chart closure rates. For example, a physician might be spending excessive hours in documentation due to inefficiencies or clinical uncertainties, and feel unable to build the panel to an appropriate size. Lastly, no show and open-slot reports, with detail on late cancellations from un-booked slots, should be regularly reviewed and monitored. This information is important for the financial fitness of the practice. A newer PCP is expected to see more new patients, and may have a greater no show rate than a more established clinician. If the under-empaneled PCP is relatively new to joining the practice, more time could be allowed to let the panel grow and marketing could be enhanced.

2. Calculate the number of visits per patient per year

The next step in understanding the factors underlying a low panel size is to calculate the number of visits per patient per year.[3] If this number is greater for the individual PCP than the clinic average, there may be both PCP and patient driven reasons for the increased number of visits. PCP driven reasons might include requesting patients to return sooner than is necessary, discomfort with long visit intervals, a high number of perceived or actual complex patients and/or young pediatric patients who require a higher number of visits per year than average. Some PCPs desire to manage a highly complex patient population; these PCPs generally have longer visits and smaller panels than his/her colleagues. Patient-driven reasons for high visit rates might include clinical or behavioral needs that are not being met, or perceived illnesses not addressed by the PCP. If the methodology for risk adjustment takes into account the number of visits per patient per year, then the PCP may already have a substantial "up weighting" of his or her adjusted panel size due to the high visit rate. If the weighted panel remains below the right-size target even with this adjustment, additional reasons should be explored for the gap between targeted and adjusted panel size.

3. Promote absorption of patients from over-empaneled colleagues

In any given practice, there are often over-empaneled and under-empaneled PCPs. The under-empaneled clinician can partner with an over-empaneled one to relieve demand. Using focused panel reduction strategies, the under-empaneled PCP can assume responsibility for selected patients of over-empaneled clinicians.

4. Direct scheduling to promote practice and panel growth

Direct scheduling of patients transitioning from the emergency room, hospital, or specialist's offices can be helpful in building under-empaneled PCP's panels and growing the practice.

5. Use the practice compensation plan to incentivize optimal panel size

Compensation plans can emphasize practice goals such as achieving a targeted right-size panel size in a defined period of time. Physician compensation models can also provide options for PCPs who prefer a lower panel size to receive less compensation, and assure that PCPs who meet or exceed expected panel size are appropriately compensated.

In addition to daily operational dashboards, all PCPs' panels should be reviewed on a monthly basis by the practice's panel manager and medical director, with the dashboard provided to each PCP. Once the over-empaneled and under-empaneled PCPs have been identified and action has been taken, the panel manager can then address empanelment for unassigned and new patients. An electronic strategy to embed the panel registry in the EHR would be ideal. The San Francisco

Department of Public Health identified its active clinic panels (one or more outpatient medical visits during the past 2 years) and automatically assigned in their EHR the previously unassigned patients to clinics based on this determination of which clinics had an overall panel size below the targeted level. Providers and medical directors can review, verify and actively manage their panels in real time.[4]

Addendum #1: Case Study of the Over-empaneled PCP

Dr. M works at a practice where the right sized panel has been determined to be 1,600. Her practice is now fully embracing empanelment, and the designated panel manager ran a report through the EHR and determined that her panel size is 2,027. When her clinic adjusts her panel size using an algorithm that takes into account not just age and gender but also level of asynchronous activity of her patients, her weighted panel size is 1,986. Dr. M has noted recently that she has been having difficulty with access for her patients; her schedule is full more than a month in advance. She receives patient portal messages from her patients complaining about the wait times to see her.

Her panel manager has identified that Dr. M is over-empaneled by 386 patients. The panel manager next runs a report that identifies that 217 of Dr. M's patients have not been seen in 24 months. The panel manager sends a bulk patient portal message to these patients asking them to confirm that they perceive that Dr. M is still their PCP. The panel manager also invites these patients to transfer care to Dr. P if they wish to do so for improved access. Of the 217 patients who have not been seen in 24 months, 43 of them have moved away or transferred their care. 20 patients wish to transfer their care to Dr. P for improved access. With this initial step, Dr. M is now 149 patients over-empaneled.

The practice decides to augment the care team of Dr. M by adding a health coach who can help support Dr. M by providing her patients with preventive and chronic disease health coaching, and access to a therapist to provide integrated behavioral health onsite. Dr. M feels more supported and also reports that she feels her patients are better cared for with this expanded team.

Addendum #2: Case Study of the Under-empaneled PCP

Dr. B also works at a practice where the right sized panel has been determined to be 1600. He has been with this practice for 2½ years now and his panel size is 1256. His clinic adjusts his panel size using an algorithm that takes into account not just patient age, sex, morbidity but also the workload associated with caring for each panel. His weighted panel size is 1201. This is the first job out of residency for Dr. B and he has wondered why some of his patients don't return to see him. He frequently runs behind schedule as he tries to cover all of the concerns of his patients in one visit. He almost always asks his patients to return just in case he has missed something.

His panel manager and medical director measure Dr. B's average number of visits per patient per year and note it to be 4.0, higher than his colleagues. His open slot report over the past month reveals that he has on average 15 slots open per week, higher than his colleague's average of 8 per week. In the past week, 7 of these slots were late cancellations, 5 were no shows and 3 were not scheduled. His patient experience reports are reviewed and there are many comments about him running behind on schedule, although many other patients comment that he is very thorough. One patient commented that she was asked to return for a visit but was not sure why she needed to return.

The medical director and Dr. B meet to discuss these findings and whether Dr. B might be asking patients to return for visits to a greater degree than is clinically necessary. Dr. B admits that he worries that he might be missing something during his initial visits with patients and feels better if patients at least have a follow up appointment scheduled. Over time, the medical director and Dr. B work together on a strategy that helps Dr. B set focused agendas with his patients at the start of each visit, prioritize actions for visits, and utilize his care team to make follow up calls to reduce subsequent unnecessary visits. Dr. B gains confidence and is better able to handle a larger panel of patients over time.

UC HEALTH PRIMARY CARE PANEL PROJECT CONCLUSIONS

UC Health's leadership is committed to optimizing access for primary care patients. The increased demand for primary care and accountability for population health through empanelment, make determination of the right sized panel and management of panel size to that target ever more critical. Panel size has significant downstream effects including quality, patient and clinician satisfaction, and access to care. Access will continue to be problematic unless the capacity or supply of a practice, measured through panel size, is known and maintained at a number that meets demand. The asynchronous work involved in quality population health must also be accounted for in identification of the adjusted right sized panel.

This collaborative effort among the primary care leadership of the five UC health systems set out to improve access and clinician engagement by examining four key questions about empanelment and panel size:

Question 1: How should patients be attributed to a primary care clinician's panel?

Question 2: What is the "right-sized" panel?

Question 3: How can practice panels be adjusted for patient and population risk?

Question 4: What are the best ways to right-size panels?

While investigating these questions, we discovered areas of both commonality and variation in how each of the five health systems approach defining, measuring, and managing primary care panel sizes. One resounding, affirmative consensus conclusion is that these four questions capture the essential steps that a health care system must take to effectively operationalize empanelment and management of primary care panels. Leadership across all five health systems agreed that there must be a clearly defined process for attributing patients to a primary care clinician, continuous assessment of the number of active patients, an articulated standard for targeted panel size per primary care clinician FTE, adjustment of the measured panel size to account for variation in patient complexity and work load, and active management of panels to align actual panel size with the targeted size. While there was consensus on the above core questions and some key elements of empanelment, each system tailored their specific method of operationalizing the core elements based on the unique local history and context of the system's primary care service line.

For the initial step of attributing active patients to primary care clinician panels, there was agreement that because the majority of patients continue to be insured by fee-for-service payors that do not require formal registration of patients with a medical home, health systems must devise their own methods for identifying patients who are active in their primary care practices and attributing them to a specific primary care clinician. Most UC health systems define an active primary care patient as having at least one visit to a primary care practice in the previous 36 months. Two sites use a shorter "look back" period (18 months) though one is considering extending the period to 36 months, and there is variation in whether one or two visits are required for inclusion in the definition of an active patient. For the purpose of attributing the active patients to a specific primary care clinician, health systems differ in the extent to which they rely on visit history or the PCP field in the EHR. Some systems exclusively use the EHR PCP field and involve their practices and clinicians in regularly "curating" the EHR field to ensure that it accurately reflects both the PCP who serves as the patient's continuity provider and the patient's active status in the practice. UCLA relies on actual visit patterns to discern the PCP most involved in the patient's care, particularly when no physician is listed in the EHR PCP field. Combining active curating of the EHR PCP field with analysis of visit patterns appears to produce the most robust empanelment attribution model.

Researching possible benchmarks for a standard panel size for a full time primary care clinician made it apparent that "one size does not fit all." There is no well-accepted national standard for panel size. Average panel sizes vary widely across health care organizations in the US and internationally, reflecting differences in populations served, care models and care team support, historical productivity, patient and clinician expectations, and other contextual factors. One often-cited method for computing target panel size based purely on availability of clinic visits and average visits per patient per year

was not widely endorsed by UC primary care leaders. The model fails to account for the large amount of primary care work that occurs outside of face-to-face visits. The lack of broadly accepted standards leads UC primary care leaders to be skeptical about the appropriateness of developing a single system-wide standard for primary care panel size. An important consensus definition is the description of a full-time clinical FTE in order to accurately reflect and compare primary care panel sizes. Some UC health systems consider 8 half day sessions of scheduled clinic time to constitute 1.0 clinical FTE (others use 32-36 hours/week) for a primary care clinician, recognizing that each half day session of clinic generates at least 25% (and probably closer to 50%) of additional work time in the form of non face-to-face visit activity (e.g., responding to My Chart messages, refilling medications, communicating with specialists, home care needs, etc).

UC primary care leaders also agreed on the principle that panel size should be adjusted to reflect differences in patient complexity. There was no consensus on the best method for weighting patients to account for variation in complexity in the primary care setting. Available methods range from relatively simple approaches based on basic patient characteristics such as age, gender and comorbidity, to models such as that developed by UCSF using sophisticated "big data" computational approaches to mine EHR data to produce complexity weights to reflect the clinician's workload for individual patients. Since there is not yet a single, national primary care standard for complexity or workload adjustment, we agreed that UC health systems should continue to innovate using a menu of weighting methods based on feasibility of local implementation. There was also a shared concern that current adjustment methods may not fully account for academic health centers' complex case mix compared with other health care organizations, and does not reflect comparison to a community-based average for patient complexity and clinician workload.

All health systems employed quite consistent strategies for actively managing panels to the system-determined right sized target, including assessing risks to access, quality, continuity, and patient satisfaction and clinician engagement.

This project affirmed the importance of implementing systematic methods for defining and managing empanelment of patients in UC Health primary care practices. Empanelment methodology at UC health systems and for the US health system overall is at a formative stage. The very genesis of this project reflects the lack of broadly accepted standards and methods of empanelment. At this time, standardization of empanelment methods and panel sizes at UC Health includes 1) the expectation that all health systems must address each of the four elements of empanelment and panel size management, and 2) should define clear parameters for each of those four elements (e.g., all attribution methods must clearly define the "look back" period for attributing active patients to a practice, definitions of 100% clinical FTE, use of the EHR PCP field). The participating UC primary care systems each benefited from this collaborative effort to develop a common conceptual framework and identify the key parameters for successfully operationalizing empanelment. Opportunities for additional learning include the definition of optimal clinical staffing ratios, the alignment of health system funds flow to practices and departments, as well as individual compensation to clinicians, and exploration of the impact of optimal panel sizes on clinician and patient engagement.

REFERENCES BY SECTION

Introduction

1. Blumenthal D, Abrams M, Nuzum R. The affordable care act at 5 years. *N Eng J Med* 2015; 372: 2451-2458.
2. Health Resources and Services Administration Bureau of Health Professions, National Center for Health Workforce Analysis. 2013. Projecting the Supply and Demand for Primary Care Practitioners Through 2020; http://bhpr.hrsa.gov/healthworkforce/supplydemand/usworkforce/primarycare/projectingprimarycare.pdf)
3. IHS Inc. for AAMC. 2016 Update: The Complexities of Physician Supply and Demand 2016 Update: Projections from 2014 to 2025; https://www.aamc.org/download/458082/data/2016_complexities_of_supply_and_demand_projections.pdf). a step-wise approach to addressing these challenges.
4. Rajkumar R, Conway PH, Tavenner M. CMS--engaging multiple payers in payment reform. *JAMA*. 2014 May 21;311(19):1967-8.4.
5. Bodenheimer T, Ghoroh A, Willard-Grace R, Grumbach K. The 10 Building Blocks of High-Performing Care. *Ann Fam Med* 2014; 12:166-71.
6. Brownlee B, Van Borkulo N. Empanelment: Establishing Patient-Provider Relationships. In: Phillips KE, Weir V, eds. Safety Net Medical Home Initiative Implementation Guide Series. 2nd ed. Seattle, WA: Qualis Health and The MacColl Center for Health Care Innovation at the Group Health Research Institute; 2013
7. Angstman KB, Horn JL, Bernard ME, et al. Family medicine panel size with care teams: impact on quality. *J Am Board Fam Med* 2016;29:444–51.
8. Dahrouge S, Hogg W, Younger J, Muggah E Russell G, Glazier R. Primary Care Physician Panel Size and Quality of Care: A Population-Based Study in Ontario, Canada. *Ann Fam Med* 2016;14:26-33.
9. Sinsky C, Colligan L, Ling L, Prgomet M, Reynolds S, Goeders L, et al. Allocation of Physician Time in Ambulatory Practice: A Time and Motion Study in 4 Specialties. *Ann Intern Med* 2016 Sep 6.
10. Reid RJ, Coleman K, Johnson EA, et al. The Group Health medical home at year two: cost savings, higher patient satisfaction, and less burnout for providers. *Health Aff (Millwood)*. 2010;29(5):835-843.
11. Raffoul M, Moore M, Kamerow D, Bazemore A. A primary care panel size of 2500 is neither accurate nor reasonable. *J Am Board Fam Med* 2016;29:496.

Question 1: How should patients be attributed to a PCP panel?

1. Ryan A, Linden A, Maurer K, Werner R, Nallamothu B. Attribution methods and implications for measuring performance in health care. National Quality Forum (NQF) Version July 15, 2016 http://www.qualityforum.org/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=82908 (Accessed online October 31, 2016)
2. Comprehensive Primary Care (CPC) Initiative. CPC 2012 Change Package. Center of Medicare and Medicaid Innovations Center. January, 2012.
3. Safety Net Medical Home Initiative. Empanelment: Establishing Patient-Provider Relationships. May 2013. http://www.safetynetmedicalhome.org/sites/default/files/Executive-Summary-Empanelment.pdf Accessed online October 17, 2016
4. Murray M, Davies M, Boushon B. Panel size: How patients can one doctor manage? *Fam Practice Mgmt* 2007;14(4): 44-51.

Question 2: What is the "right sized" panel?

1. Murray M, Davies M, Boushon B. Panel size: how many patients can one doctor manage? *Fam Pract Manag* 2007;14:44 –51.
2. Arndt B, M. W.-J. (2014). Panel Workload Assessment in US Primary Care: Accounting for Non-Face-to-Face Panel Management Activities. *Journal of the American Board of Family Medicine*, 27, 530-537.7.
3. Sinsky C, Colligan L, Li L, Prgomet M, Reynolds S, Goeders L, Westbrook J, Tutty M, Blike G. Allocation of Physician Time in Ambulatory Practice: A Time and Motion Study in 4 Specialties. *Ann Intern Med*. 2016 Sep 6. doi: 10.7326/M16-0961
4. Palen TE, Ross C, Powers JD, Xu S. Association of online patient access to clinicians and medical records with use of clinical services. *JAMA*. 2012;308:2012-9.
5. Altschuler J, Margoulis D, Bodenheimer T, Grumbach K. Estimating a Reasonable Patient Panel Size for Primary Care Physicians With Team-Based Task Delegation. *Ann Fam Med* 2012;10:396-400. doi:10.1370/afm.1400.
6. Østbye T, Yarnall KSH, Krause KM, et al. Is There Time for Management of Patients With Chronic Diseases in Primary Care? *Ann Fam Med*. 2005;3(3):209-214.
7. Yarnall KSH, Østbye T, Krause KM, Pollak KI, Gradison M, Michener JL. Family physicians as team leaders: "time" to share the care. *Prev Chronic Dis*. 2009;6(2):A59-A64.
8. Yarnall KSH, Pollak KI, Østbye T, Krause KM, Michener JL. Primary care: is there enough time for prevention? *Am J Public Health*. 2003; 93(4):635-641.
9. Peterson L, Cochrane A, Bazemore A, Baxley E, Phillips RL Jr. Only one third of family physicians can estimate their patient panel size. *J Am BoardFam Med* 2015;28:173– 4.
10. Alexander GC, Kurlander J, Wynia MK. Physicians in retainer ("concierge") practice. A national survey of physician, patient, and practice characteristics. *J Gen Intern Med* 2005;20:1079–83.
11. Raffoul M, Moore M, Kamerow D, Bazemore A. A primary care panel size of 2500 is neither accurate nor reasonable. *J Am Board Fam Med* 2016;29:49612.
12. Huang PY, Yano EM, Lee ML, Chang BL, Rubenstein LV. Variations in nurse practitioner use in Veterans Affairs primary care practices. *Health Serv Res* 2004; 39(4 Pt 1): 887-904
13. http://longevity3.stanford.edu/blog/2012/06/13/californias-aging-population-not-forever-young/4/ Accessed 11/3/16.
14. Fried, L; Hall, W: Leading on Behalf of an Aging Society, *J Am Geriatr Soc* , JAGS 2008; 56, 1791-1795.
15. AGS Forum: http://myagsonline.americangeriatrics.org/communities/community-home/digestviewer/viewthread?GroupId=91&MID=1605&CommunityKey=c5a3cee9-72e7-4d4d-b129-765a68546712&tab=digestviewer#bm9 Accessed 11/3/16
16. Phelan EA, Genshaft S, Williams B et al. How "geriatric" is care provided by fellowship-trained geriatricians compared to that of generalists? J Am Geriatr Soc 2008;56:1807–1811.

Question 3: How can practice panels be adjusted for patient and population risk?

1. Ash AS, E. R. (2000). Using diagnoses to describe populations and predict costs. Health Care Financial Review , 21 (3), 7-28.
2. Gilmer T, K. R. (2001). The Medicaid Rx model: pharmacy-based risk adjustment for public programs. Medical Care, 39 (11), 1188-202.
3. Arndt B, M. W.-J. (2014). Panel Workload Assessment in US Primary Care: Accounting for Non-Face-to-Face Panel Management Activities. *Journal of the American Board of Family Medicine* , 27, 530-537.

4. Ikeda TS, K. G. (2013). Determining Panel Capacity and Physician Effort in a Complex Resident/Faculty Family Medicine Office. Retrieved from Society of Teachers of Family Medicine Conference on Practice Improvement Poster Presentation November 2013.
5. Rajkomar A, Y. J. (2016). Weighting Primary Care Patient Panel Size: A Novel Electronic Health Record-Derived Measure Using Machine Learning. *Journal of Medical Internet Research Medical Informatics* , 4 (4), e29.

Question 4: What are the best ways to right size panels?

1. Brownlee B, Van Borkulo N. Empanelment: Establishing Patient-Clinician Relationships. In: Phillips KE, Weir V, eds. Safety Net Medical Home Initiative Implementation Guide Series. 2nd ed. Seattle, WA: Qualis Health and The MacColl Center for Health Care Innovation at the Group Health Research Institute; 2013.
2. Altschuler J, Margolius D, Bodenheimer T, Grumbach K. Estimating a Reasonable Patient Panel Size for Primary Care Physicians with Team-Based Task Delegation. *Ann Fam Med* 2012; 10(5); 396-400.
3. Murray M, Davies M, and Boushon B. Panel Size: How Many Patients Can One Doctor Manage? *Fam Prac Manag* 2007; 14(4):44-51.
4. Marx, R, Drennan, M and Johnson, E. Creating a Medical Home in the San Francisco Department of Public Health: Establishing Patient Panels, July/August 2009 - Volume 15 - Issue 4 *Journal of Public Health Management and Practice.*