June 28, 2021

Centers for Medicare & Medicaid Services
Department of Health and Human Services
7500 Security Boulevard, Mail Stop C4-26-05
Baltimore, MD 21244-1850

RE: CMS-1752-P; FY 2022 IPPS Proposed Rule; Closing the Health Equity Gap in CMS Hospital Quality Programs – Request For Information

Dear Administrator Brooks-LaSure:

We, the undersigned organizational members of The Academy Advisors, appreciate the opportunity to provide the following feedback in response to the Request for Information on Closing the Health Equity Gap in CMS Hospital Quality Programs within the FY 2022 Inpatient Prospective Payment System Proposed Rule (CMS-1752-P: Medicare Program; Hospital Inpatient Prospective Payment Systems for Acute Care Hospitals and the Long Term Care Hospital Prospective Payment System and Proposed Policy Changes and Fiscal Year 2022 Rates; Quality Reporting and Medicare and Medicaid Promoting Interoperability Programs Requirements for Eligible Hospitals and Critical Access Hospitals).

The Academy Advisors is a group of clinically integrated delivery networks that pursue innovative care efforts throughout our communities. Our health systems serve more than 30 million patients annually in 26 states across the country. We commend the Administration for their recognition of health disparities in the United States, and applaud the Centers for Medicare & Medicaid Services (CMS) for their ongoing efforts to evaluate appropriate initiatives to reduce health disparities. The Academy Advisors coalition and our member organizations are committed to reducing health disparities in our individual communities and are dedicated to supporting the Administration in nation-wide efforts to create equity in the U.S. healthcare system.

The Academy Advisors believes that our member health systems are the Administration’s ideal partner in the identification of existing health disparities, as well as in the planning, analysis, and execution of innovative interventions to address the unique needs of communities across the country. Integrated delivery networks provide care through the lens of population health, and have been leaders in implementing key tenets of the Patient Protection and Affordable Care Act (ACA) through the coordination of care across delivery settings, and the implementation of value-based delivery models. As demonstrated throughout the COVID-19 pandemic, clinically integrated delivery networks have the scale and infrastructure to maneuver and re-allocate necessary resources across their clinical footprint when addressing the needs of their populations. Finally, integrated delivery networks have the operational expertise and experienced leaders to implement innovative, unique, and differentiated solutions to address persistent systemic issues impeding health equity in our communities.

As part of our ongoing commitment to addressing health disparities, our organizations have partnered separately in the creation of the Health Equity Alliance. The goal of the Alliance is to develop and disseminate best practices across member health systems to accelerate progress toward equitable patient care. This alliance of prominent healthcare organizations will work together to optimize innovative methods to performance measurement and pilot new approaches to multi-sector partnerships. In reviewing the background information enclosed in the current Request For Information (RFI), we recognize that your team(s) at CMS might benefit from understanding more about what our organizations are currently doing to collect data, analyze outcomes, and address inequities. Before CMS engages in future rulemaking related to this RFI, we urge the agency to meet with our organizations to better...
understand current market approaches, including what is working and what is not working, and where we believe the agency can offer organizational, financial, and other support so that we are all working together to achieve common goals.

In one example of how our member organizations are working to improve health equity at the clinical, operational, and community levels, Adventist Health, a California-based clinically integrated delivery network that also serves Washington, Oregon, and Hawaii, is using a rigorous measurement approach to assess their health equity work across four quadrants:

1. Metrics of Inclusion: tracks utilization data using race, ethnicity, and language (REaL) and sexual orientation and gender identify (SOGI) stratification;
2. Culture of Inclusion: tracks whether councils, governing boards, and mission is aligned with Health Equity;
3. Linking Health Equity and Quality of Care: tracks whether performance reviews and rewards are linked to efforts in diversity and inclusion, and tracks accountability for quality care across all groups; and
4. Inclusive Community Engagement: tracks diverse community outreach and alignment of population health with community needs.

In another example highlighting ways in which integrated delivery networks are incorporating health equity work across their entire footprint, Novant Health, primarily based in North Carolina, integrates health equity goals and equity-related metrics as standard organizational practice across safety and quality outcomes, systemwide care coordination, team member cultural competency education, patient satisfaction evaluations, research, and community outreach. Novant’s interdisciplinary Health Equity Council works in partnership with all service line institutes to identify disparities by segmenting data across race, ethnicity, and language, and gender/gender identity, age, payor, and sexual orientation (REaL GAPS) and other dimensions of diversity. Using this data, the Health Equity Council addresses inequities through the development of strategic action plans, provides oversight for community partnership, determines metrics for success, identifies education needs for internal team members, and serves as key advisors to the executive team. Executive compensation at Novant Health is directly tied to long-term health equity goals related to gap closure in mammography, vaccinations, and heart failure and sepsis outcomes.

As with the Request for Information, our comments are organized into three categories: Future Potential Stratification of Quality Measure Results by Race and Ethnicity; Improving Demographic Data Collection; and, Potential Creation of a Hospital Equity Score to Synthesize Results Across Multiple Social Risk Factors.

Future Potential Stratification of Quality Measure Results by Race and Ethnicity

The Academy Advisors recognizes CMS’ interest in better understanding and building awareness of health disparities. We support the goal of measuring, collecting, and analyzing quality measures and outcomes data by race, ethnicity, and other sociodemographic variables and believe the information would be extremely helpful for our organizations on their population health, value-based care, and equity-specific initiatives. Ultimately, the lens of equity should be incorporated into all quality measurement and improvement fields.

In a specific example, Sutter Health was able to use REAL data to understand ethnic disparities in COVID-19 hospitalization rates. While the state data lacked key details that hindered a full understanding of the scope of the issue, Sutter was able to use REAL data from its own electronic health record (EHR)
system to identify and confirm disparities in COVID-19 outcomes\(^1\) and developed a COVID-19 vaccine equity index (paper attached as Amendment I).

Given the importance of REAL data and the myriad opportunities for using the data to improve health equity, we strongly discourage CMS from using an algorithm to indirectly estimate race and ethnicity, even in the short term. As CMS notes in the RFI, algorithms have the potential for initial biases and to develop additional biases in the future. We believe that the existing limitations in algorithms (i.e., limitations in surname analysis) outweigh the potential benefit and could even exacerbate health disparities. If CMS decides an algorithm is absolutely necessary, however, we encourage the agency to enable separation of self-reported versus algorithm-calculated information when using the data to analyze outcomes or metrics.

In lieu of adopting an algorithm to estimate demographic data, The Academy Advisors recommends CMS consider supporting efforts to collect self-reported data, which, as CMS notes in the RFI, is the gold standard approach. Because self-reported race, ethnicity, ancestry, and language is the gold standard, many health systems have already made significant investments and implemented efforts to collect this information and are willing and eager to share best practices. Many of our organizations (including Sutter Health, Ochsner Health, ChristianaCare, Adventist Health, and others) have already been working to streamline their data intake process by educating their provider and administrative teams about the registration and data collection process, and partnering with community groups to share why a hospital would want to gather race and ethnicity information from patients, and how the demographic data will and will not be used.

Ochsner Health, based in New Orleans, Louisiana, has implemented a three-pronged approach to improving sociodemographic data collection:

1. **Data capture, accuracy and validity**
   a. Validate existing data within current patient-facing information systems (Ochsner currently uses an EPIC electronic health record system).
      i. The team noted limitations in race and ethnicity categories and determined a need for standard definition for consistency
      ii. The team decided to use the US Census categories as standard definitions
         1. Note: with use of Census definitions, they will have to keep up with changes made every 10 years
   b. Create consistent data capture workflows at data integration points across the system, including scheduling, registration, patient portal, and check-in kiosk
      i. Note: certain domains (sexual orientation; gender identity) must be captured by “licensed providers” and would not be appropriate to collect at the front desk
      ii. Note: Also must consider asking patients to confirm a bundle of domains at the same time at a set minimum frequency per year
   c. Develop an educational approach to explain why collecting this information is important, targeting patients / community, staff, and clinicians

2. **Develop performance metrics and insights**
   a. Partner with Ochsner Health leaders to develop key health measures and dashboards to create insights into care delivery models
   b. This will be driven by value-based health plan metrics

3. **Inform innovations**
   a. Integrate insights into innovative care delivery models
   b. Utilize implementation research to measure innovation impact

We also wish to share with CMS that as part of the ongoing work of the Health Equity Alliance, our members are currently developing a survey to better understand current practices and real-world learnings in health system data collection. The survey will be distributed to our member health systems mid-July, and we anticipate having findings and data to share by August 16th. We would be happy to share the results of this survey with CMS, as we believe it will be a useful tool to help the agency better understand what health systems are currently doing in terms of data collection, where our organizations have found success, and where we believe CMS could offer support to tackle remaining obstacles.

The Academy Advisors also believes that CMS should create a set of standard definitions for each demographic data point and should consider ways to capture patients who self-identify as multiple races/ethnicities. Our organizations have experienced challenges in self-reporting, where some patients will select different answers depending on the context (e.g., who is asking the questions, for what purposes the patients believe the data will be used). Some patients have even switched their self-reported designation in recent years. In creating these standard definitions, we highly urge CMS to engage with local community groups across the country as well as national associations to align standard definitions with the designations patients use to identify themselves. This standardization across the country will be invaluable for understanding systemic inequities that exist. Similarly, standardizing the way in which hospitals collect sociodemographic data points will be essential to ensuring the data is comparable across hospitals, payers, and EHR platforms, and will help facilitate the exchange of information.

ChristianaCare, based in Wilmington, Delaware, developed a course, in-house, to help standardize the data collection process and align their registrars across the system. The course, “Get REL,” coaches registrars on micro-messaging and how to ask questions related to race, ethnicity and language, as well as how to answer patients’ questions related to data collection. The course utilizes videos with patients modeling behaviors and includes multiple exercises to walk registrars through the process. Course trainees learn about implicit biases and compare their guesses about a patient’s REL data to the patient’s self-reported information. While there is still more work to be done, the goal of the course is to help registrars understand why data collection is important, why self-reported information is preferred, and ultimately, to create alignment and standardization throughout the system.

Additionally, The Academy Advisors urges CMS to consider the importance of metrics beyond race and ethnicity when thinking about stratification by sociodemographic factors. To get a better sense of the myriad elements that may impact a patient’s health and health outcomes, CMS should also consider sexual orientation, gender identity, payor type, and other measures of socioeconomic status that are readily available in the electronic health record system. These may include sociodemographic indicators available through geocoding (e.g., median household income). Economic disparities are an important contributor to health inequities and health outcomes and must be given equal consideration when formulating opportunities to improve equity. We would also note that SDOH data is frequently collected outside of traditional health care settings. This data, whether it be self-reported or collected through community-based organizations, should also be reported to CMS.

Furthermore, we recommend that CMS stratify payer claims datasets provided by hospitals by race and ethnicity. Without it, hospitals and individual providers must attempt to connect the payer data with their own internal EHR data to create a profile of their patient population, which may potentially compromise the accuracy of the data. Finally, we believe that collection of any demographic information must be paired with appropriate privacy and security safeguards. These safeguards should be described in plain language and communicated to patients as part of the demographic data collection education process.

Improving Sociodemographic Data Collection

The Academy Advisors recognizes CMS’ intent to develop and disseminate solutions to achieve health equity and we agree with CMS’ observation that some certified health IT vendors are better than others at demographic data collection. In our collective experience, vendors have variable success in designing
user interfaces that can guide the registrant through self-reported data collection in a manner that is culturally appropriate, and in the patients’ own language.

In 2010, Sutter Health (based in Sacramento, California) underwent a system-wide effort to update their patient-facing portal and to collect self-identified information. The interface update included changing the demographic variables for race, ethnicity, and ancestry to match the US Census categories and to disaggregate Asian and Hispanic subgroups. The effort also included the addition of a robust “drop down” menu for ancestry. Sutter Health created a toolkit reflecting their process (available upon request) and published a paper based on an internal audit of the data they collected once their updated interface was created (attached as Amendment II).

Other systems have had different experiences working with other electronic health record vendors. For one system working with Cerner, the “Gender Identity” category is frequently confused with “Sex.” Furthermore, because of the way the dashboard appears on the screen, providers will often see the legal name of the patient first and not the patient’s preferred name. This immediately sets an unintentional negative tone to a conversation between patient and provider (if the provider is unintentionally misgendering the patient), and could easily be avoided with appropriate adjustments to the EHR platform.

**Potential Creation of a Hospital Equity Score to Synthesize Results Across Multiple Social Risk Factors**

The Academy Advisors recognizes that CMS is looking to implement sustainable actions to achieve health equity. Our organizations support CMS’ goal of creating an equity-based scoring or ranking system to synthesize results across multiple social risk factors and increase accountability. We believe this could be a useful tool for our organizations to better understand our own data for purposes of identifying opportunities for improvement, and to compare our data with that of other communities across the country to understand where there might be greater systemic issues that need to be addressed (e.g., racial biases in medical education, patterns related to social determinants of health). It is our belief that a successful framework would also help to demonstrate impact and progress towards closing equity gaps.

Already, there are multiple stakeholder groups working to build an equity-based scorecard or ranking system for hospitals and health systems (including the Johns Hopkins University Bloomberg School of Public Health, U.S. News & World Report, and health systems). Sutter Health authored a paper (attached as Amendment III) highlighting their work in developing a health equity index. We believe the creation of an equity score, if done correctly, could be an invaluable tool to encourage the entire healthcare market to move in unison to achieve a more equitable system. However, if done incorrectly, an equity score could aid in exacerbating current systemic inequities or could miss the opportunity to affect real change by focusing on symptoms instead of root causes of outcomes disparities.

Therefore, The Academy Advisors strongly urges CMS to create a separate taskforce, comprised of different stakeholder representatives, health equity leaders, and population health specialists, dedicated to building the proposed equity score methodology for hospitals. In recommending a framework for a Hospital Equity Score, the taskforce could consider potential data sources, metrics, and processes. The taskforce should conduct an inventory of existing equity indices, assess their reliability and validity, and assess whether these prototypes are informative across diverse healthcare settings and intersections of social determinants of health. The taskforce should then nominate a set of candidate metrics for further testing. We strongly believe that having a single metric as a marker to evaluate equity is not ideal, and instead it is our hope that the taskforce can recommend a comprehensive framework to evaluate health equity and ensure accountability at the system level.

We recommend the taskforce convene on a regular basis to update the framework, methodology, and metrics to reflect developments and changes in the population’s health and health outcomes. Furthermore, we urge the agency to ensure that the framework is actionable: that the output does not
solely exist in a database or spreadsheet with no meaningful opportunity for use. The output of the framework should be able to inform healthcare providers at the clinical level as well as at the operational level to truly have an impact on health outcomes and inequities.

Finally, to avoid deepening existing systemic inequities in the healthcare system, we urge the agency to avoid pursuing punitive actions or establishing perverse incentive structures for hospitals and health systems with lower health equity scores. To illustrate our recommendation, data suggests that in certain areas of the country, Black patients are seen in hospitals with lower financial margins and lower quality ratings. Those hospitals would likely receive low marks in any hospital equity score or ranking framework. Punitive actions, especially those that could bring additional pressure to already low financial margins, would not serve the patients in need and would only further exacerbate the systemic inequities.

Instead, we recommend that CMS create a grant program that would support patients by encouraging health systems to pursue innovative care models designed to improve equity. We envision these grants being awarded to innovative organizations looking to address a specific issue related to health equity within their market or community. As part of the grant process, the recipient would work closely with CMS to identify the appropriate patients, interventions, short- and long-term outcomes, and metrics to evaluate success. This would allow necessary flexibility for health systems to pursue different solutions designed for unique patient populations throughout the country, and would allow health systems the opportunity to partner with community, state and local agencies to achieve common goals. Ideally, CMS would evaluate the success of these grant-supported programs to determine if the program is scalable on a national level, and/or what additional patient populations would benefit from said intervention, and/or if additional policy interventions (both new policy and the reduction of existing barriers) are needed to achieve the desired outcomes.

In addition to the grant program, CMS should consider providing incentives within the Medicare quality programs for hospitals that report meaningful information on steps taken to address the equity gaps found in the data. This could be done via a value-based incentive or a penalty reduction in programs such as the Hospital Readmissions Reduction Program, Hospital Value-Based Purchasing Program, and the Hospital Acquired Conditions Reductions Program. Ultimately, this would incentivize hospitals to address health inequities found in the data by providing financial support and would allow CMS the opportunity to gather and analyze best practices in the market.

Again, we appreciate your commitment to addressing inequities in health and health outcomes, and sincerely hope we can partner with CMS and the Administration to identify the root cause(s) of these disparities, as well as aid in the planning and execution of innovative solutions that get us closer to our common goal. Thank you again for the opportunity to provide feedback to the Request for Information on Closing the Health Equity Gap in CMS Hospital Programs. We would welcome the opportunity for our coalition, or individual integrated delivery network members, to serve as a resource for you and your staff. Please do not hesitate to reach out to Stephanie Bernardes, Senior Director, Health Policy & Strategy (sbernardes@hmacademy.com) with any questions. We look forward to working with you.

Sincerely,

Advent Health
Adventist Health
Advocate Aurora Health
ChristianCare
Inova Health System
Intermountain Healthcare
Novant Health
Ochsner Health
Sutter Health
UnityPoint Health
Amendment I
Measuring and Promoting Severe Acute Respiratory Syndrome Coronavirus 2 Vaccine Equity: Development of a Coronavirus Disease 2019 Vaccine Equity Index

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Abstract
Purpose: The coronavirus pandemic has created the greatest public health crisis in a century, causing >500,000 deaths in the United States alone. Minoritized and socioeconomically disadvantaged groups have borne a disproportionate burden of severe illness, hospitalization, and death from COVID-19. Recently developed FDA-approved vaccines have been shown to significantly reduce severe COVID-19-related outcomes. Vaccination campaigns have the potential to advance health equity by prioritizing allocation to those at highest risk while striving for herd immunity. Large integrated health systems have been faced with the daunting task of meeting the rapidly evolving needs of diverse patient populations for the provision of population-based testing, treatment, education, and now vaccine distribution. We have designed a COVID-19 vaccine equity index (CVEI) to guide health system vaccination strategy.

Methods: We considered proportion unvaccinated within a health care system. We then used real-time readily available FHR COVID-19 testing positivity and proportion hospitalized to measure burden of illness by race/ethnicity. We used conditional probability and statistical theory to measure equity for unvaccinated individuals and to derive an index to highlight these inequities for specific subgroups.

Results: We present an illustrative hypothetical example using simulated data for which we calculated the CVEI for non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, and Hispanic patients. In the example, non-Hispanic Black and Hispanic patients had inequitable outcomes.

Conclusion: The index can be widely implemented to promote more equitable outcomes among racial/ethnic groups, reducing morbidity and mortality within the overall population as we pursue the collective goal of herd immunity through mass vaccination.

Keywords: COVID-19; health equity; vaccine equity; SARS-CoV-2; COVID-19 vaccine equity index

Introduction
As the United States shifts its focus from COVID-19 pandemic mitigation to vaccination, health equity is at the forefront of the conversation. President Biden has placed renewed focus on COVID-19 health disparities by establishing the COVID-19 Health Equity Task Force,2 intended to mobilize federal resources to aid state-level health department vaccination efforts. The Centers for Disease Control and Prevention (CDC) issued vaccine allocation recommendations3 through

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the Advisory Committee on Immunization Practices, suggesting that health care workers and long-term care residents be the first to receive the vaccine. The next tier included those 75 years and older, the highest risk patient group, and gradually "high-risk" younger age groups have been included.

Despite these efforts, early evidence suggests we are once again falling short in our efforts to prevent disparities from occurring among minoritized subgroups of the population. State governments have been assigned the ultimate authority in vaccine distribution efforts. This has resulted in inconsistencies that have impacted state-level capacities for appointments, vaccine supply, and priority setting for vaccination. These inconsistencies have also created an opportunity for further widening of disparities documented since the start of the pandemic.

At the population level, tracking vaccine administration, disaggregated for important subpopulations, such as gender, race/ethnicity, and geography (e.g., urban vs. rural), is a crucial first step in identifying and addressing emerging disparities. However, states and the federal government are already facing challenges in this regard. On March 17, the CDC reported detailed demographic characteristics of persons vaccinated (including race/ethnicity). However, at that time, race/ethnicity was unknown or not reported for 47% of the vaccinated population. Most states use either their existing immunization information systems, CDC-supported Vaccine Administration Management System, or both systems to support their vaccine management and reporting. These systems, however, have limited ability to capture and report crucial demographic breakdowns, such as race/ethnicity where the fields are not required or simply not available. Furthermore, as of March 15, only 39 states were reporting vaccine distribution by race/ethnicity.

Since the start of this pandemic, large integrated multihospital health systems have been faced with daunting tasks. Not only must they meet the rapidly evolving needs of diverse patient populations for the provision of population-based testing, treatment, and education, but now also vaccine distribution. With this central role and added responsibility, health systems have an opportunity to be proactive and mitigate barriers to vaccine access for those already disproportionately affected by the disease.

Considering these challenges, real-time EHR data can and should be leveraged by key stakeholders to guide and inform policy decisions, especially at the local level where distribution decisions are made. In a recent blog in health affairs, they state "Vaccine implementation strategies should address social and structural barriers to vaccination among populations disproportionately affected by COVID-19, target known disparities, be conducive to 'real-time' refinement, and mitigate any unintended negative effect on health care disparities." EHR data are needed to inform community-based collaborations, deployment of mass vaccination and pop-up sites, and targeting of educational campaigns and outreach efforts. A data-driven approach is critical. Severe illness, hospitalizations, and deaths from COVID-19 have not been experienced equally among racial/ethnic groups in the United States. The predominant burden has fallen on communities of color. We propose to use real-time readily available EHR data to derive a vaccine equity index that accounts for disproportionate burden of illness and can be used to guide health system vaccine mitigation strategy. The index, presented, builds on concepts from our prior health equity index (HEI), intended to provide insight into the impact that thoughtful vaccination strategies can have on addressing disparities. The goal is to promote more equitable outcomes among racial/ethnic groups, thus reducing overall morbidity and mortality as we pursue the collective goal of herd immunity through mass vaccination.

**Materials and Methods**

**Derivation of the index**

The index is focused on measuring equity, which occurs when the same patient outcomes are achieved regardless of sociodemographic factors (e.g., age, gender, race/ethnicity). By contrast, equality focuses on behaviors and actions, where members of all sociodemographic subgroups receive the same treatment. In this context, the desired outcome and a major goal of vaccination are to reduce severe illness, hospitalizations, and death. Equity is achieved when the likelihood of these adverse outcomes is comparable across all groups. The COVID-19 vaccine equity index (CVEI) identifies and quantifies disparities in outcomes for each racial/ethnic group and illustrates the potential impact of vaccine distribution on advancing equity.

The mathematical concepts used to derive the index are based in the theory of joint and conditional probabilities. We present standard notation to derive the index. We use the subscript "s" to denote members of...
a specific racial/ethnic subgroup (e.g., "Hispanic") and the subscript "r" to denote members of the entire (or total) population at-large. Probability of an event occurring is noted by \( p(\text{event}) \). Therefore, the probability of a member of subgroup "s" being unvaccinated and the same probability for the total population at large are represented by \( P(U_s) \) and \( P(U_t) \), respectively.

The index extends the notion of equality to the broader goal of equity. It is useful in our mathematical derivation to show how we start with equality and extend to measure equity. Equality is based upon taking the same actions regardless of subgroup. Here the action is vaccination. If we vaccinate all subgroups equally, the likelihood of being vaccinated (or conversely the likelihood of being unvaccinated, \( U \)) is the same for all subgroups.

For all subgroups, under equality, \( P(U_s) = P(U_t) \), and it follows that \( P(U) = 1 \), for all s.

If this ratio is \( > 1 \) for a given subgroup, that group is receiving unequal and less favorable treatment, whereas a value \( < 1 \) implies unequal but favorable treatment. This ratio is a building block for the index but does not measure outcomes.

To address equity, we invoke the concept of joint and conditional probabilities. A joint probability represents the probability that more than one event occurs simultaneously. For example, we are interested in identifying those individuals who are unvaccinated (U) and are infected with COVID-19 (I) and subsequently are hospitalized (H) with severe illness. The expression \( P(U, I, H) \) represents the probability of a member of subgroup (s) being unvaccinated, infected, and hospitalized with severe disease. This is the term articulating the adverse outcome that the vaccine has been shown to prevent. Equity, measured by this outcome, is achieved when the likelihood of this event is the same for all racial/ethnic subgroups.

For all subgroups and total population, under equality, \( P(U_s, I_s, H_s) = P(U_t, I_t, H_t) \), and it follows that \( P(U_s, I_s, H_s) / P(U_t, I_t, H_t) = 1 \), for all s.

If this ratio is \( > 1 \) for a given subgroup, outcomes are worse than the equitable solution; values \( < 1 \) indicate outcomes that are better than an equitable solution. This ratio is the definition of the CVEI.

\[
\text{CVEI}_s = P(U_s, I_s, H_s) / P(U_t, I_t, H_t).
\]

Using conditional probabilities (Fig. 1), this ratio can be deconstructed into a product of terms that are intuitive to understand, reasonably straightforward to estimate, and useful in practice. A person who is unvaccinated may become infected, then once infected may become hospitalized. Conditional probabilities measure the chance of an event happening given that certain antecedent events have already transpired.

A conditional probability of interest is the chance that, given that a person in subgroup \( s \) is both unvaccinated (\( U_s \)) and infected (\( I_s \)), that individual is hospitalized (\( H_s \)). This is denoted mathematically as \( P(H_s | U_s, I_s) \), where the events to the right of the vertical line are antecedent events. We are also interested in the probability that, given a person in subgroup \( s \) is unvaccinated, that this person goes on to be infected. This is denoted as \( P(I_s | U_s) \).

The chain rule of conditional probabilities permits the calculation of joint probabilities in the CVEI using only these more easily estimated conditional probabilities.

\[
P(U_s, I_s, H_s) = P(H_s | U_s, I_s) \times P(I_s | U_s) \times P(U_s).
\]

Thus the CVEI can be rewritten as the product of three ratios.

Ratios 3 (R3) and 2 (R2) Ratio 1 (R1)

\[
\text{CVEI}_s = \frac{P(H_s | U_s, I_s)}{P(U_s)} \times \frac{P(I_s | U_s)}{P(U_s)} \times \frac{P(U_s)}{P(U_t)}
\]

Each is a risk ratio, or ratio of probabilities comparing a specific subgroup with the total. The first risk ratio, R1, is a risk ratio describing our actions, the likelihood that a member of the subgroup will be unvaccinated compared with the general population, and by itself, measures equality, the extent to which we vaccinate all groups equally. The second, R2, compares the relative likelihood of contracting COVID-19 for subgroup \( s \) members who are unvaccinated compared with the general unvaccinated population. The third, R3, compares the relative likelihood of being hospitalized for members of the subgroup who are both unvaccinated and infected compared with members of the general population. It should be noted that this series of conditional probabilities is based on the assumption that a vaccinated person will not become infected or hospitalized with COVID-19, and it is only the unvaccinated group that is at risk for R2 and R3.

A value for the CVEI can be calculated for each distinct subgroup and be used to assess the degree to
which outcomes for that subgroup achieve equity. We propose and compare two methods for estimating these risk ratios.

Method 1, using logistic regression, is more computationally complex. Using EHR data, outcomes (hospitalizations for R3 or infections for R2) among racial/ethnic subgroups can be compared using logistic regression, which allows for estimation of these probabilities while adjusting for covariates such as age, gender, clinical characteristics, socioeconomic status, and insurance status. The coefficients in the logistic regression are used to compute the relevant probabilities and risk ratios. Because this approach allows us to account for differences with respect to various characteristics among subgroups, it is a more precise way to estimate these probabilities attributed to a specific racial and ethnic subgroup.

Estimating R1 is straightforward, computing $P(U_i)$ as the ratio of the observed total number of unvaccinated people in the subgroup to the total number of individuals in the subgroup and calculating $P(U_i)$ similarly.

Method 2, using observed counts, provides a computationally simple way to calculate the CVEI. Although the estimates it provides are unadjusted, and, therefore, less precise, it is simple to implement, understand, and may provide insights that are directionally accurate and still useful for developing on-the-ground vaccination strategies. Estimating R3 numerator, $P(H_i|U_i, I_i)$, is done using the number of subgroup $s$ members with a positive COVID-19 test who are hospitalized divided by the total number of subgroups $s$ who tested positive for COVID-19. The same approach is applied to the denominator to estimate $P(H_i|U_i, k)$. Estimating R2 numerator, $P(I_i|U_i)$, is done using the number of subgroups $s$ members who had a positive test result divided by the total number of subgroups $s$ who were tested. The same approach is applied to the denominator, $P(I_i|U_i)$. R1 is estimated as above.

All computations for analytic examples were conducted using STATA version 16. This study was approved as a quality improvement initiative by the Sutter Health Institutional Review Board.

**Simulation Results**

The CVEI: an illustrative example and practical application

The CVEI and associated ratios (R1, R2, and R3) give insight into how to construct targeted vaccine strategies to enhance equity. The CVEI indicates whether equity has been achieved for a given subgroup and its value reflects the magnitude of the disparity. The ratios inform the specific actions we may be able to take to reduce that disparity. Elevations in R1 reflect equality of our vaccination efforts, whereas R2 and R3 help identify which members of the subgroup, if vaccinated, would have the greatest impact on reducing the disparity. For example, deviations in R2 suggest that vaccinating members of the subgroup most at risk of becoming
infected would improve measures of equity. Elevations in \( R_3 \) suggest that preferentially vaccinating subgroup members at greatest risk for severe illness and hospitalization, if infected, would have the maximum impact on improving equity.

Large health systems provide a window into a representative segment of the population within regions of the country. For illustrative purposes, using simulated data, we calculated the CVEI for non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, and Hispanic patients. The indices, computed using both methods, are presented in Table 1.

The results in Table 1 indicate that as we pursue our goal of reaching herd immunity, we would be wise to focus our outreach in the Black and Hispanic communities, groups for which vaccination must increase, if we wish to achieve equity. Furthermore, for Black communities, where the driving force is \( R_3 \), we focus on those most likely to require hospitalization, such as elderly and those with underlying chronic conditions. For Hispanic communities, where the highest score is \( R_2 \), we should craft mass vaccination efforts to limit the likelihood of infection.

As a practical application, if we plan to vaccinate 70% of the total population, a reasonable herd immunity goal, then 30% would potentially remain unvaccinated or \( P(U) = 0.30 \).

Under equity, each CVEI\(_i\) = \( R_1 \times R_2 \times R_3 \) = \( \frac{P(U_1)}{P(U_i)} \times \frac{P(U_2)}{P(U_i)} \times \frac{P(U_3)}{P(U_i)} = 1 \).

Therefore, \( P(U) = P(U_i)/(R_2 \times R_3) = 0.3/(R_2 \times R_3) \).

In Table 2, we derive subgroup vaccine equity goals or \([1 - P(U)]\) using the CVEI values in Table 1. As expected, vaccination goals for Black and Hispanic subgroup are higher than the 70% overall goal to achieve equity.

In the context of the health systems, Figure 2 illustrates the two goals. First (dark blue) is subgroup equality goals. Second (light blue) is subgroup equity goals. These goals provide insight for identifying how vaccinations can be used to improve outcomes for those groups most heavily impacted by COVID-19 while striving for herd immunity.

**Discussion**

COVID-19 provided a new perspective and a public emphasis on inequities that exist in our society and our health care system. Mass vaccination is a powerful tool that can lead to herd immunity among the population by decreasing the pool of those susceptible to COVID-19. All currently FDA-approved COVID-19 vaccines have shown significant reduction in likelihood of severe illness, hospitalization, and death for those vaccinated.\(^{22-25}\) The proposed CVEI is a tool that can be used to monitor and inform local strategies at the health system level for achieving herd immunity while enhancing equity by incorporating the disproportionate burden of illness into subgroup targets and goals.

COVID-19 continues to have disproportionate impact based on race/ethnicity, age, health status, occupation, and other social determinants of health.\(^{26}\) The disproportionate and untenable burden of severe illness, hospitalizations, and death borne by marginalized racial/ethnic groups has been well documented.\(^{6,7,9,12,27}\) Although calls for equitable vaccine distribution have predated the FDA’s approval of available vaccines,\(^{28-30}\) little has been proposed for a data-driven approach at the local level to accomplish this goal. In 2020, the National Academies of Science, Engineering, and Medicine (NASEM) articulated a framework for equitable allocation of the COVID-19 vaccine,\(^{30}\) which advocates for a phased and tiered approach in which those most vulnerable to infection and negative health consequences are prioritized. Within each phase, all groups are given equal priority. Although this approach has been central to the CDC’s guidelines for national vaccine allocation,\(^2\) variation in policies and approaches at the state and local levels has made it challenging to implement. Some states have attempted to incorporate health equity more directly in their vaccination strategies and distribution efforts. The California Department of Public...
Health, for example, incorporates the California Healthy Places Index\textsuperscript{31} of social vulnerability to guide allocation of vaccine, prioritizing the socially and economically vulnerable. Despite this type of statewide effort to prioritize vaccination for vulnerable groups, it is the local governments and health care provider institutions that have assumed the bulk of the responsibility for vaccine administration. They have the potential to have the greatest impact on disparities, and the CVEI can assist them in developing vaccination strategies that advance equity in outcomes for COVID-19.

Given the pivotal role that large health systems are playing in implementing mass vaccination strategies, the CVEI is a pragmatic tool that leverages available EHR data to guide equitable decision making. As demonstrated in our example, the CVEI is relatively straightforward to calculate, interpret, and update. Hence, it can be employed as a dashboard metric to monitor progress and strategically allocate resources during vaccination campaigns. The real-time monitoring and use of disaggregated data to drive action\textsuperscript{32} at the local level are necessary to ensure equity. It allows for targeting interventions to facilitate a nimble and data-driven approach to achieve quantifiable equity goals. To our knowledge, no other attempts to guide local decision making have suggested the use of an index based on EHR data.

There are some underlying assumptions and limitations in the CVEI that should be noted. First, we assumed that vaccinated patients are not likely to become infected or hospitalized. This is supported by current data regarding the performance of the vaccines.

\begin{table}
\centering
\caption{Practical Application of the COVID-19 Vaccine Equity Index for Health System Vaccine Equity Goals}
\begin{tabular}{|l|c|c|c|c|c|}
\hline
Method 1—adjusted Goal: 70\% of total population vaccinated & Equality subgroup goals & $P(U_1)$ & $R_2$ & $R_3$ & $P(U_2)$ & Equity subgroup goals \\
\hline
Non-Hispanic White & 0.70 & 0.30 & 0.78 & 0.69 & 0.43 & 0.57 \\
Black/African American & 0.70 & 0.30 & 1.19 & 1.64 & 0.18 & 0.82 \\
Asian & 0.70 & 0.30 & 0.84 & 1.24 & 0.29 & 0.71 \\
Hispanic & 0.70 & 0.30 & 2.21 & 1.37 & 0.12 & 0.88 \\
\hline
\end{tabular}
\end{table}

\textbf{FIG. 2.} Demonstration graph of equality and equity goals by race/ethnicity. Bar graph represents percentage vaccinated for each race/ethnicity. A goal for herd immunity of 70\% is assumed. Dark blue markers represent goals for each race/ethnicity based on a vaccination strategy of equality. Light blue markers represent goals for each race/ethnicity based on a vaccine strategy of equity.
available in the United States.22–25 Should data later emerge that vaccine effectiveness varies among subgroups, this additional complexity could be readily incorporated into a more complex version of the index. We also assume that test positivity is a reasonable proxy for infection rate. Infection rates are extremely difficult to measure and, as a result, test positivity has been routinely used as a proxy by state and local health departments and the CDC. Finally, we assume that the subset of those tested is representative of the larger population and that testing behavior among subgroups is not overly biased.

A strength of the CVEI is that the subgroup structure of this index makes it amenable to use not only in comparing racial/ethnic groups but also evaluating disparities associated with other factors such as socioeconomic status. By focusing on equity, this flexible metric extends beyond what can be achieved with equality, and minimizes severe illness and suffering as we reach herd immunity.

Conclusion

The index is a novel innovative metric that provides information to identify and quantify disparities where they exist. Based upon concepts of equity previously deployed by the authors in the creation of the HEI,20 used to address disparities for ambulatory care sensitive conditions, this tool facilitates targeting of interventions to achieve high-quality equitable health care outcomes for COVID-19. It is the authors’ desire that the index be further developed, validated, and widely implemented. Our hope is to provide guidance and insight for equitably vaccinating populations, and in some measure, addressing the disparities that have so clearly been demonstrated with COVID-19. The CVEI suggests that this outcome can be achieved while simultaneously reaching herd immunity.

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Author Disclosure Statement

No competing financial interests exist.

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Abbreviations Used
ACIP — Advisory Committee on Immunization Practices
CDC — Centers for Disease Control and Prevention
CEVI — COVID-19 vaccine equity index
HEI — health equity index
HPI — Healthy Places Index
NAEBM — National Academies of Science, Engineering, and Medicine

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Amendment II
Accuracy of Data Entry of Patient Race/Ethnicity/Ancestry and Preferred Spoken Language in an Ambulatory Care Setting

Kristen M.J. Azar, Maria R. Moreno, Eric C. Wong, Jessica J. Shin, Christy Soto, and Latha P. Palaniappan

Objective. To describe data collection methods and to audit staff data entry of patient self-reported race/ethnicity/ancestry and preferred spoken language (R/E/A/L) information.

Data Source/Study Setting. Large mixed payer outpatient health care organization in Northern California, June 2009.

Study Design. Secondary analysis of an audit planned and executed by the Department of Clinical Services.

Data Collection/Extraction Methods. We analyzed concordance between patient written responses and staff data entry.

Principal Findings. The data entry accuracy rate across questions was high, ranging from 92 to 97 percent. Inaccuracies were due to human error (62 percent), flaws in system design (2 percent), or some combination of both (35 percent).

Conclusions. This study highlights the high accuracy of patient self-reported R/E/A/L data entry and identifies some areas for improvement in staff training and technical system design to facilitate further progress.

Key Words. Racial/ethnic differences in health and health care, health care organizations and systems, demography, survey research and questionnaire design, quality of care/patient safety (measurement)

BACKGROUND

Accurate collection of race/ethnicity/ancestry and preferred spoken language (R/E/A/L) patient information is a fundamental building block for disparities research and quality improvement efforts in a health care setting. Patient R/E/A/L data are increasingly being used to evaluate population
outcomes, measure health care disparities, and improve quality of care. Accurate R/E/A/L data collection allows health care organizations to better understand population health and outcomes. In addition, patient race/ethnicity and language reporting is mandatory to state agencies, such as the California Office of Statewide Health Planning and Development (OSHPD), and federal agencies, such as Medicare (Medicare Improvements for Patients and Providers Act of 2008). Most recently, the Patient Protection and Affordable Care Act (PPACA) (PPACA and Education Reconciliation Act 2010, March 23, 2010) calls for reliable and enhanced collection and reporting of patient race/ethnicity and language data to ensure accurate information on the health status and health care needs of all Americans.

Advances in health information technology such as the implementation of electronic health records (EHRs) provide a promising approach to collecting and utilizing patient R/E/A/L information. Even as health care organizations shift from paper to EHRs, demographic data are often collected using a paper format and then entered by staff into the EHR (or Practice Management System). The modern health care environment involves frequent interaction between human (people, tasks, and organization) and system (technologies, equipment, and physical settings of work) aspects that impact performance outcomes (Harrison, Henriksen, and Hughes 2007) such as data entry accuracy. Regular audits of new data entry processes may be helpful to assess and improve data collection efforts (Peabody et al. 2004), by identifying opportunities for improvement in both the human and system aspects of accurate data entry.

Although there is extensive literature on the accuracy of data from disease registries and clinical trial databases (McKee 1993; Wagner, and Hogan 1996; Hogan, and Wagner 1997; Brennan, and Stead 2000; Arts, De Keizer, and Scheffer 2002; Warsi, White, and McCulloch 2002; Peabody et al. 2004; Hobson, Khemani, and Singh 2005), there have been surprisingly few studies on measuring staff data entry accuracy of patient self-reported R/E/A/L in patient registration databases. This article seeks to describe an audit of staff data entry of patient R/E/A/L data in a large outpatient clinical setting, to

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understand the root causes of data entry errors, and to make recommendations for other organizations embarking on the process of patient demographic data collection.

CASE DESCRIPTION

The Palo Alto Medical Foundation (PAMF) has been using EHRs since 2000, and it began collecting patient self-reported R/E/A/L information in May 2008 using a paper questionnaire closely modeled after the relevant questions on the U.S. Census 2000 (and 2010). The questionnaire, described briefly here and in detail elsewhere (Palaniappan et al. 2009), consists of questions pertaining to race, Hispanic origin, ancestry, preferred spoken language, and need for interpreter services. The questionnaire is distributed and collected from all patients by the front desk staff at patient check-in (Palaniappan et al. 2009). For patients with limited English proficiency (LEP) (<7 percent of the clinic population), interpreter services are available to assist patients. Interpreter services are openly advertised (in print) at the registration desks in 20 major languages. Patients complete the R/E/A/L questionnaire (available at http://www.pamf.org/real/) privately in the waiting area and return it to the front desk staff for data entry. Most patients are willing to provide the requested information (>90 percent). A few patients choose to leave race information blank altogether (<7 percent) or choose the “I prefer not to answer” option (<3 percent).

All clinic administrative staff received training prior to the implementation of the new R/E/A/L data collection procedures via a “train the trainer” approach. Department managers participated in a mandatory, standardized, 4-hour seminar on the rationale and protocol for R/E/A/L data collection administered by trainers from the Sutter Health Institute for Research and Education (SHIRE). Clinic administrative staff were trained to enter patient R/E/A/L responses into the patient registration software exactly as the responses appear on the questionnaire. The questionnaire consisted of both checkbox and free response questions. The presentation on the user interface on computer registration screen was only slightly different than the paper questionnaire. All of the data fields were represented in the same order. Check boxes and lists (e.g. Race, Hispanic Origin, and Interpreter Services) were replicated on the computer screen. Free response questions on the questionnaire (e.g. Ancestry and Preferred Spoken Language) correspond to free text fields in the registration screen that are
linked to extensive drop-down menus with text auto-complete functionality to aid staff in entering the information quickly and efficiently. Slight variations between the paper questionnaire and the registration screen are described in detail in the sections to follow.

METHODS

Setting

Palo Alto Medical Foundation, a Sutter Health affiliate, is a large multispecialty ambulatory care organization with health care clinics throughout Northern California and the San Francisco bay area. PAMF delivers health care coverage to approximately 15 percent of the general population in four Northern California counties (Alameda, San Mateo, Santa Clara, Santa Cruz), with 35 medical clinics and over 830 clinic administrative staff. Across PAMF, there are over 650,000 active patients with approximately 2.3 million patient visits per year, characterized by wide racial/ethnic and linguistic diversity. To date, of the active PAMF patients who have self-reported their R/E/A/L (65 percent of all active patients), 54 percent self-identify as White/Caucasian, 30 percent self-identify as one of the six major Asian racial/ethnic groups (12 percent Asian Indian, 11 percent Chinese, 3 percent Filipino, 1 percent each of Japanese, Korean, and Vietnamese), 2 percent identify themselves as Black/African American, and approximately 10 percent self-identify as Hispanic/Latino.

Design

The PAMF clinical services team audited staff data entry of patient self-reported R/E/A/L data for 1 week: June 15–June 19, 2009. A complete week was selected to moderate potential bias resulting from the day of the week. The organization’s purpose for this audit was quality improvement, to assess the accuracy of data entry, and to inform interventions to improve data entry accuracy. The audit was designed for quality improvement (not research) by the Department of Clinical Services, and, therefore, conclusions about the results should be interpreted with caution. We have secondarily analyzed the results of this audit to provide generalizable lessons regarding errors resulting from human and system interactions in R/E/A/L data entry for other organizations attempting a similar approach. Two auditors (C.S. and J.S.) manually reviewed patient paper
questionnaire responses (completed in the waiting room prior to the physician visit) and compared them with the values entered by staff into the patient’s electronic registration record. The questionnaire was composed of five questions on race, Hispanic origin, ancestry, preferred spoken language, and interpreter services. Patients can respond with up to two races and two ancestries; yes or no Hispanic origin and interpreter services; and one preferred spoken language. Questions from the paper questionnaire are linked to seven audited database fields: Race1, Race2, Hispanic Origin, Ancestry1, Ancestry2, Preferred Spoken Language, and need for Interpreter Services (Palaniappan et al. 2009). If differences between questionnaire response and electronic entries were discovered, the auditors made appropriate corrections directly in the electronic patient registration system. These corrections were automatically monitored and classified (Figure 1). Accuracy rates were calculated for each

Figure 1: Distribution of Data Entry Errors by Contributing Factor across R/E/A/L Database Fields. HUMAN, error resulting from human behaviors; SYSTEM, error resulting from suboptimal system features; COMBO, error resulting from combined contribution
question. Errors were classified as human errors, system errors, or some combination of both (see Figure 2).

**FINDINGS**

**Overall Observations**

The total number of eligible questionnaires for analysis was 1,451, after 310 questionnaires were excluded as ineligible by the Department of Clinical Services, mostly due to multiple patient visits within the same week. These questionnaires were excluded due to anticipated systematic differences in these frequent use patients. The accuracy rate for questionnaires (i.e., all seven possible responses on the questionnaire were accurately entered into the electronic registration system) was 81 percent. Among the questionnaires containing any type of error (19 percent of all questionnaires), most had only one error (59 percent), 22 percent had two errors, and 19 percent had three or more errors. The accuracy rate across questions was uniformly high, ranging
from 92 percent (Ancestry 2) to 97 percent (Race1). The mean accuracy rate across all questions was 95 percent (see Figure 2). The types of errors varied across questions and were categorized as resulting from human-related error (62 percent), a flaw purely in system design (2 percent), or some combination of both (35 percent) (see Figure 2).

Observations of Human Contribution to Data Entry Errors

Human errors (62 percent) account for the majority of errors made in the Race 1, Hispanic Origin, and Ancestry fields (see Figure 1). Human errors in R/E/A/L data entry most often occurred when the clinic administrative staff (1) entered a completely different value in the patient’s electronic registration record than what the patient indicated on the questionnaire (38 percent) or (2) did not enter the patient’s response at all (62 percent). Differences between patient written responses and electronic entries were the most frequently occurring errors in the Race1 (54 percent), Ancestry 1 (66 percent), and Ancestry 2 (44 percent). Situations where the written patient response was not entered at all into the electronic registration record constitute a large portion of total errors in the Hispanic Origin (52 percent) and Interpreter Services (60 percent) fields.

Observations of System Contribution to Data Entry Errors

Other data entry errors (2 percent) stemmed from flaws in the electronic system set-up and structure of the paper questionnaire, which they were revealed in audit analysis. For example, administrative staff did not have editing privileges in the electronic system for these R/E/A/L values, and they were not able to update or correct database fields that had pre-existing data (with the exception of Preferred Spoken Language and Interpreter Services). Lack of editing privileges accounted for the majority of all system errors.

Observations of Combined Contribution to Errors

Combination (combo) errors accounted for 35 percent of all errors. Most often, small inconsistencies between the paper questionnaire and the electronic system led to confusion in data entry by the staff. For example, when a patient returns a blank paper questionnaire, the clinic administrative staff is instructed to enter the term “Left Blank” in the electronic system according to the protocol. Although the Race, Hispanic Origin, and Ancestry questions
had an option for “Left Blank” in the electronic system, the Preferred Language and Interpreter Services database fields did not have a “Left Blank” option in the drop-down menu of choices. These inconsistencies in the system account for the vast majority (90 percent) of all combo errors and led to human error. In some instances, administrative staff did not utilize the “Left Blank” option when it was available, resulting in 58 percent of all combo errors made. In the Interpreter Services database field, where “Left Blank” was not an option, errors in which the staff enters a response when none was indicated by the patient account for 15 percent of all combo errors and 33 percent of total errors in that particular field. In addition, the Preferred Language field is programmed as a mandatory field in the electronic system. Therefore, when a patient does not write a response for this question on the paper questionnaire, the administrative staff is more likely to enter a possible patient response based on assumption, consequently resulting in 42 percent of all of the errors for the Preferred Spoken Language field.

**DISCUSSION**

Data entry audits are important to ensure valid and reliable data, which enable continuous quality improvement efforts. This audit revealed that the overall accuracy rate of data entry for R/E/A/L is high, at 92–97 percent for each question. The mean accuracy rate across all questions was 95 percent. Existing literature on accuracy of race/ethnicity and language data mainly compares administrative data with self-report (Boehmer et al. 2002; Kressin et al. 2003) or externally completed survey data (Arday et al. 2000) and report much lower rates of accuracy. Our study has taken previous work in R/E/A/L data collection a step further by examining data entry accuracy within an ambulatory care system that already collects *self-reported* R/E/A/L information (Palaniappan et al. 2009). This article is the first to our knowledge that examines an audit process for the collection of self-reported R/E/A/L in an ambulatory care setting.

Accurate R/E/A/L data entry allows an organization to better understand its patients and provide targeted services and prevention efforts to more effectively address the needs of the community it serves. For example, Asian Indians make up a substantial portion (12 percent) of the PAMF patient population and are at increased risk for cardiovascular disease due to certain genetic, cultural, and environmental risk factors (Palaniappan, Wang, and Fortmann 2004). The collection of granular and accurate R/E/A/L has lead
to the creation of a culturally sensitive South Asian consult service that specifically provides preventive cardiology services to South Asian PAMF patients.

Although the data entry accuracy of Preferred Spoken Language and Interpreter Services in this instance was found to be high (94 and 95 percent, respectively), the consequences of inaccurate language and interpreter data entry are especially detrimental to the provision of high-quality patient care. Inability to capture accurate language data may mislead the clinic to assume that there are more English speakers than there really are, resulting in insufficient allocation of language or interpreter services. This is especially burdensome when the clinic needs to determine language needs for health care delivery, communications, and written informed consent. From the patient perspective, pervasive language barriers can easily discourage patients from seeking timely medical care. Not surprisingly, patients with LEP are reluctant to seek services from providers who are unable to communicate effectively with them (Mateo, Gallardo, and Huang 2009; Hunt, and de Voogd 2007). Currently, 10 percent, or approximately 66,000 of all PAMF patients who have completed the survey, report a language other than English as their preferred spoken language. The implications of inaccurate data entry in Interpreter Services in a largely diverse patient community could potentially impact the quality of care.

With health information technology infiltrating all aspects of the patient encounter, the technological interface between humans and systems, in this case regarding patient R/E/A/L data entry, has become paramount. Common errors in data entry in this study were associated with human behavior (62 percent), flaws in the system (2 percent), or a combination of the two (35 percent). Although the audit process uncovered that there was considerable human error, flaws in the technical system design also resulted in errors. By clearly identifying these sources of error, appropriate interventions can be implemented in the form of targeted training and system changes to increase data accuracy.

Proposed training enhancements and system changes are shown in Table 1. Retraining in the importance of accurate data entry, including the database field option for “Left Blank”, would improve overall data accuracy by more than 3 percent. As described above, clinic administrative staff were trained via a “train the trainer” model. The extent to which front line staff was subsequently trained by their department managers is unclear. A better model, which we are currently implementing, may be direct training of all staff via a mandatory online training module. The revised training will
<table>
<thead>
<tr>
<th>Contributing Factor</th>
<th>Intervention</th>
<th>Examples</th>
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<tbody>
<tr>
<td>HUMAN Targeted, staff training through a mandatory online training module</td>
<td>Directly train clinic administrative staff by requiring them to complete an online R/E/A/L data collection training module through the institution’s preexisting staff training infrastructure Educate staff on the importance of exact input of patient responses in the electronic system Educate staff that no database fields should be left empty in the electronic system Educate staff on the availability of “Left Blank” as a valid and necessary option in the electronic system</td>
<td></td>
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<tr>
<td>SYSTEM System modifications to registration software and paper questionnaire</td>
<td>Give clinic administrative staff system permissions to edit R/E/A/L database fields Ensure consistency of the electronic field options that includes the addition of the option for “Left Blank” in both the Preferred Language and Interpreter Services electronic fields Ensure consistency between paper questionnaire response options and electronic field response options Change the system to prevent entries in Race 2 or Ancestry 2 in electronic system unless Race 1 or Ancestry 1 are completed when more than one response is indicated on the paper questionnaire</td>
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HUMAN, error resulting from human behaviors; SYSTEM, error resulting from suboptimal system features.
highlight common data entry errors. System changes include greater consistency across questions, and the ability to edit data fields as appropriate.

Given the majority of data entry errors (62 percent) were due to human error, the ideal system might involve patients entering their R/E/A/L information directly. This can be done with a kiosk or online patient portal in which the patient can directly interface with the electronic system and enter their R/E/A/L information. This would eliminate the human-related error that exists when administrative staff serves as the intermediary. Although the majority of R/E/A/L data is still collected during a face-to-face patient encounter, health plans such as Aetna, HealthPartners, and UnitedHealth Group, as well as large institutional health care providers, are increasingly utilizing web-based patient portals to allow patients the opportunity to self-enter R/E/A/L information (National Health Plan 2008).

**CONCLUSION**

Overall, this study highlights the high data entry accuracy of patient self-reported R/E/A/L information from paper questionnaires and identifies some areas for improvement in staff training and technical systems. The overall goal for staff data entry accuracy at PMF is 99 percent for each question. We have identified several areas of social and technical improvement, which are currently being implemented. For more detailed information on training protocols and R/E/A/L data collection, please visit http://www.pamf.org/real/.

**ACKNOWLEDGMENTS**

*Joint Acknowledgment/Disclosure Statement:* All authors comply with the editorial policies and do not report any competing interests. This manuscript is an original work of authorship that is not under simultaneous consideration elsewhere, and the final version has been read and approved by all individuals named as authors. This work presents novel information that differs substantially from that presented in works published by the authors previously.

In addition, each author has (1) contributed significantly to the work’s conception, design, and analysis; (2) participated in the writing or critical revision of the article in a manner sufficient to establish ownership of the intellectual content; and (3) read and approved the version of the manuscript being submitted.
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Disclosures: None.

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REFERENCES


SUPPORTING INFORMATION

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Amendment III
Measuring Health Equity for Ambulatory Care Sensitive Conditions in a Large Integrated Health Care System: The Development of an Index

Alice Pressman,1,*Stephen Lockhart,2 John Petersen,1 Sarah Robinson,1 Maria Moreno,2 and Kristen M.J. Azar1

Abstract
Disparities in outcomes for preventive and primary health care services often result when vulnerable patients rely on episodic encounters for emergency services that do not meet their long-term health needs. Understanding health outcomes in socially or economically disadvantaged subgroups is crucial to improving community health, and it requires innovative analytics and dynamic application of clinical and population data. While it is common practice to use proxy indicators, such as quality of life and mortality, when discussing health equity, these have shown limited utility and are rarely applied at a population-level within a health system. Therefore, we designed and implemented an index, calculated as the ratio of observed-to-expected encounters, to identify and quantify health inequalities in health care systems. Providing equitable care, as measured by health outcomes, is analogous to precision medicine applied to social determinants. For health systems, the use of this index will facilitate the development of specially-tailored interventions to address inequity and provides a tool to measure the impact of such programs.

Keywords: ambulatory care sensitive conditions; health disparities; health equity; quality improvement

Introduction
Addressing health inequity, or differences in health outcomes between some population subgroups,1 requires innovative analytics and the dynamic application of health and population data to accurately identify inequity in real time. Recently, the National Institutes of Health called for an enhancement in their capacity to address health disparities in its 2009–2013 Strategic Plan2 and articulated a need for research aimed at furthering the evolution of health disparities research from its predominantly descriptive methods of identifying and addressing health care inequities, to analytic and actionable approaches through the increased application of advanced health information technology and tools. Despite this call to action, little progress has been made in part because of the difficulty in measuring and monitoring changes in inequities within health systems in real time.3–6 To date, proxy indicators to measure and inform health disparities, such as quality of life and mortality, have shown limited utility and have rarely been implemented at a population level within a health system dashboard.7 A commonly used indicator of disadvantage and inequity has been disproportionate absolute numbers of hospital admissions for ambulatory care sensitive conditions (ACSCs),8–10 and, as a result, health systems have begun to monitor and report this activity. It is recognized that, effectively managed, these conditions can be treated in an outpatient setting given the appropriate access to quality care, reducing the incidence of acute illness and hospitalization.11

Although previous studies have used electronic health

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record (EHR) data to measure equity through volume of ACSCs, there remains a large need to develop rigorous and widely applicable tools to quantify inequity in a health system, accounting for demographic variation existing in the area of service on a large system-wide scale. Given the wealth of health care data now available for large health care systems, there is tremendous potential to harness and synthesize a variety of data elements in addition to EHR information on clinical encounters. These include, but are not limited to, event and disease registries, health system utilization, cost information, disease status, and quality and safety data.

Applying analytics, which combine existing health system data with population data, offers a unique opportunity to identify and address disparities with greater precision because the data are available in real time, are objectively collected within the system, and are already being captured through systematic clinical and administrative protocols during the patient experience.

Large health systems provide a window into a representative segment of the population within regions of the country and, therefore, have the potential to enhance our understanding of disparities and to advance our efforts to achieve health equity in new and innovative ways. Sutter Health, a large integrated health system in Northern California, is one such example. Serving >3 million patients in the most diverse state in the nation in both urban and rural settings, Sutter provides a unique opportunity to investigate new and innovative solutions. To address the existing lack of real-time dynamic measurement solutions for health equity, we used a novel empirical approach to design and implement an index to identify and prioritize health inequities for ACSC management in health care systems. Our goal was to present an analytical method intended to enable large health care systems to identify and prioritize actions to reduce health disparities among patients. The index also works as a comparison tool to assess impact of these interventions on health equity.

The Health Equity Index
What is the index?
Our index is a flexible metric that utilizes multiple data sources to quantify any excess in actual hospital encounters compared with what would be expected if health equity was realized. At Sutter Health, the index is calculated monthly for each of the 22 hospitals and disseminated through a dashboard to provide administrators with an assessment tool and starting point for evaluating disparities. Focusing on a given disease and time period, patients are segmented by age (3 groups), race/ethnicity (4 categories), and gender, and a health equity score (HES) is derived for each of the 24 groups by calculating the observed-to-expected ratio of hospital encounters. Providing a summary of the magnitude of disparities among all 24 groups, the index is calculated by taking the average, weighted by encounter frequency, of the amount by which each HES exceeds one. The index provides a summary that can be benchmarked and used as a “stoplight tool” to identify the existence of inequity among subgroups. The HES, used in calculating the index, further identifies the specific groups whose outcomes are negatively affected. For both the index and the HES, values >1.0 indicate a potential opportunity to improve the health outcomes for specific segments of the patient population.

Utilizing multiple data sources (Fig. 1), the number of expected encounters for each age/gender/race stratum is derived from the underlying population distribution within the hospital catchment area, condition prevalence, the average propensity to utilize the given hospital, and frequency of that utilization. After identifying the hospital catchment area (defined as the collection of census tracts whose residents comprise at least 80% of the hospital's patient population), underlying United States Census tract population estimates are derived from the American Community Survey and combined with published prevalence estimates to approximate the number of individuals with the given condition within the catchment area. In our calculations, we used prevalence estimates from various sources, relying on the most granular and most accurate public data available. For asthma, prevalence estimates were provided by the California Behavioral Risk Factor Surveillance System and the California Health Interview Survey and compiled by the California Department of Public Health. For diabetes, these estimates were taken from the Centers for Disease Control and Prevention (CDC) published Morbidity and Mortality Weekly Report. Hospital utilization is calculated from Sutter Health’s EHR and used to estimate the average proportion of people with the particular condition who sought care from the catchment area and the average number of encounters made per person. The expected number of condition-specific encounters is then calculated by the product of these factors. For a more detailed explanation of the calculations, please see Supplementary Appendix 1.

The observed number of condition-specific encounters is derived directly from Sutter’s EHR database. The HES for each category is defined as the ratio of
observed-to-expected values, whereas the index value is calculated as a weighted average as described previously. Critical success factors for the calculation and use of the index include access to robust, self-identified race and ethnicity data, publicly available prevalence and demographic data, and the ability to extract real-time data from an EHR.

This project does not meet the definition of human subject research or clinical investigation at Sutter Health, as such Internal Review Board approval is not required.

**Why was it developed?**
We first developed an index for asthma and diabetes. As an example, we present the results for asthma from one Sutter Health hospital in Alameda County, California—Alta Bates Summit Medical Center (ABSMC). In 2016, at ABSMC there were 649 patients who utilized the emergency department (ED) 877 times for asthma. The index value for this facility was 1.5 indicating that among age–gender–race subgroups that experienced higher than expected numbers of encounters, there was a 50% weighted average excess. This was primarily driven by disproportionate utilization by African American (AA) patients, and in particular, AA women 60+ years of age (HES = 2.3) and AA men 45–64 years (HES = 2.2). At this facility, Hispanics and non-Hispanic whites utilized emergency services less than expected across all ages regardless of gender.

Based on this information, administrative and clinical leaders at ABSMC set out to design and implement a pilot program to address the disparate outcomes for AA patients with asthma in that facility. Partnership with a community-based federally qualified health center was essential to collaboratively design and implement a program intended to address the specific needs of AAs who utilize the ED for asthma. The goals of the program are to connect patients with culturally appropriate community-based primary care, to provide education about disease and medication self-management, and to use both high-touch and high-tech solutions to provide real-time counseling services. Although the pilot is ongoing, the approach has shown the potential to help patients better manage their asthma in the ambulatory setting and avoid reliance on the use of emergency services.

Sutter Health created a steering committee, led by the Chief Medical Officer, to evaluate health equity at Sutter Health, and to assess the role of the index in improving health equity within our health system. Leadership at Sutter Health, including executive leaders and the board of directors, are committed to identify, quantify, and address inequities in health outcomes wherever they might exist. This work is a component of our quality program and part of our continuous improvement journey. The hope is that we can demonstrate the ability of provider organizations to take actions that can make a national impact on health equity. The index is a first step
in helping to identify and quantify the collective impact that we, as providers, can have.

How can the index be used?
Sutter Health is a large health system in Northern California comprising 24 hospitals (22 with emergency departments) and 5 affiliated medical foundations. Sutter provides acute and ambulatory care to >3 million people per year from >100 communities across 22 counties in Northern California. Because geography and demographics vary for each hospital, we developed health equity statistics referable to each hospital, which can also be combined into a system-wide metric. The index values for each condition are published monthly on a leadership dashboard, and a team of analysts, with expertise in health equity, is available to operational leaders for consultation. Early in 2017, the index was added as a new regular entry in Sutter’s Acute Care Quality Dashboard. As part of a program to advance health equity at Sutter Health, a Health Equity Strategy Leadership Team was formed, and this team works with leadership at each hospital to help develop appropriate programs to bring equity to the patients they care for by identifying novel and unique opportunities to intervene.

Application in an integrated health system: an example
In March 2017, the system-level index value for diabetes was 2.2. Breaking it down by race, it is clear that the AA patients account for approximately a quarter of the encounters, and have the highest score (Fig. 2). To further understand where the excess in observed visits for diabetes originated, the leadership team considered the HES for each gender, age, and race/ethnicity category (Fig. 3, panel A). Across AA, Hispanic, and white patients between the age of 20 and 44 years, each HES exceeded 2.0 with the highest among AA men (HES=14.7) and AA women (HES=6.2). This means that there were nearly 15 times and 6 times more encounters than expected given the underlying prevalence for diabetes among the age, race, and gender subgroups, respectively. Upon further examination of the underlying patient distributions (Fig. 3, panel B, C) they found that 197 young AA men accounted for 319 encounters and 162 young AA women accounted for 299 encounters. In total, 359 patients were not receiving the care they needed to successfully control their diabetes. As next steps, the leadership team recommended monitoring changes in the index scores over time and focusing resources on addressing potential inequalities among AAs of young age.

How to obtain
For more information or to request an Excel version of the index code, please email Alice Pressman (pressmar@sutterhealth.org).

**FIG. 2.** Example of HESs by race. Pie slices are proportionate to the number of encounters for each group. The health equity index is a composite measure weighted by encounter frequency.
The index is a novel empirical approach to identify and quantify health inequalities in health care systems. We describe its development and provide two examples of its application at Sutter Health, a large integrated health care system. We believe this measurement system holds promise in helping to identify health inequalities among patient populations served by a hospital or health care system and enables provider organizations to assess the effectiveness of interventions.

Other attempts have been made to measure and monitor health equity. One effort, aimed at addressing disparities in primary care clinics in Baltimore (MD) used data from the Johns Hopkins Community Physician primary care EHR.12,13 Data elements, specifically related to patients with hypertension, were displayed

FIG. 3. Example of HESs and relationship to health equity index. This figure consists of three different panels labeled. **(A)** HES for diabetes, **(B)** observed diabetes encounters, and **(C)** observed diabetes patients. These three panels together make up Figure 3.
on a virtual dashboard for primary care providers to see. The primary goal was to increase awareness about existing disparities. The initiative was introduced as part of a three-part effort to improve health outcomes. However, the dashboard metrics were focused on individual providers’ outcomes as opposed to system-wide/hospital-wide outcomes. An approach focused on individual provider outcomes may face resistance or considerable challenges given the sensitive nature of these metrics and the implications the findings may have in terms of provider practices. Although individual providers can make constructive contributions to health equity within their practices, a system, through community-based partnerships and deployment of resources, can exert far greater leverage in changing disparate outcomes than an individual provider. Another method that has been explored by others is a health equity “audit” where data are used from EHRs within a practice setting to generate periodic health equity reports to be reviewed by the individual practice groups.16 The audits focus on three ACSCs; coronary heart disease, type 2 diabetes, and chronic obstructive pulmonary disease (COPD). Disparities of interest include race, age, and gender. However, there are differences compared with our proposed metric. The reports do not reflect real-time data and report the proportion of patients meeting a healthy guideline for various conditions as opposed to hospital encounters. Badrick et al.16 discussed the impact their reports had on the health system and report that disparities were identified, but even after surveillance and some evidence of improvement in chronic disease management, these discrepancies persist.

Recently, in England, the National Health Service (NHS) has attempted to quantify health equity by comparing preventable hospitalizations for ACSCs.15 Data are pulled from the NHS Hospital Episode Statistics and presented as standardized emergency admission rates versus a neighborhood deprivation rank. However, in contrast to our proposed metric, the data are presented as a one-time report to be delivered to management rather than a real-time, actively updated dashboard. Reports and analysis are focused on the national level in England as opposed to a system or site level. In addition, this initiative does not examine race/ethnicity, but instead focuses on differences between neighborhoods.

Another major difference between previously reported health equity measures and our index is that ours is designed to be portable to any health care system. The only requirements are access to health records, including encounter diagnoses, geographical data, age, gender, and race/ethnicity; access to local census tract data; and access to local-level prevalence data. The index is also designed to be adapted to any health condition as long as there are available prevalence data.

The index presented here is not intended to replace traditional methods of identification of disparities. Rather it should provide a different vantage point. In developing and vetting the index, we compared results with those obtained through our standard methods of identification of disparities; comparison of rates by racial/ethnic subgroup with white serving as the standard. We found that in general if the inequity was very large, the methods were similar; however, with the traditional methods that do not adjust for underlying population characteristics, where a subgroup is overrepresented in a geographical region, the inequity may be magnified. Conversely, where a subgroup is underrepresented, standard methods may mask smaller inequities. In addition, our index can be used to identify gender and age inequity, typically more difficult to discern because there is no obvious reference group.

There are several limitations to the use of this index. First, the calculation of “expected counts” is constrained by availability of prevalence data for the underlying condition. For asthma and diabetes, we have used publicly available state-wide data from the California Department of Public Health and the CDC, but we have not yet identified a source for COPD and heart failure, the next two high-priority ACSCs for our health system. For the prevalence estimates, the closer the denominator’s geographic unit is to the underlying catchment area, the more accurate the “expected” calculations will be. Second, users must have access to adequate sources of EHR data from which to derive “observed” counts. We are fortunate that the Sutter Health EHR is comprehensive and integrated across all hospitals in the system. Finally, in the process of calculating “expected counts,” we have made several assumptions: the prevalence of the condition in our system is similar to those values for the state of California; the demographics of the census tracts are similar to our patients from those tracts who utilize our EDs; the prevalence estimates for each subgroup can be applied uniformly across everyone in that subgroup.

It is the authors’ hope that the index will be widely implemented and tested by others and adapted for additional health conditions. It also has the potential to serve as a prototype for the development of future metrics that combine an even greater degree of patient (consumer) data that can yield greater precision in identifying inequities. As providers, the extent to which we can understand inequities with greater
precision allows us to craft more targeted and hence more effective solutions.

Conclusion

The index is a novel, innovative metric that provides the information to allow a health system to identify population subgroups that suffer the most from outcome disparities, and to develop interventions to address these inequities. This tool facilitates the targeting of interventions to particular care facilities where minority patients are likely to receive most of their care. Identifying and measuring health outcome disparity is the first step toward achieving health equity, and it will allow us to turn our efforts toward understanding and correcting the underlying causes.

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Author Disclosure Statement

No competing financial interests exist.

Supplementary Material

Supplementary Appendix

References


Abbreviations Used

AA = African American
ABSMC = Alta Bates Summit Medical Center
ACSC = ambulatory care sensitive condition
CDC = Centers for Disease Control and Prevention
COPD = chronic obstructive pulmonary disease
EHR = electronic health record
HES = health equity score
NHS = National Health Service

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