WHITEPAPER

Social Determinants of Health, Chronic Conditions, and Provider Specialties: A Retrospective Electronic Health Record-Derived Analysis

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ABBREVIATIONS

AAFP	American Academy of Family Physicians
ACP	American College of Physicians
AHC	Accountable Health Communities
AMA	American Medical Association
CDC	Centers for Disease Control
CMS	Centers for Medicare and Medicaid Services
COPD	Chronic Obstructive Pulmonary Disease
CVD	Cardiovascular Disease
EHR	Electronic Health Record
HCP	Healthcare Provider
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
ICD-10-CM	International Classification of Disease-Tenth Revision-Clinical Modification
IHMI	Integrated Health Model Initiative
IOM	Institute of Medicine
NAM	National Academy of Medicine
NCDHHS	North Carolina Department of Health and Human Services
NLP	Natural Language Processing
RCT	Randomized Clinical Trial
RWD	Real-World Data
RWE	Real-World Evidence
SDoH	Social Determinants of Health
SNOMED CT	Systematized Nomenclature of Medicine Clinical Terms
WHO	World Health Organization

EXECUTIVE SUMMARY

Social determinants of health (SDoH)—the socioeconomic and place-based factors that influence an individual's well-being—are a concern for many Americans. These complex and interconnected variables are widely acknowledged as main drivers of health disparities and inequities. An approach by healthcare providers, hospitals, and communities that takes into account social determinant risk has the potential to improve health outcomes, reduce medical costs, and facilitate the transition to value-based care.

Social determinant data captured in electronic health records may help to identify individuals at risk, enable social services referrals and outreach efforts, inform clinical decision-making and population health management, and support research. In this retrospective cohort analysis, de-identified patient data sourced from the electronic health record Practice Fusion, a Veradigm™ offering, were used to generate real-world evidence that is actionable and meaningful to a discussion of social determinants in chronic disease. In ambulatory patients who were newly assigned social determinant codes, Adjustment Disorder was the top-ranking code for each of the chronic condition cohorts. More than two-thirds of patients with chronic conditions were assigned codes related to Social and Community Context. Most patients in all but one of the chronic condition cohorts were assigned codes by primary care practitioners. In two of the cohorts, approximately one-quarter of patients received codes from pediatricians. For patients with chronic medical conditions and social risk, electronic health records may afford deeper understanding of the barriers that hinder treatment or contribute to care plan non-adherence. Studies using real-world data may offer insight into the challenges of and opportunities for caring for individuals with complex health and social needs.

WHAT ARE SOCIAL DETERMINANTS OF HEALTH?

The overall health and well-being of individuals and their communities depends on more than just good medical care. In fact, the relative contribution of medical care to health status and outcomes is small (10%) compared with the impact of behavioral patterns (40%), genetic predisposition (30%), social circumstances (15%), and environmental exposures (5%) (McGinnis et al. 2002; Schroeder 2007).

Social determinants of health (SDoH) encompass the socioeconomic and place-based factors that exist outside of clinical settings. Social determinants include the influences and systems that affect daily life; they are the prevailing conditions in which people are born and live; where they grow, play, learn, work, worship, and age (World Health Organization [WHO] 2019; healthypeople.gov). Social determinants are widely acknowledged as main drivers of health inequities and disparities (WHO, 2019). The United States contends with significant disparities in health among its citizens despite being among the world's wealthiest nations (Daniel et al. 2018).

Findings from a recent national survey demonstrate social determinants are a concern for many Americans (Kaiser Permanente 2019a).

- One-third (32%-39%) of Americans have struggled with social needs related to their neighborhood or housing, transportation, food, and other non-medical factors.
- More than one-quarter (28%) of respondents reported social needs have been barriers to obtaining necessary health care in the past year.
- Unmet social needs correlated with impaired mental and physical health status, as respondents with unmet needs were more likely (16%) to rate their health as fair or poor compared with those (6%) without any need.
- More than one-third (35%) of respondents were not sure they could identify a resource to help with housing, transportation, food, or social isolation.

The survey also showed that most respondents (97%) wanted their healthcare providers (HCPs) to inquire about social needs.

Increased social risk correlates with worsening health outcomes and greater healthcare expenditures.

- Disparities arising from socioeconomic, behavioral, and geographic factors were reported for multiple health indicators, including disease prevalence and life expectancy, in a study that examined long-term trend data (1935-2016) (Singh et al. 2017).
- Population-level health disparities relating to social risk result in an estimated $135 billion economic loss ($93 billion due to excess medical costs and $42 billion to lost productivity) each year (Orgera and Artiga 2018).

An approach by HCPs, hospitals, and communities that considers social determinant risk has the potential to improve individual and population health outcomes, reduce downstream medical costs, and facilitate the transition to value-based care (Caplea G 2019a, Caplea G 2019b). In a study that evaluated spending rates on social services and health care, states with higher social-to-health spending ratios had better health outcomes one year and two years later than states with lower spending ratios. Significant effects were demonstrated for seven health measures (i.e., obesity, asthma, mentally unhealthy days, days with activity limitations, and mortality rates for lung cancer, acute myocardial infarction, and diabetes) (Bradley et al. 2016). Effects were considerable—for example, the effect size for obesity alone corresponded to 85,000 fewer adults with obesity across the United States population. Medical costs would be expected to be reduced, as annual healthcare costs are higher—on average, $2,700 higher (Cawley and Meyerhoefer 2012)—for adults with obesity than for adults without obesity (Bradley et al. 2016).

CHRONIC CONDITIONS AND SOCIAL DETERMINANTS

Data collected from national surveys on prevalence and healthcare expenditures indicate nearly 150 million Americans have a diagnosis of one or more chronic conditions. Patients with five or more chronic conditions (~30,000,000) account for greater than 40% of healthcare spending (RAND 2019). Although healthcare spending continues to increase, population health appears to be worsening, with lower average life expectancy and greater burden of chronic disease (Hayes

and Delk 2018). In 2017, total healthcare spending in the United States reached $3.5 trillion, a nearly 4% increase over the previous year (CMS.gov 2019a).

Socioeconomic and geographic disparities are increasingly recognized as contributing factors to chronic disease (Cockerham et al. 2017). A study that evaluated long-term trend data reported adults with lower education and income levels had a greater prevalence of heart disease than adults with higher education and income levels, unemployed adults had a 55% greater prevalence of cardiovascular disease (CVD) than their fully employed peers (Singh et al. 2017).

In 2000, United States mortality estimates attributable to low education and low social support were comparable to the number of deaths caused by acute myocardial infarction (245,000 vs 192,898) and lung cancer (162,000 vs 155,521), respectively (Galea et al. 2011).

INITIATIVES ADDRESSING SOCIAL DETERMINANTS

Initiatives that address social determinants have been implemented by federal, state, and local governments or by non-government organizations. One such initiative is Healthy People, a federally and publicly backed program that develops national goals and health objectives for adoption by communities across the country (Healthypeople.gov 2019a). Healthy People 2020 has chosen social determinants of health as a target topic area (Healthypeople.gov 2019b).

At the federal level, the Centers for Medicare and Medicaid Services (CMS) has authorized Medicare Advantage plans to provide supplemental benefits (e.g., adult day health services or in-home support services) to address social determinants for people with chronic disease (CMS.gov 2019b). CMS has initiated the Accountable Health Communities (AHC) Model to support community bridge organizations in testing approaches to delivering health-related social services; currently, 30 organizations are participating (CMS.gov 2019c). The AHC model uses a validated Health-Related Social Needs Screening Tool to inform treatment plans and to make referrals (CMS.gov 2019d). Recently, the Social Determinants Accelerator Act, bi-partisan federal legislation, was introduced to assist states and communities in coordinating existing programs that address social determinants, with the aim of improving the health and well-being of individuals participating in Medicaid (aligningforhealth.com 2019; bustos.house.gov 2019).

States have sponsored programs that encourage partnerships with public and private organizations to mitigate social determinant risks. North Carolina has initiated NCCARE360, the first statewide coordinated care network to connect health care and human services providers to individuals with social needs (NCDHHS 2019). Through a shared technology platform, the network enables communication between HCPs, insurers, and community-based organizations, securely exchanging client information and tracking outcomes (Foundation for Health Leadership and Innovation, 2019).

As part of their Integrated Health Model Initiative (IHMI), the AMA is collaborating with United-Healthcare to standardize social determinant data collection by supporting the creation of 23 International Classification of Disease-Tenth Revision-Clinical Modification (ICD-10-CM) codes

that capture financial ability and caregiver needs (AMA 2019). Through its EveryONE Project, the American Academy of Family Physicians (AAFP) has developed a screening tool and an action plan for social needs as well as Neighborhood Navigator, a point-of-care interactive tool to assist HCPs in connecting individuals to social service resources according to zip code (AAFP 2019).

Recently, Kaiser Permanente, a non-profit integrated health system, launched Thrive Local, a social health network that connects health care with public and private resources and programs. Thrive Local is intended to address the social needs of millions of Americans, with the aim of improving the health and well-being of individuals and their communities (Kaiser Permanente 2019b).

ELECTRONIC HEALTH RECORDS (EHRS), REAL-WORLD EVIDENCE (RWE), AND SOCIAL DETERMINANTS

The American College of Physicians (ACP) has published a position paper focusing on social determinants and systemic issues affecting patient care and health equity. Among its recommendations, the ACP advises stakeholders to develop best practices in using EHRs to support patient and population health while avoiding undue burden on HCPs (Daniel et al. 2018). The ACP further recommends social determinant data captured within EHR clinical workflows has the potential to identify individual risk, support referrals to public health organizations and social services agencies, identify population needs, and support research (Adler et al. 2015; Daniel et al. 2018). They further recommend increased social determinant screening to improve patient care while also acknowledging the difficulties encountered when there is no capacity to refer or treat. Most physician practices and hospitals do not screen for five key social needs (i.e., food insecurity, housing instability, utility needs, transportation needs, and interpersonal violence) (Fraze et al. 2019).

The National Academy of Medicine (NAM) (formerly the Institute of Medicine [IOM]) has also issued a paper advocating routine, structured collection of social and behavioral measures and domains in EHRs (IOM 2014). Using EHR clinical data linked to survey data documenting social and behavioral risk factors identified by NAM, a prospective RWE study that evaluated adults without baseline hypertension (n=18,133) or diabetes (n=35,788) demonstrated an association between individual and cumulative risk factors and onset of these chronic conditions (follow-up, 3.5 years). Patients with three or more social risk factors were shown to have the greatest increased risk of developing hypertension or diabetes (Pantell et al. 2019). The study suggests social determinant data collected at the point of care may inform HCPs regarding which patients require more intensive preventive care. That the survey included a diverse, insured population further suggests screening for social and behavioral risk could be conducted outside of "safety-net" settings (Pantell et al. 2019).

RETROSPECTIVE COHORT ANALYSIS

To investigate how real-world data (RWD) collected during routine clinical care might offer insight into SDoH and patients with chronic conditions, de-identified RWD sourced from the EHR Practice Fusion, a Veradigm™ offering, were used to generate RWE. As the largest cloud-based EHR platform in the United States, Practice Fusion enables 20,000 medical practices to deliver better care to five million patients each month (Veradigm 2019).

The objectives of this retrospective cohort analysis were as follows:

1) To characterize patients with social determinant codes according to key demographics and chronic conditions

2) To identify the provider subspecialties assigning the codes

Social determinants have been shown to influence morbidity and mortality in the chronic conditions selected for the analysis: diabetes, HIV/AIDs (human immunodeficiency virus/acquired immunodeficiency syndrome), asthma/chronic obstructive pulmonary disease (COPD), cancer, mental illness, and cardiovascular disease (CVD) (Singh et al. 2017). In the United States, CVD, diabetes, and cancer are the main drivers of annual healthcare costs (CDC 2019).

ICD-10-CM codes, specifically "Z" codes, identify individuals with evidence of potential health hazards related to socioeconomic and psychosocial circumstances. ICD-10-CM codes for problems related to education and literacy (Z55), employment and unemployment (Z56), occupational exposure to risk factors (Z57), housing and economic circumstances (Z59), social environment (Z60), upbringing (Z62), primary group support including family circumstances (Z63), certain psychosocial circumstances (Z64), and other psychosocial circumstances (Z65) are used by hospitals and health systems to capture social risk (American Hospital Association 2018). The use of ICD 10-CM diagnosis codes to chart health conditions in EHRs is recommended by the ACP (Daniel et al. 2018).

ICD-10-CM Z55 through Z65 codes cross map through observational medical outcomes partnership (OMOP) vocabulary to corresponding codes in Systematized Nomenclature of Medicine Clinical Terms (SNOMED CT). A total of 120 social determinant codes from the ICD 10-CM and the SNOMED CT sets accounted for over 99% of de-identified patients with evidence of social determinants in the Practice Fusion dataset.

These ICD-10-CM and SNOMED CT codes were grouped according to five social determinant categories identified in the Healthy People 2020 framework:

- Economic stability
- Education
- Social and community context
- Health and health care
- Neighborhood and built environment (Healthypeople.gov 2019b)

The analysis included ambulatory patients who were assigned at least one new social determinant code during the period between April 15, 2016 and April 15, 2019 (intake).

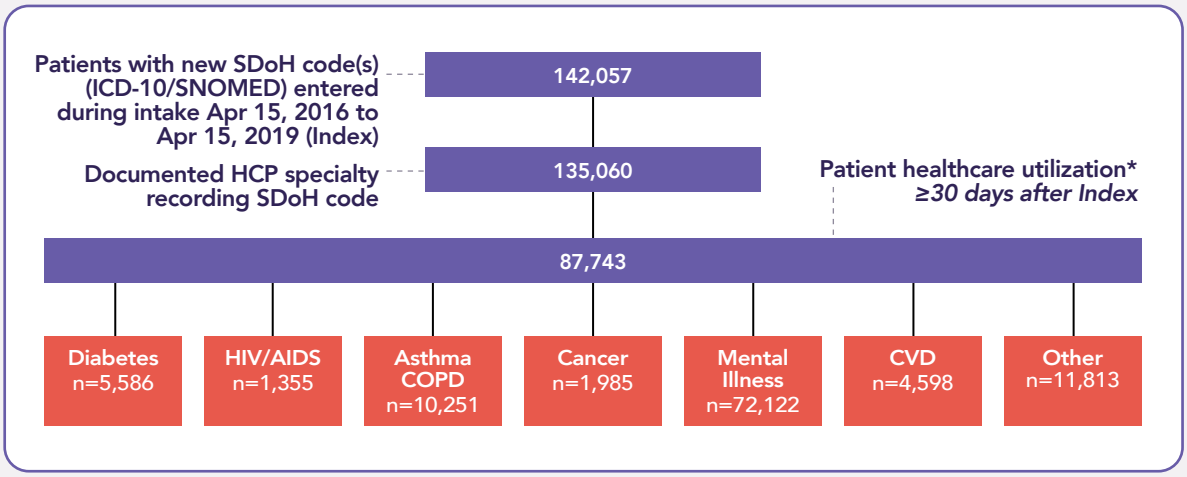
De-identified patients included in the analysis met the following eligibility requirements:

- At least one new social determinant code recorded during intake (Index)
- Known specialty of HCP who recorded the social determinant code at Index
- Documentation of at least one healthcare encounter (e.g., office visit, phone consult, lab assessment) 30 days or more after Index

Eligible patients could have one or more social determinant codes recorded between Index and the end of intake and one or more of the six chronic conditions in their historical records. Eligible patients were evaluated as a group (All) and were also stratified according to chronic condition to yield six chronic condition cohorts. Patients without a diagnosis for any the chronic conditions were assigned to their own group (Other).

During intake, 142,057 patients were assigned a new SDoH code; 87,743 patient met intake criteria for HCP specialty and return visits (**Figure 1**). A total of 75,930 patients were distributed among the six chronic condition cohorts; these patients had 95,897 chronic conditions recorded in their history from the six (some with more than one). For 11,813 patients (13.5%), there were no recorded diagnoses for any of the six chronic conditions (Other cohort).

FIGURE 1 | Sample Selection



Abbreviations/Definitions:SDoH=social determinant of health; ICD-10=International Classification of Diseases (Tenth Revision-Clinical Modification); SNOMED=Systematized Nomenclature of Medicine (Clinical Terms); HCP=healthcare provider; Diabetes=type I or type II diabetes; HIV/AIDS=human immunodeficiency virus I or II/acquired immunodeficiency syndrome; Asthma/COPD=asthma and/or chronic obstructive pulmonary disease; Cancer=any liquid or solid malignancy; Mental Illness=adjustment disorder, anxiety, bipolar disorder, depression, psychosis, or schizophrenia; CVD=cardiovascular disease; Other=eligible individuals without a diagnosis (ICD-9 or ICD-10) for any of the six chronic conditions. Because individuals may have more than one chronic condition, cohort numbers cannot be summed for individuals meeting analysis critiera.

*Healthcare utilization=one visit or phone consult with an HCP, laboratory assessment, or order for/documented use of medication or intervention.

Table 1 shows baseline characteristics for each chronic condition cohort. The most prevalent chronic condition was Mental Illness followed by Asthma/COPD, Diabetes, and CVD (82.2%, 11.6%, 6.4%, and 5.2% of patients, respectively). Women represented more than one-half of

patients in the cohorts combined, including the Other cohort. Patients in the Other cohort were generally younger (mean [SD] age, 31.2 [23.4] yr) than patients in the chronic condition cohorts (range, 36.9 [21.7] [Mental Illness]-66.9 [14.6] [CVD]). Among the chronic condition cohorts, mean ages were greater for Diabetes, Cancer, and CVD than for Mental Illness, Asthma/COPD, and HIV/AIDS. Fewer patients in the Other cohort were smokers (11.1%) versus patients in the chronic condition cohorts (range, 19.9% [Mental Illness]-42.6% [CVD]).

TABLE 1 | Baseline Characteristics

VARIABLES	Chronic Condition							
	All n=87,743	**Diabetes** n=5,586	**HIV/AIDS** n=1,355	**Asthma COPD** n=10,251	**Cancer** n=1,985	**Mental Illness** n=72,122	**CVD** n=4,598	**Other** n=11,813
Age, mean (SD)	36.6 (22.4)	60.6 (15.2)	41.3 (17.6)	40.9 (25.6)	64.3 (15.7)	36.9 (21.7)	66.9 (14.6)	31.2 (23.4)
Female Gender, n (%)	51,229 (58.4)	3,249 (58.2)	810 (59.9)	5,930 (57.9)	1,178 (59.4)	42,548 (59.0)	2,553 (55.5)	6,734 (57.0)
Smokers, n (%)	16,560 (18.9)	2,029 (36.3)	529 (39.1)	3,400 (33.2)	774 (39.0)	14,350 (19.9)	1,960 (42.6)	1,312 (11.1)
BMI, n (%)	41,390 (47.2)	4,838 (86.6)	1,125 (83.0)	6,651 (64.9)	1,750 (88.2)	33,107 (45.9)	3,945 (85.8)	5,679 (48.1)
BMI, mean kg/m^2 (SD)	29.2 (7.3)	32.4 (7.8)	29.7 (7.5)	30.2 (8.1)	28.3 (7.0)	29.1 (7.4)	29.6 (7.5)	29.1 (7.0)

Abbreviations/Definitions: Diabetes=type I or type II diabetes; HIV/AIDS=human immunodeficiency virus I or II/acquired immunodeficiency syndrome; Asthma COPD=asthma and/or chronic obstructive pulmonary disease; Cancer=any liquid or solid malignancy; Mental Illness= adjustment disorder, anxiety, bipolar disorder, depression, psychosis, or schizophrenia; CVD=cardiovascular disease; Other=eligible individuals without a diagnosis (ICD-9 or ICD-10) for any of the six previous chronic conditions; SD=standard deviation; BMI=Body Mass Index.

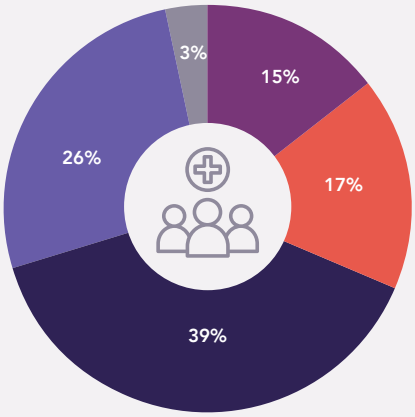


FIGURE 2 | United States Regional Distribution of All Patients* with New Social Determinant Codes

- Northeast
- Midwest
- South
- West
- Not Recorded

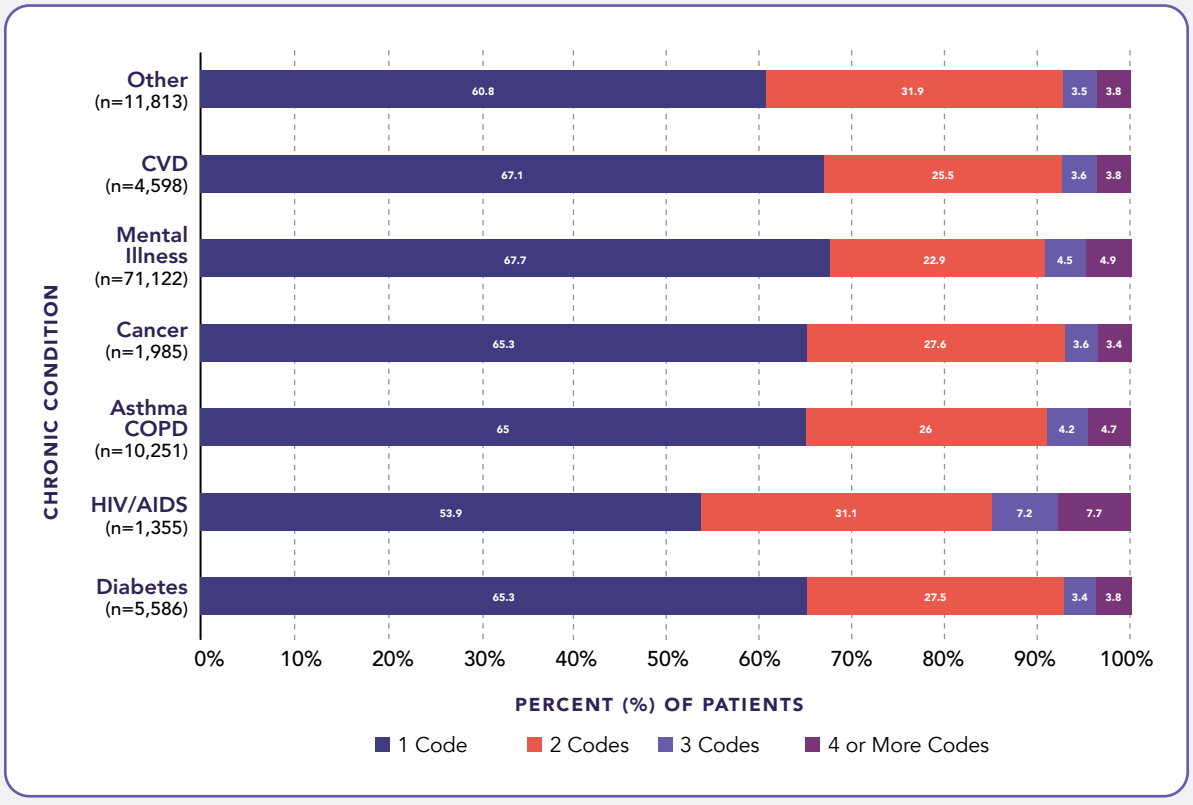
*N=87,743 at intake.

Approximately sixty-five percent (65.2%) of patients resided in the Southern and Western United States combined. Relatively fewer patients lived in the Northeast (All cohort, 14.6%; chronic condition cohorts, range, 10.2% [Diabetes]-15.6% [HIV/AIDS]) and the Midwest (All cohort, 16.9%; chronic condition cohorts, range, 9.8% [HIV/AIDS]-18.1% [Mental Illness]) (**Figure 2**).

This distribution approximates that obtained for residents in the United States census (Northeast, 17.4%; Midwest, 21.0%; West, 23.7%; South, 37.9%) (United States Census Bureau 2019).

The percentages of patients with 1, 2, 3, or 4 or more codes were similar across the chronic condition cohorts. Most patients were assigned one code (range, 53.9% [HIV/AIDs]-67.1% [Mental Illness]) or two codes (22.9% [Mental Illness]-31.1% [HIV/AIDs]) at Index and during the remainder of intake (**Figure 3**). Greater percentages of patients in the HIV-AIDS cohort were assigned 3 codes and 4 or more codes at Index and during the remainder of intake compared with patients in the other chronic condition cohorts.

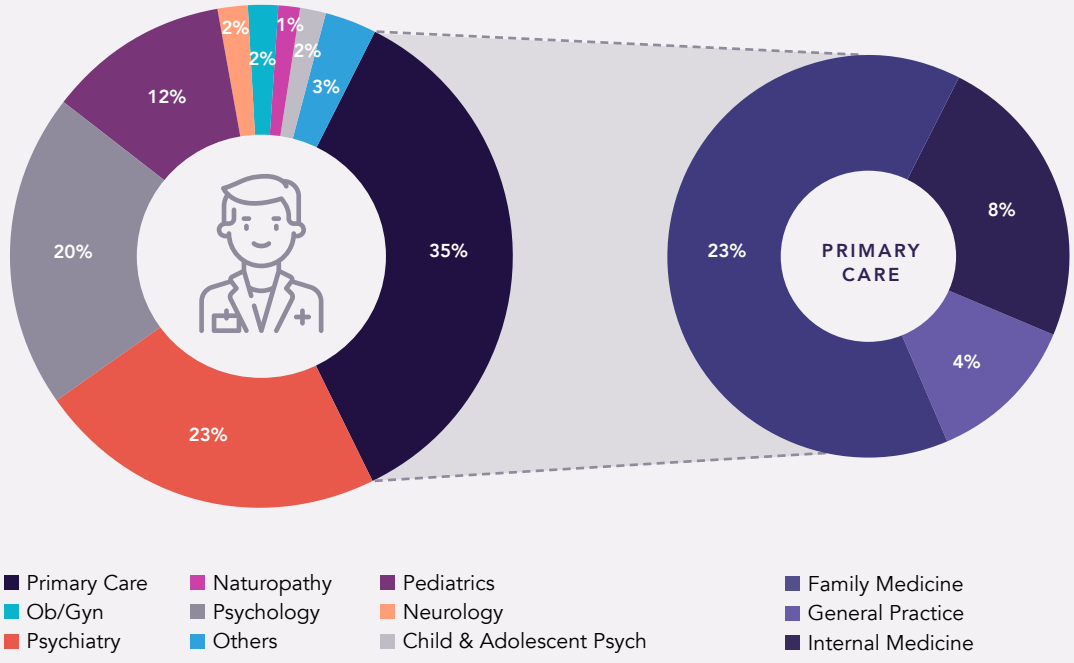
FIGURE 3 | Percent (%) of Patients by Chronic Conditions for Social Determinant Code Frequency



The number of Index and any follow-up social determinant codes recorded during intake are shown in the legend. Abbreviations/Definitions: Diabetes=type I or type II diabetes; HIV/AIDS=human immunodeficiency virus I or II/ acquired immunodeficiency syndrome; Asthma/COPD=asthma and/or chronic obstructive pulmonary disease; Cancer=any liquid or solid malignancy; Mental Illness= adjustment disorder, anxiety, bipolar disorder, depression, psychosis, or schizophrenia; CVD=cardiovascular disease; Other=eligible individuals without a diagnosis (ICD-9 or ICD-10) for any of the six chronic conditions.

Figure 4 shows the percentage of all patients assigned social determinant codes according to provider specialty at Index and during the remainder of intake. Approximately one-third (35.5%) of patients were assigned codes by primary care practitioners (i.e., family medicine, internal medicine, and general practice combined). Twenty-percent (20.2%) and 22.7% of all patients were assigned codes by specialists from psychiatry and psychology, respectively.

FIGURE 4 | Percent (%) of all Patients Assigned Social Determinant Codes by Provider Specialty



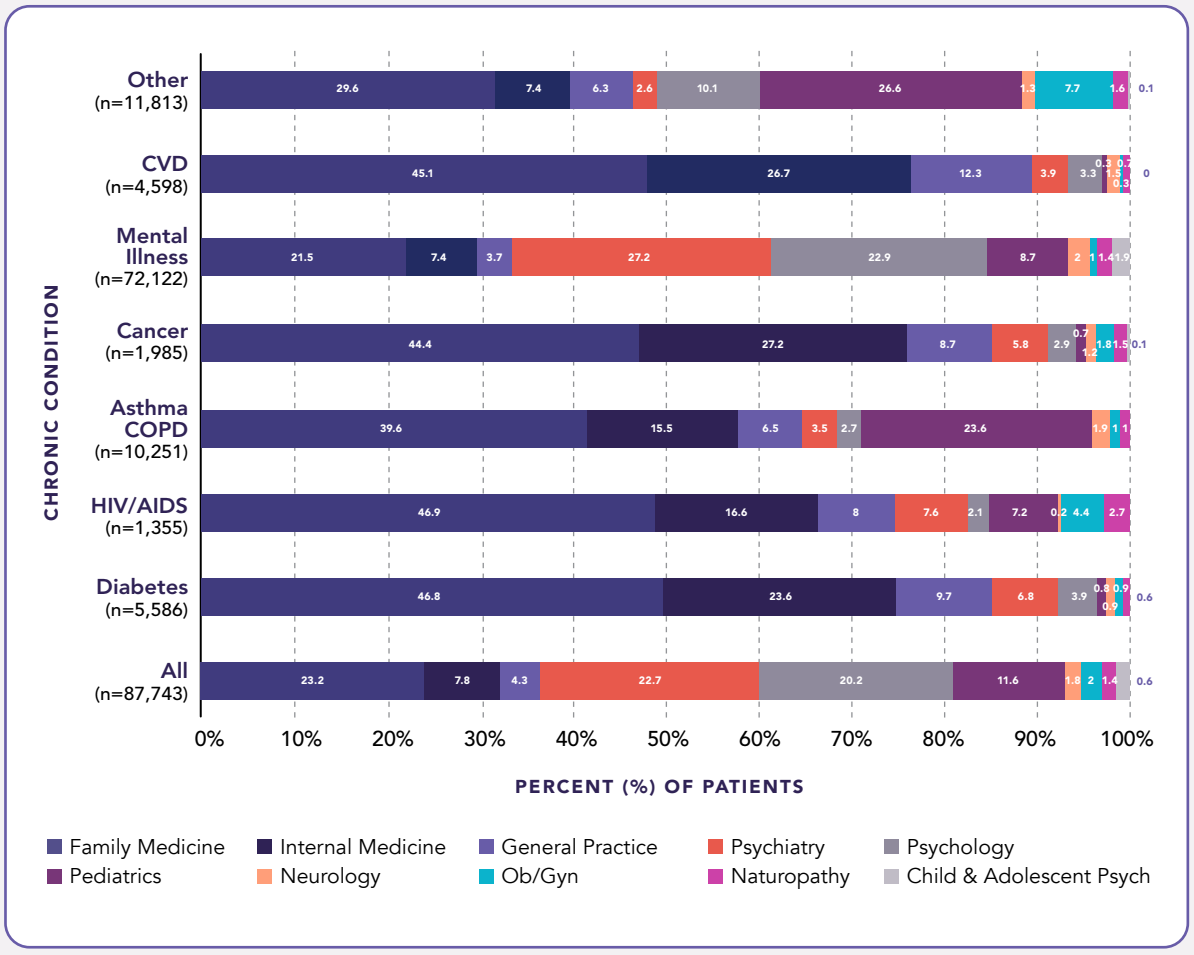
The percentage of patients with a social determinant code at Index are illustrated according to the provider specialty that recorded the code. Others include: Physical Medicine and Rehabilitation, Pain Medicine, Pulmonology, Endocrinology, Cardiology, Infectious Disease, Hematology/Oncology, and Other.

Figure 5 shows the percentage of patients in each of the chronic condition cohorts assigned social determinant codes by provider specialty. More than one-half of patients in the Asthma/COPD cohort (61.6%), HIV/AIDS cohort (71.5%), Diabetes cohort (80.1%), Cancer cohort (80.3%), and CVD cohort (84.1%) were assigned social determinant codes by primary care practitioners (i.e., family medicine, internal medicine, and general practice combined). Patients with mental illness were primarily assigned codes by specialists from family medicine (21.5%), psychiatry (27.2%), and psychology (22.9%).

Patients in the Other cohort were mainly assigned codes by primary care practitioners (43.3%).

Approximately one-quarter of patients in the Asthma/COPD cohort (23.6%) and the Other cohort (26.6%) were assigned codes by pediatricians.

FIGURE 5 | Percent (%) of Patients by Chronic Condition for Top Ten Provider Specialties



Abbreviations/Definitions: Diabetes=type I or type II diabetes; HIV/AIDS=human immunodeficiency virus I or II/acquired immunodeficiency syndrome; Asthma/COPD=asthma and/or chronic obstructive pulmonary disease; Cancer=any liquid or solid malignancy; Mental Illness=adjustment disorder, anxiety, bipolar disorder, depression, psychosis, or schizophrenia; CVD=cardiovascular disease; Other=eligible individuals without a diagnosis (ICD-9 or ICD-10) for any of the six chronic conditions.

Top social determinant codes according to chronic condition are shown in **Table 2**. The top-ranking code in each of the chronic condition cohorts was Adjustment Disorder (SNOMED CT) (range, 12.5% [HIV/AIDS]-38.2% [Mental Illness]), whereas the top-ranking code in the Other cohort was Problems with Upbringing (ICD-10-CM) (9.0%). Other code rankings (2nd through 10th place) varied across the chronic condition cohorts. The majority of ranked codes were clustered in the Social and Community Context category (Family Problems [SNOMED CT], Parent-Child Problem [SNOMED CT], Other Problems Related to Primary Support Group, Including Family [ICD-10-CM, Z63], Problems Related to Other Psychosocial Circumstances [ICD-10-CM, Z65]).

TABLE 2 | Top Social Determinant Codes by Chronic Condition*

CODE	RANK (% OF COHORT)	Chronic Condition							
		ALL n= 87,743	Diabetes n= 5,586	HIV/ AIDS n= 1,355	Asthma COPD n= 10,251	Cancer n= 1,985	Mental Illness n= 72,122	CVD n= 4,598	Other n= 11,813
SNOMED	**SNOMED Description**								
1722 6007	Adjustment disorder	1 (31.4)	1 (22.8)	1 (12.5)	1 (18.4)	1 (27.5)	1 (38.2)	1 (24.6)	
24853 9004	Family problems	5 (5.7)	4 (7.8)	2 (10.2)	6 (6.6)	4 (8.7)	4 (5.7)	4 (7.2)	6 (5.9)
5218 4009	Parent-child problem	8 (4.5)		11 (4.4)	10 (3.7)		7 (4.4)		8 (5.6)
27607 4009	Stress at work	11 (3.4)	9 (3.9)	8 (7.0)	11 (2.9)	8 (3.7)	13 (2.9)	11 (2.8)	7 (5.9)
ICD-10	**ICD-10 Description, rank (%)**								
Z55	Problems related to education and literacy	4 (5.7)			2 (8.8)		5 (5.5)		5 (6.4)
Z56	Problems related to employment and unemployment	9 (4.2)	7 (5.4)	4 (9.6)	9 (3.8)	6 (5.4)	10 (3.9)	10 (3.7)	9 (5.6)
Z57	Occupational exposure to risk factors	19 (1.9)	13 (2.5)	19 (1.8)	8 (3.9)	9 (3.3)		18 (1.7)	2 (8.5)
Z59	Problems related to housing and economic circumstance	15 (2.4)	6 (5.6)	7 (7.3)	7 (4.6)	10 (3.0)	15 (2.3)	6 (6.0)	15 (2.7)
Z60	Problems related to social environment		10 (3.5)		14 (2.6)	13 (2.0)		7 (4.9)	20 (2.3)
Z62	Problems related to upbringing	12 (2.9)		10 (5.7)	16 (2.5)		16 (2.2)		1 (9.0)
Z63	**Other problems related to primary support group, including family**								
Z63.0	Problems in relationship with spouse or partner	2 (7.2)	8 (4.5)	12 (4.4)	13 (2.7)	7 (4.8)	2 (7.8)	8 (3.8)	11 (5.4)
Z63.5	Disruption of family by separation and divorce	14 (2.7)		14 (3.0)	17 (2.4)	16 (1.6)	14 (2.7)		16 (2.7)
Z63.72	Alcoholism and drug addiction in family			13 (4.4)					
Z63.79	Other stressful life events affecting family and household	7 (4.8)	3 (9.3)	3 (9.7)	5 (6.8)	2 (10.3)	8 (4.2)	3 (9.4)	4 (7.3)

Rank: 1st 2nd 3rd 4th 5th 6th 7th 8th 9th 10th

TABLE 2 | Top Social Determinant Codes by Chronic Condition* Continued

CODE	RANK (% OF COHORT)	Chronic Condition							
		ALL n= 87,743	Diabetes n= 5,586	HIV/ AIDS n= 1,355	Asthma COPD n= 10,251	Cancer n= 1,985	Mental Illness n= 72,122	CVD n= 4,598	Other n= 11,813
Z63	**Other problems related to primary support group, including family Continued**								
Z63.8	Other specified problems related to primary support group	3 (6.9)	5 (6.1)	6 (8.0)	3 (8.0)	5 (6.8)	3 (6.7)	5 (6.1)	3 (8.4)
Z63.9	Problem related to primary support group unspecified		15 (2.3)	9 (6.1)	15 (2.5)	14 (1.9)	9 (4.1)	14 (2.2)	14 (3.3)
Other									
Z64	Problems related to certain psychosocial circumstances								12 (4.0)
Z65	Problems related to other psychosocial circumstance	6 (5.0)	2 (9.7)	5 (9.4)	4 (7.9)	3 (9.3)	6 (4.7)	2 (12.4)	10 (5.6)

Rank: 1st 2nd 3rd 4th 5th 6th 7th 8th 9th 10th

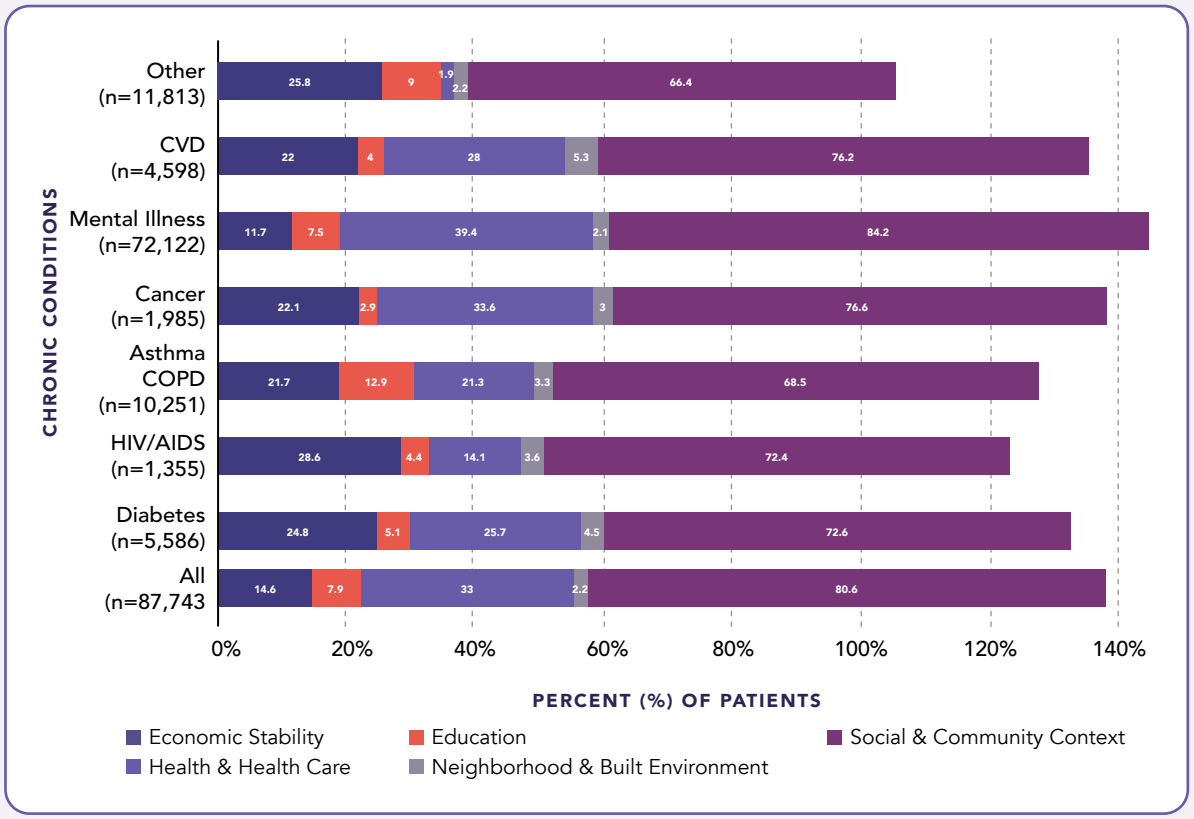
Abbreviations/Definitions: ICD-10=International Classification of Disease-Tenth Revision (Clinical Modification); SNOMED=Systematized Nomenclature of Medicine (Clinical Terms); Diabetes=type 1 or type 2 diabetes mellitus; HIV/AIDS=human immunodeficiency virus-1 or -2/acquired immunodeficiency syndrome; Asthma/COPD=asthma and/or chronic obstructive pulmonary disease; Cancer=liquid and solid malignancies; Mental Illness= adjustment disorder, anxiety, bipolar disorder, depression, psychosis, or schizophrenia; CVD=cardiovascular disease; Other=eligible patients without a diagnosis (ICD-9 or ICD-10) for any of the six chronic conditions.

*Social determinant codes were recorded during intake (at or after Index).

Figure 6 shows the social determinant categories assigned at Index and during the remainder of intake. More than two-thirds of patients in each of the chronic condition cohorts were assigned social determinant codes categorized under Social/Community Context (range, 68.5% [Asthma/COPD]-84.2% [Mental Illness]). The percentages of patients in the chronic condition cohorts who were assigned codes in the Health/Health Care category ranged from 14.1% (HIV-AIDS) to 39.4% (Mental Illness). Less than 30% of patients in each of the chronic condition cohorts were assigned codes categorized under Economic Stability (range, 11.7% [Mental Illness] to 28.6% [HIV-AIDS]. Fewer than 15% and 6% of patients in each of the chronic condition cohorts were assigned codes related to Education and Neighborhood/Built Environment, respectively.

Almost two-thirds of patients in the Other cohort were assigned social determinant codes categorized under Social/Community Context (66.4%). Approximately one-quarter of these patients were assigned codes in the Economic Stability category (25.8%), with smaller percentages of patients assigned codes related to Education (9.0%), Neighborhood/Built Environment (2.2%), and Health/Health Care (1.9%) (**Figure 6**).

FIGURE 6 | Percent (%) of Patients by Chronic Condition for Five Social Determinant Categories



Abbreviations/Definitions: Diabetes=type I or type II diabetes; HIV/AIDS=human immunodeficiency virus I or II/acquired immunodeficiency syndrome; Asthma/COPD=asthma and/or chronic obstructive pulmonary disease; Cancer=any liquid or solid malignancy; Mental Illness=adjustment disorder, anxiety, bipolar disorder, depression, psychosis, or schizophrenia; CVD=cardiovascular disease; Other=eligible individuals without a diagnosis (ICD-9 or ICD-10) for any of the six chronic conditions. Patients could be assigned more than one code; some codes are represented in more than one social determinants category.

DISCUSSION

Social determinants greatly influence an individual's health and well-being; they are a concern for many Americans (McGinnis et al. 2002; Schroeder 2007; Kaiser Permanente 2019a). Coordinating public policy with outreach initiatives implemented at federal, state, local, and organizational levels has been widely acknowledged as essential for mitigating the effects of social determinant risks; improving individual and population health outcomes; and reducing care costs.

In this retrospective cohort analysis, de-identified patient data from the EHR Practice Fusion, a Veradigm offering, were leveraged to generate RWE that is actionable and meaningful to a discussion of SDoH in chronic disease.

Several findings for patients who were newly assigned social determinant codes were noteworthy.

- Mental Illness was by far the most prevalent condition among the six chronic conditions selected for the analysis.
- Adjustment Disorder was the top-ranking social determinant code assigned to patients in each of the chronic condition cohorts but not in the cohort of patients without a chronic condition diagnosis.
- More than two-thirds of patients in each of the chronic condition cohorts were assigned codes related to the Social and Community Context category.

Regarding provider specialties,

- Most patients (up to 84%) in each of the chronic condition cohorts except for Mental Illness were assigned codes by primary care practitioners.
- Approximately one-quarter of patients in the Asthma/COPD cohort and in the cohort without diagnoses for any of the six chronic disorders were assigned codes by pediatricians.

Defined as the presence of emotional or behavioral symptoms occurring within three months of the onset of an identifiable stressor, adjustment disorder is a common diagnosis (American Psychiatric Association 2013). Its prevalence across five of the six chronic condition cohorts (12.5%-24.6%) in the current analysis generally aligns with that reported for primary care (3%-10%) and outpatient mental health treatment (5%-20%) (Johns Hopkins 2017). In the Mental Illness cohort, the prevalence of adjustment disorder (38.2%) is greater than that reported for primary care and outpatient treatment but less than that reported for hospital psychiatric consultation settings (50% or higher) (Johns Hopkins 2017).

For the analysis, primary care providers included family medicine, internal medicine, and general practice. As the largest platform for healthcare delivery and a principal of care that encompasses health promotion, disease prevention, and patient education, primary care is one natural point of connection between clinical care, community services, and public health systems (DeVoe et al. 2016; Katz et al. 2018). The proportion of patients assigned codes by pediatricians in the Asthma/COPD cohort and the cohort without chronic conditions reflects the inclusion of sizable numbers of younger patients, with or without chronic disease, who are subject to social determinant risk.

The second largest cohort in the analysis included those patients who had social determinant codes but no diagnoses for any of the chronic conditions. Social determinant risk factors, both individually and cumulatively, have been shown to significantly increase risk for developing diabetes and hypertension (Pantell et al. 2019). For patients with demonstrated social risk, social determinant data captured together with clinical data may be assessed longitudinally using predictive analytics to help determine which patients might require more intensive social or clinical support to forestall the onset of chronic disease.

Until recently, social determinants remained largely outside the purview of the healthcare system. A cross-sectional study that used survey and census data reported most hospitals and physician practices in the United States screen for at least one social need; however, only 24% of hospitals and 16% of physician practices screen for five key social risks (Fraze et al. 2019). National medical professional associations advocate increased screening and collection of social determinant data

(SIREN 2019) and caution against imposing additional administrative burden on HCPs (Daniel et al. 2018).

While social determinant data are more routinely being collected in clinical care settings, lack of industry standards for data collection remains a significant issue (Burchell 2019). Integrating standardized, interoperable social risk data into EHRs is essential not only for identifying at-risk patients and enabling data exchange at the point-of-care among providers of clinical and social services but also for supporting quality and payment reforms and enabling research and other analytics opportunities (Arons et al. 2018; Burchell 2019). The construction of comprehensive coding frameworks that align definitions across medical vocabularies would be expected to facilitate efficient capture and exchange of social determinant data (Paruk 2019). In addition, information technology tools such as natural language processing (NLP) are being used to extract and standardize social determinant data from problems lists and other semi-structured and unstructured text fields within EHRs (Patel and Nguyen 2019).

A challenge for providers is in understanding and anticipating how behavioral, socioeconomic, and place-based factors might raise barriers to treatment access. Non-adherence to medications and care plans is another clinical challenge deeply rooted in social determinant risk (Daniel et al. 2018). Non adherence is common—20% to 30% of new prescriptions go unfilled; one-half of medications for chronic conditions are not taken as prescribed—and costs up to $289 billion annually (Viswanathan et al. 2012). In a survey of American adults with chronic disease, four reasons—financial hardship, side effects, medication concerns, and lack of perceived need—were most commonly cited for non-adherence to medications (McHorney et al. 2010).

As interactive, cloud-based platforms that securely manage patient data and offer evidence-based tools (HealthIT.gov 2017), EHRs may provide insight into the barriers that hinder treatment or contribute to non-adherence. Behavioral, socioeconomic, geographic, and clinical data from EHRs linked to payer encounter (drug and health services utilization/cost) data may be leveraged to assist in identifying and managing cases of medication non-fulfillment and non persistence. EHR analytic tools may support access to social services interventions when, for example, lack of transportation keeps patients from picking up prescription first fills or refills, or when financial hardship compels them to ration their blood pressure and diabetes medications. Aggregated social, clinical, and claims data may be of use to population health researchers and life sciences stakeholders interested in gaining a deeper understanding of barriers to access and non-adherence.

EHRs may also host personalized care plans that incorporate social and clinical risks, identify resources, outline treatment goals, list medications with instructions for proper use, and provide instruction for self-management; patients with formalized action plans and chronic disorders have better medication adherence, fewer acute care visits or hospitalizations, and greater overall satisfaction with care (Kuhn et al. 2015). EHR support tools may provide access to educational content that raises health literacy and understanding of medication value; such tools may enable shared decision-making regarding, for example, cost considerations and pathways to accessing mutually agreed-upon therapies. Evolving NLP capability (HealthITAnalytics 2018) within EHRs may enable better understanding of medical records and other information provided on patient-facing, web- or mobile-based portals for status updates and educational content. A patient-empowering approach that includes data sharing may support patients in making appropriate health decisions (Black 2019).

The life sciences industry is currently evaluating how to contextualize social risk. Of interest are findings from a retrospective study that explored whether cardiovascular outcomes vary by socioeconomic factors (Shahu et al. 2019). Using data from a randomized clinical trial (RCT) in hypertension, the study looked at the effect of median household income of study sites. Despite equal access to study resources, patients receiving care at the lowest-income sites were less likely to achieve blood pressure control than patients receiving care at the highest-income sites. Moreover, they were more likely to be hospitalized, to die from all causes or complications of heart failure, and to develop end-stage renal disease. That RCT outcomes may be affected by socioeconomic factors highlights the importance of measuring and addressing such factors when study populations are socioeconomically diverse (Shahu et al. 2019). Such contextualization of socioeconomic diversity may be realized in real-world studies conducted within integrated research networks, in which clinical research takes place at the point of care (HealthITNews 2019).

CONCLUSION

As interactive, cloud-based platforms that securely manage comprehensive patient data and offer evidence-based tools, EHRs hold the potential to support the clinical, social, and educational needs of patients with chronic conditions and social risk. Studies that leverage real-world data from EHR platforms may provide incremental insight into treatment barriers, non-adherence, and other challenges encountered in caring for patients with complex health and social needs.

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