Considerations When Aggregating Data to Measure Performance Across Levels of the Health Care System

Sarah L. Reeves, PhD, MPH; Kevin J. Dombkowski, DrPH, MS; Brian Madden, MS; Lindsay Cogan, PhD, MS; Shanshan Liu, MS, MPH; Paul B. Kirby, MA; Sara L. Toomey, MD, MPhil, MPH, MSc

From the Department of Pediatrics, Susan B Meister Child Health Evaluation and Research (CHEAR) Center, University of Michigan (SL Reeves, KJ Dombkowski, and B Madden), Ann Arbor, Mich; Department of Epidemiology, University of Michigan (SL Reeves), Ann Arbor, Mich; New York State Department of Health, Office of Quality and Patient Safety (L Cogan), Albany, NY; Department of Health Policy Management & Behavior, School of Public Health, University at Albany (L Cogan), Albany, NY; Boston Children's Hospital (S Liu and SL Toomey), Boston, Mass; Commonwealth Medicine Center for Health Policy and Research, University of Massachusetts Medical School (PB Kirby), Quincy, Mass; and Harvard Medical School (SL Toomey), Boston, Mass
The authors have no conflicts of interest to disclose.
Address correspondence to Sarah L. Reeves, PhD, MPH, 300 N Ingalls, Room 6D19, Ann Arbor, MI 48109 (e-mail: sleasure@umich.edu).
Received for publication April 20, 2021; accepted November 21, 2021.

Abstract

Background: Measuring quality at varying levels of the health care system requires attribution, a process of determining the patients and services for which each level is responsible. However, it is important to ensure that attribution approaches are equitable; otherwise, individuals may be assigned differentially based upon social determinants of health.

Methods: First, we used Medicaid claims (2010−2018) from Michigan to assess the proportion of children with sickle cell anemia who had less than 12 months enrollment within a single Medicaid health plan and could therefore not be attributed to a specific health plan. Second, we used the Medicaid Analytic eXtract data (2008−2009) from 26 states to simulate adapting the 30-Day Pediatric All-Condition Readmission measure to the Accountable Care Organization (ACO) level and examined the proportion of readmissions that could not be attributed.

Results: For the sickle cell measure, an average of 300 children with sickle cell anemia were enrolled in Michigan Medicaid each year. The proportion of children that could not be attributed to a Medicaid health plan ranged from 12.2% to 89.0% across years. For the readmissions measure, of the 1,051,365 index admissions, 22% were excluded in the ACO-level analysis because of being unable to attribute the patient to a health plan for the 30 days post discharge.

Conclusions: When applying attribution models, it is essential to consider the potential to induce health disparities. Differential attribution may have unintentional consequences that deepen health disparities, particularly when considering incentive programs for health plans to improve the quality of care.

Keywords: Attribution; health plans; Medicaid; readmission; sickle cell disease

Academic Pediatrics 2022;22:S119−S124

What's New

When applying attribution models, it is essential to consider the potential to induce health disparities. Differential attribution may have unintentional consequences that deepen health disparities, particularly when considering incentive programs for health plans to improve the quality of care.

Quality measurement is integral to the ongoing and systematic improvement of the US health care system; quality metrics are used to evaluate health services and identify opportunities for improvement.[1] Quality measures can be applied at many levels of the health care system, reflecting the perspectives of purchasers, health services providers, and patients. Incentive programs have been developed and applied using health care performance metrics to foster improvements in the quality of care provided at varying levels within the health care system.[2] The data necessary to assess these performance metrics at various levels of the health care system are increasingly being derived from clinical and administrative data.[2] Consequently, methods to accurately assess the quality of care across a wide range of levels of the health care system are of increasing importance.

A fundamental requirement to appropriately aggregate administrative, clinical, or patient data is the accurate attribution of health care services to patients, providers, health systems and health plans.[3] Attribution methods reflect a set of rules developed to reflect the individual patients, their health care services, and the duration of care for which providers and organizations are held accountable and incentivized. Importantly, the level of attribution aggregation may affect the accuracy of

performance measurement.[4] There are numerous attribution models that have been implemented or are under consideration; these methods can be applied retrospectively or prospectively and address a diverse set of health conditions and settings, including acute and chronic episodes as well as primary versus specialty care.[4–9] Attribution models may be applied at the population level to determine who is assigned for the program (eg, Accountable Care Organization [ACO]) or applied at the performance measure level to determine who is assigned, and in some cases may be a combination of both. For example, families of pediatric patients can prospectively designate a primary care provider responsible for the care of their child to their health plan; the designated provider would then be accountable for all quality metrics regarding the child. Another attribution approach would be to attribute accountability to the provider with the greatest number of evaluation and management visits within a specified time frame.[10]

While each of these methods has its respective strengths, limitations may exist that must be carefully considered to ensure that the measures of quality of care at the specified level are valid.[4] For example, one particularly concerning limitation of attribution models is the possibility that persons could be attributed differentially based upon social determinants of health.[11–14] Therefore, in this study, we consider two different attribution models and the impact of the attribution models across population characteristics such as managed care enrollment, continuous enrollment criteria, or enrollment in a program. Our first case study evaluates a model to attribute children with sickle cell anemia to Michigan Medicaid health plans at the performance measure level. In our second case study, we consider the characteristics of attribution for use in ACOs.

METHODS

SICKLE CELL ANEMIA MEASURES

Children with sickle cell anemia, the most common subtype of sickle cell disease, are at an increased risk of serious complications, including infections and stroke.[15] Importantly, much of this morbidity can be prevented through receipt of preventive services, specifically, daily antibiotic prophylaxis to prevent infection and annual transcranial Doppler screening to identify children at highest risk of stroke.[16] The Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium at the University of Michigan developed two quality measures, both of which are endorsed by the National Quality Forum, to assess the proportion of children with sickle cell anemia that 1) received at least 300 days of antibiotics within a year; and 2) received an annual transcranial Doppler screen.[17–19] Incentives provided directly to the Medicaid health plans for improving the quality of care among children with sickle cell anemia have promise; such programs have been implemented for other preventive services.[20–23] Therefore, we applied attribution models to the state Medicaid data to assign children with sickle cell anemia to their respective Medicaid health plans. Here we provide the example of applying an attribution model to the transcranial Doppler screening measure. First, we identified all children with sickle cell anemia ages 2 through 16 who were enrolled in Michigan Medicaid for at least one calendar year from 2010 to 2018. Then, using the enrollment files for the state Medicaid program, each person-month of enrollment was attributed to a Medicaid health plan; months were then summed across the measurement year. The number of children with sickle cell anemia who were continuously enrolled within the same Medicaid health plan throughout the calendar year (January−December) was calculated. The proportion of children with sickle cell anemia who could not be attributed to a Medicaid health plan for the entire 12 months (eg, switched health plans at some point during measurement period), as well as the proportion enrolled for 12 months in fee-for-service, was also calculated.

30-DAY PEDIATRIC ALL-CONDITION READMISSION MEASURE

As part of the Pediatric Quality Measures Program, the Center of Excellence in Pediatric Quality Measurement (CEPQM) developed a 30-Day Pediatric All-Condition Readmission measure.[24,25] The measure calculates case-mix adjusted, 30-day all-condition readmission rates for the pediatric population <18 years old using inpatient claims data. The measure focuses on patients discharged from general acute care hospitals, including children's hospitals and excludes the following: 1) specialty hospitals; 2) nonacute care institutions; 3) admissions for obstetric conditions, mental health conditions, and birth of healthy newborns; and 4) readmissions for planned procedures and chemotherapy. Hospital-level readmission rates were calculated using a 2-level hierarchical logistic regression with fixed effects for patient-level characteristics and a random intercept for hospital. The hierarchical modeling adjusts for differences in case-mix and sample size across hospitals.

A consistent concern raised by hospitals regarding readmissions is that the health care provider most closely responsible for a preventable readmission often extends beyond the hospital to include other groups such as primary care providers or outpatient specialists. One of the potential benefits of developing alternative health care delivery structures such as the ACO is that ACOs usually include not only hospitals, but also primary and specialty outpatient services. Given the growth of ACOs, we adapted measure specifications for the use of our readmission measures at the ACO level and tested their use. This analysis examines the impact on how readmissions are attributed when shifted from being a hospital measure to being applied at the ACO level of aggregation.

We tested our adapted ACO readmissions measure by simulating ACOs using our 2008-2009 Medicaid Analytic eXtract dataset from 26 states. We attributed patients to

health plans and applied the measure specifications at the level of health plans, that is, simulated "ACOs." A patient was attributed to a health plan if the patient was enrolled in that plan at the time of the index admission and could be included in the analysis if the patient remained enrolled in that plan for at least the 30 days following the index admission. We fitted mixed effects models that included case-mix adjusters (patient age group, patient gender, presence of chronic conditions in 17 chronic condition indicator body systems, and number of body systems affected by chronic conditions) as fixed-effects and health plan as random-effects. The dependent variable was 30-day readmission, modeled as a binomial variable with a logit link. Using the parameter estimates from these models, we estimated plan-level case-mix-adjusted readmission rate through direct standardization using a case-mix representative of all plans in the entire dataset.

RESULTS

SICKLE CELL ANEMIA MEASURES

From 2010 to 2018, the number of children with sickle cell anemia enrolled in Michigan Medicaid in a calendar year ranged from 227 to 340. Across the years, the proportion of children that could not be attributed to a specific Medicaid health plan due to less than 12-month enrollment in any plan, or entirely fee-for-service, ranged from 12.2% (2014) to 89.0% (2011). We found a sharp decline in the proportion of children with sickle cell anemia who were enrolled in fee-for-service Medicaid for the entire year during the period 2010 through 2013; this is consistent with the Michigan Medicaid policy in which enrollees of Children's Special Healthcare Services were carved out of Medicaid managed care through 2012. The proportion of children who were not enrolled in any Medicaid health plan or fee-for-service for at least 12 months ranged from 9.3% (2011) to 53.7% (2013). From 2010 to 2013, the proportion of children enrolled for 12 months in fee-for-service was substantially higher (approximately 85%) than in subsequent years (Figure). The proportion of children who were not continuously enrolled in a health plan drastically decreased substantially over the study period but there still remains almost 13% of total children who were not unattributed.

30-DAY PEDIATRIC ALL-CONDITION READMISSION MEASURE

There were 158,003 index admissions attributed to 2863 hospitals in the Medicaid Analytic eXtract 2008 to 2009 data from 26 states that we could attribute to 235 simulated ACOs. Twenty-two percent of index admissions were excluded in the ACO-level analysis because we were unable to attribute the patient to a health plan for the 30 days after the index admission, which is similar to the proportion of index admissions being excluded when attributing patients for the hospital-level readmission measure. The state-level exclusion rates ranged from 11% to 35%. Among all index admissions, the overall adjusted hospital-level readmission rate was 5.9% (hospital-level variance 0.06, standard error 0.005). Among the 158,003 index admissions, the overall adjusted ACO-level readmission rate was 4.9% (ACO-level variance 0.08, standard error 0.02).

DISCUSSION

In our review of two methods of attribution among children enrolled in Medicaid, we found that there was a substantial proportion of children that could not be attributed to Medicaid health plans to assess quality of care; these findings likely further extend to ACOs. It is essential to consider the implications of applying attribution models to establish responsibility for patients or services.

Children with sickle cell anemia often experience fragmented care and have high acute care utilization.[26,27] Therefore, health plans are uniquely positioned to implement quality improvement initiatives, as they can track enrollees' health services across time and hospital systems.[28] Health plans also have extensive experience with quality improvement, as improvement in performance is often incentivized through programs at the state Medicaid level.[29,30] These incentive plans have the potential to improve the quality of care for children with sickle cell anemia. One promising approach to improve quality of care for rare diseases or outcomes is to encourage health plans to work together collaboratively to improve measures. This could be accomplished through specific state-level incentives which reward for regional improvement in measures across all health plans as opposed to plan-specific payments for improvement within the health plans.

Unfortunately, these quality improvement initiatives will only target children for which a health plan is deemed responsible.[4] Weighting measures proportional to the amount of time an enrollee contributes to a plan is a common approach to attribution. However, this approach has shortcomings when considering rare diseases or outcomes, particularly as related to pediatrics, as it will be challenging to implement quality improvement initiatives in partial attribution circumstances. For example, children eligible for the measure denominator may be retrospectively identified to receive enhanced quality improvement efforts such as case managers or specialized pharmacy benefits. Children who are not attributed to a plan within a 12-month window will not be identified as a potential beneficiary for these initiatives and will therefore, not benefit from their implementation.

We found that over the last 5 years of our study period, more than one in 8 children with sickle cell anemia was unable to be attributed to a health plan. Study inclusion criteria required that eligible children be enrolled in Medicaid for the entire study period. Therefore, children who were unable to be attributed are those who switched between Medicaid health plans, or fee-for-service, during a calendar year. More work should be done to better understand those children who remain unattributed due to moving between health plans. These children will not benefit from quality improvement initiatives implemented by

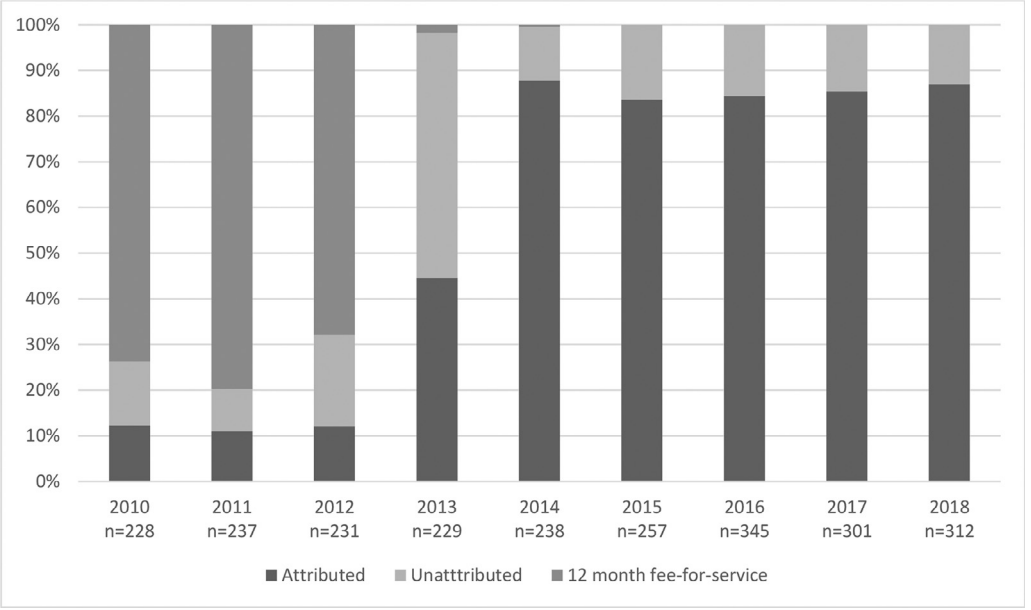

Figure. *Single health plan enrollment patterns among children with sickle cell anemia in Michigan Medicaid, 2010 to 2018*. *Attributed: Enrolled in single Medicaid health plan for 12-month calendar year (January–December); Unattributed: Enrolled in two or more Medicaid health plans for 12-month calendar year (January–December); 12-month fee-for-service: Enrolled in fee-for-service for 12-month calendar year (January–December). **Children enrolled in Children's Special Healthcare Services were carved out of Medicaid Managed Care through 2012.*

Medicaid health plans. Unlike the sickle cell anemia measure, the CEPQM readmission measure only requires a 30-day window of continuous enrollment post index admission. However, our results suggest that even narrowing the window to a 30-day enrollment period remains challenging and each attribution model involved loss when rolling up to accountable units even at the program level.

Further research is necessary to understand the predictors of this lack of continuous enrollment within a single Medicaid health plan. It is possible that a lack of continuous enrollment in a single Medicaid health plan may be associated with adverse social determinants of health. For example, although Medicaid policies are state-specific, individuals often may switch Medicaid health plans at any time during the year if special circumstances are met. These circumstances vary across states, but may include having children in the foster care system, moving to an area where services are not offered, and being unable to find the necessary care for your condition in the enrolled plan.[31] Each of these special circumstances may be more likely to occur among individuals experiencing adverse social determinants of health, such as living in rural areas or lacking access to stable housing. This is further supported by evidence from previous studies examining enrollment gaps in Medicaid overall, which indicated that children living in poverty or rural areas, and those with more acute care utilization, were more likely to experience issues with continuous enrollment than their counterparts.[12–14]

This is particularly true among those living with sickle cell anemia, as the significant health burden for these children is often exacerbated by the burden of racial inequity, resulting in excess vulnerability to adverse social determinants of health, such as housing, insurance, discrimination, socioeconomic status, and transportation.[32–34] Future research should expand upon our findings to consider the impact of attribution methods on health disparities, particularly among marginalized populations. In addition, an understanding of how specific child characteristics, such as demographics, social determinants of health, and patterns of health care utilization, vary by attribution status would underscore the contributions to variation in quality of care.

The simulation of adapting the readmission measure for ACOs has additional value. A common concern in using readmission measures has been that hospitals are not always in control of the factors that contribute to the readmission. However, ACOs by definition have accountability for the health care of their population across the continuum of care and, as such, are perhaps a better level for applying the readmission measure. Since ACOs can map on to multiple possibly overlapping hospitals and will be fewer in number than hospitals, testing the CEPQM adapted ACO readmission measure was necessary and the CEPQM simulation was the best approximation available. This analysis suggests that as great patient populations receive their care in ACOs, the CEPQM readmission measure has the potential to be a useful measure. Further, our results indicated that the hospital readmission rate was 1% lower when considering attribution at the ACO level as compared to the hospital level. Additional research is necessary to understand the drivers in measure variation at the ACO level as compared to the hospital level. However, we acknowledge the limitations of our approach, which leveraged health plans to simulate

ACOs. Further research should examine the specific implications of attribution to ACOs, particularly as related to rare pediatric events such as hospital readmissions.

In conclusion, although policies that encourage continuous enrollment within a state Medicaid program are essential, particular attention should be paid to the way in which this is implemented within individual Medicaid health plans. Development of sustainable strategies at the state Medicaid level that incentivize Medicaid health plans to retain pediatric members may be one such opportunity. This would allow Medicaid health plans to identify members to target for improvement in performance scores. Otherwise, mechanisms to assign responsibility for the quality of care of these children should be in place. Care should be taken to ensure that children who enroll in different health plans across one year do not fall through the cracks, thereby further inducing health disparities often already experienced among children enrolled in Medicaid.

ACKNOWLEDGMENTS

Financial statement: This project was supported by grant numbers U18HS025292 and U18 HS025299 from the Agency for Healthcare Research and Quality. The sponsor had no involvement in the design, collection, analysis or interpretation of data, nor the writing of the report.

The views expressed in this article are those of the authors, and no official endorsement by the Agency for Healthcare Research and Quality (AHRQ), the Centers for Medicare and Medicaid Services (CMS), or the Department of Health and Human Services (DHHS) is intended or should be inferred.

This article is published as part of a supplement sponsored by the US Department of Health and Human Services, the Centers for Medicare and Medicaid Services, and the Agency for Healthcare Research and Quality.

REFERENCES

1. Burstin H, Leatherman S, Goldmann D. The evolution of healthcare quality measurement in the United States. *J Intern Med*. 2016;279:154–159.
2. Adirim T, Meade K, Mistry K, et al. A new era in quality measurement: the development and application of quality measures. *Pediatrics*. 2017;139: e20163442. https://doi.org/10.1542/peds.2016-3442.
3. McCoy RG, Bunkers KS, Ramar P, et al. Patient attribution: why the method matters. *Am J Manage Care*. 2018;24:596.
4. Ryan A, Linden A, Maurer K, et al. Attribution methods and implications for measuring performance in health care. 2016. Available at: http://www.qualityforum.org/Projects/a-b/Attribution_2015-2016/Commissioned_Paper.aspx. Accessed December 20, 2021.
5. Huckfeldt P, Chan C, Hirshman S, et al. Specialty payment model opportunities and assessment. *Rand Health Q*. 2015;5:12.
6. Halpern R, Kothari S, Fuldeore M, et al. GERD-related health care utilization, therapy, and reasons for transfer of GERD patients between primary care providers and gastroenterologists in a US managed care setting. *Dig Dis Sci*. 2010;55:328–337.
7. Adams JL, McGlynn EA, Thomas JW, et al. Incorporating statistical uncertainty in the use of physician cost profiles. *BMC Health Serv Res*. 2010;10:57.
8. Metfessel BA, Greene RA. A nonparametric statistical method that improves physician cost of care analysis. *Health Serv Res*. 2012;47:2398–2417.
9. Thomas JW, Ward K. Economic profiling of physician specialists: use of outlier treatment and episode attribution rules. *INQUIRY: J Health Care Org Provis Financ*. 2006;43:271–282.
10. Centers for Medicare & Medicaid Services. Two-step attribution for measures included in the value modifier. Available at: https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/PhysicianFeedbackProgram/Downloads/Attribution-Fact-Sheet.pdf. Accessed November 8, 2021.
11. National Quality Forum (NQF). Attribution: principles and approaches. Final report.2016. Available at: https://www.qualityforum.org/Publications/2016/12/Attribution_-_Principles_and_Approaches.aspx. Accessed December 20, 2021.
12. Guevara JP, Moon J, Hines EM, et al. Continuity of public insurance coverage: a systematic review of the literature. *Med Care Res Rev*. 2014;71:115–137.
13. Satchell M, Pati S. Insurance gaps among vulnerable children in the United States, 1999−2001. *Pediatrics*. 2005;116:1155–1161.
14. Coburn AF, McBride TD, Ziller EC. Patterns of health insurance coverage among rural and urban children. *Med Care Res Rev*. 2002;59:272–292.
15. Payne AB, Link-Gelles R, Azonobi I, et al. Invasive pneumococcal disease among children with and without sickle cell disease in the United States, 1998 to 2009. *Pediatr Infect Dis J*. 2013;32:1308–1312. https://doi.org/10.1097/INF.0b013e3182a11808.
16. Thornburg CD, Files BA, Luo Z, et al. Impact of hydroxyurea on clinical events in the BABY HUG trial. *Blood*. 2012;120:4304–4310. https://doi.org/10.1182/blood-2012-03-419879.
17. Reeves S, Madden B, Shevrin C, et al. Antibiotic prophylaxis among children with sickle cell anemia. National Quality Forum (NQF). Available at: http://chear.org/sites/default/files/SCA_Antibiotic%20Measure%20Testing.pdf. Accessed October 22, 2019.
18. Reeves S, Madden B, Shevrin C, et al. Transcranial Doppler screening among children with sickle cell anemia. National Quality Forum (NQF). Available at: https://chear.org/sites/default/files/TranscranialDopplerScreeningMeasureSpecification.pdf. Accessed October 22, 2019.
19. National Quality Forum (NQF). Improving healthcare quality. Available at: https://www.qualityforum.org/setting_priorities/improving_healthcare_quality.aspx. Accessed April 14, 2021.
20. LLanos K, Rothstein J. Physician Pay-for-Performance in Medicaid: A Guide for States. Center for Health Care Strategies, Incorporated; 2007. Available at: https://www.chcs.org/media/Physician_P4P_Guide.pdf. Accessed December 24, 2021.
21. Center for Health Care Strategies. Medicaid oral health performance improvement project resources. Available at: https://www.chcs.org/resource/medicaid-oral-health-performance-improvement-projects/. Accessed December 20, 2021.
22. Centers for Medicare & Medicaid Services. Medicaid incentives for the prevention of chronic diseases model. 2020. Available at: https://innovation.cms.gov/innovation-models/mipcd. Accessed December 20, 2021.
23. Kane R, Johnson P, Town R, et al. Economic incentives for preventive care: summary. *AHRQ Evidence Report Summaries*. Agency for Healthcare Research and Quality (US); 2004. Available at: https://www.ncbi.nlm.nih.gov/books/NBK11845/. Accessed December 20, 2021.
24. National Quality Forum (NQF). Quality Positioning System (QPS) measure description display information: pediatric all-condition readmission measure. Available at: http://www.qualityforum.org/QPS/MeasureDetails.aspx?standardID=2393&print=0&entityTypeID=1. Accessed April 14, 2021.
25. Agency for Healthcare Research and Quality (AHRQ). Types of health care quality measures. Available at: https://www.ahrq.gov/talkingquality/measures/types.html. Accessed April 14, 2021.
26. Panepinto J, Owens P, Mosso A, et al. Concentration of hospital care for acute sickle cell disease-related visits. *Pediatr Blood Cancer*. 2012;59:685–689.
27. Raphael JL, Dietrich CL, Whitmire D, et al. Healthcare utilization and expenditures for low income children with sickle cell disease.

Pediatr Blood Cancer. 2009;52:263–267. https://doi.org/10.1002/pbc.21781.

28. Warren LR, Clarke JM, Arora S, et al. Transitions of care across hospital settings in patients with inflammatory bowel disease. *World J Gastroenterol*. 2019;25:2122.
29. Kuhmerker K, Hartman T. Pay-for-performance in state Medicaid programs. 2007. Available at: https://www.commonwealthfund.org/publications/fund-reports/2007/apr/pay-performance-state-medicaid-programs-survey-state-medicaid. Accessed December 20, 2021.
30. Garfield R, Hinton E, Cornachione E, et al. Medicaid Managed Care Plans and Access to Care. Washington: Kaiser Family Foundation; 2018. Available at: https://www.kff.org/report-section/medicaid-managed-careplans-and-access-to-care-introduction/. Accessed December 24, 2021.
31. Ohio Department of Medicaid. Change plans. Available at: https://www.ohiomh.com/home/changeplans. Accessed November 8, 2021.
32. Farber MD, Koshy M, Kinney TR. Cooperative Study of Sickle Cell Disease: demographic and socioeconomic characteristics of patients and families with sickle cell disease. *J Chronic Dis*. 1985;38:495–505.
33. Power-Hays A, Li S, Mensah A, et al. Universal screening for social determinants of health in pediatric sickle cell disease: a quality-improvement initiative. *Pediatr Blood Cancer*. 2020;67:e28006. https://doi.org/10.1002/pbc.28006.
34. Artiga S, Hinton E. Beyond health care: the role of social determinants in promoting health and health equity. *Health (N Y)*. 2019;20:1–13.