Case Study

Mapping the Correlation Between Emergency Department Utilization and Social Determinants of Health

ABSTRACT

The Colorado Hospital Association (CHA) partnered with Carrot Health to perform a statewide analysis of the relationship between emergency department (ED) utilization and readmissions and social determinants of health (SDoH). This analysis enables CHA members to understand the unique fingerprint of risk within their populations, identify optimal opportunities for intervention, estimate which efforts will produce the greatest return on investment, and ultimately, reduce healthcare costs.

By measuring and analyzing SDoH using the Carrot Health Social Risk Grouper® (SRG) alongside CHA de-identified claims data, a distinct correlation was identified between SDoH and ED utilization and readmissions within the state of Colorado. The analysis showed a positive correlation between individual SRG scores and the rate of ED utilization – the higher the SRG score, the higher the rate of ED super-utilization. The analysis also identified key underlying social factors driving utilization and readmissions, such as food insecurity.

BACKGROUND & OBJECTIVE

Defining, quantifying, and measuring social determinants of health (SDoH) has traditionally been difficult and limited to geographic or population "averages." Such averages often mask the discrete and unique experiences of individuals, and can lead organizations to implement inefficient, costly programs or interventions, instead of addressing individuals' barriers that represent the greatest potential for improving health outcomes and return on investment.

The Colorado Hospital Association (CHA), representing more than 100 member hospitals and health systems throughout Colorado, serves as a trusted, credible, and reliable resource on health issues, hospital data, and trends for its members, media, policymakers and the general public. Through CHA, hospitals and health systems work together to improve health and healthcare in Colorado. As part of this commitment, CHA wants to help members implement effective programs to help reduce ED utilization and readmissions through proactive measures and programs by leveraging data.

Each month, CHA receives hospital claims data from all members, allowing them to identify and monitor patient trends and utilization metrics. By combining de-identified data from CHA's On Demand Hospital Information Network (ODHIN) with consumer behavior data from the Carrot MarketView® platform, we produced an industry-first analysis of healthcare utilization across the state, as well as the relationship between social risk and its impact on ED utilization, inpatient admission and readmissions (as defined by HEDIS). Using this data, analysts were able to score patient risk using the Carrot Health Social Risk Grouper® (SRG).

This case study examines and discusses the relationship between the SRG (a taxonomy for measuring and monitoring SDoH) and healthcare utilization in Colorado. The scope of this analysis includes scoring across the Colorado adult patient population with a hospital interaction within the past two years, and matched between the two datasets (approximately 2.5 million unique adult patients). It also discusses the patterns and relationship observed through patient data, social risks, and ED utilization and readmissions.
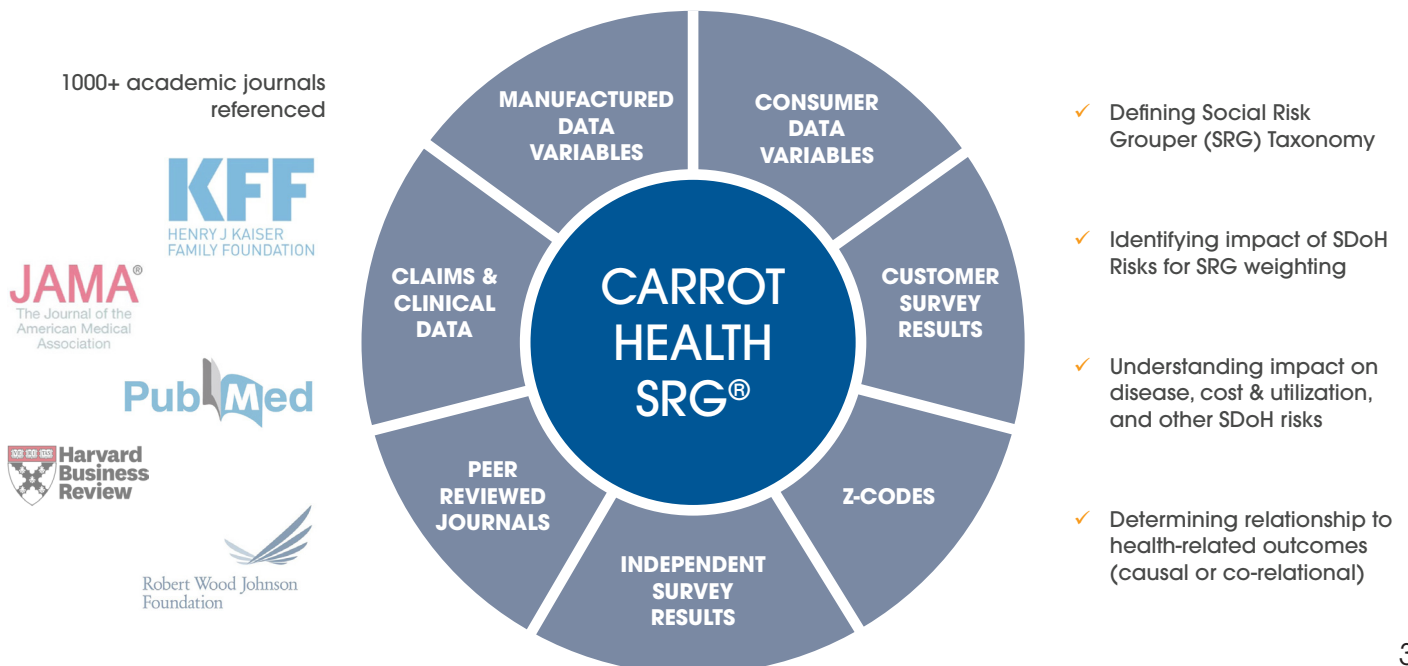
METHODOLOGY & DATA

Using the World Health Organization's definition, this report defines Social Determinants of Health as "the conditions in which people are born, grow, work, live, and age." These circumstances are shaped by the distribution of money, power, and resources at the global, national and local levels. In effect, SDoH are barriers that outline and influence health inequities – the unfair and avoidable differences in health status seen within and between nations, populations and individuals.

Carrot Health, a leader in consumer data and predictive analytics, developed the Carrot Social Risk Grouper (SRG), a proprietary SDoH taxonomy, to help understand, identify, measure, and quantify the social barriers and circumstances in which people live. SRG helps predict the likelihood of an individual having an adverse health outcome due to SDoH. Scores are available for every individual in the U.S. and range from 0 (low) to 99 (high).

SRG is a composite score that is driven by four components: behavioral, social, economic and environmental. Within these components are 11 Social Risk categories: loneliness, housing instability, health literacy, food insecurity, financial insecurity, discord at home, unemployed, uninsured, low socioeconomic status, transportation needs, and unacculturated. These categories allow healthcare organizations to understand, at an individual level, the unique fingerprint of risk and potential barriers to appropriate care.

SRG scores are based on consumer data, primary surveys, research, and Carrot Health's proprietary consumer and health database. Specific SRG inputs include consumer data variables, ICD-10 Z-codes, independent survey results, peer-reviewed studies, healthcare claims and clinical data, and other Carrot Health proprietary data. Survey results are based on representative samples of consumers across age, gender, insurance type, and socioeconomic status to identify perception of SDoH risks.

1000+ academic journals referenced

KFF
HENRY J KAISER FAMILY FOUNDATION

JAMA®
The Journal of the American Medical Association

PubMed

Harvard Business Review

Robert Wood Johnson Foundation

MANUFACTURED DATA VARIABLES

CONSUMER DATA VARIABLES

CLAIMS & CLINICAL DATA

CARROT HEALTH SRG®

CUSTOMER SURVEY RESULTS

PEER REVIEWED JOURNALS

Z-CODES

INDEPENDENT SURVEY RESULTS

✓ Defining Social Risk Grouper (SRG) Taxonomy

✓ Identifying impact of SDoH Risks for SRG weighting

✓ Understanding impact on disease, cost & utilization, and other SDoH risks

✓ Determining relationship to health-related outcomes (causal or co-relational)

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KEY DATASETS & DEFINITIONS USED IN THE ANALYSIS

Consumer

Adult individuals (18 years or older), with a Colorado address, in Carrot Health's consumer database. This population was used as the basis for our analysis, and as the "denominator" for calculations. There are 5,175,337 unique individuals within this population.

Patient

Adult individuals (18 years or older), with a Colorado address, who had at least one encounter record with a CHA member hospital in the 24-month period from January 2017 through December 2018. This population consisted of 2,534,951 unique individuals, matched In both the CHA and Carrot Health datasets. Using de-identified patient information, only positive individual matches were included in the study; no household or ZIP+4 matches were included.

Counts Used In Analysis	
Unique Consumers	5,175,337
Unique, Matched Patients	2,534,951
Number of Claims or Patient Service Days	16,524,876
Unique ED Super-Utilizer Patients	117,290

Emergency Department Super-Utilizers

Adult individuals with four or more visits to a CHA member emergency departmentl in the 24-month period from January 2017 through December 2018. This population consisted of 117,290 unique individuals (2.3% of the consumer population or 4.6% of the patient population).

Readmission Rate

The rate of adult acute inpatient stays followed by an unplanned acute readmission for any diagnosis within 30 days after discharge based on 2019 claims data.

CDPS Risk Score

Chronic Illness & Disability Payment System (CDPS); Risk Adjustment Model. CDPS demographic risk score based on age and gender was used to adjust risk across the population.

THE CORRELATION BETWEEN SRG SCORES & EMERGENCY DEPARTMENT SUPER-UTILIZATION

The analysis identified a correlation between social risk factors and ED super-utilization at both an aggregate and individual level. Analysis found that the higher the SRG score, the higher the rate of ED super-utilization.

Figure 1 shows the rate of ED super-utilizers per thousand people in the population of each county. Figure 2 shows the average SRG score for each county. The southeastern part of the state has a higher level of risk (color-coded in orange), and the wealthier mountain and more populated front range areas are lower risk (color-coded in blue).
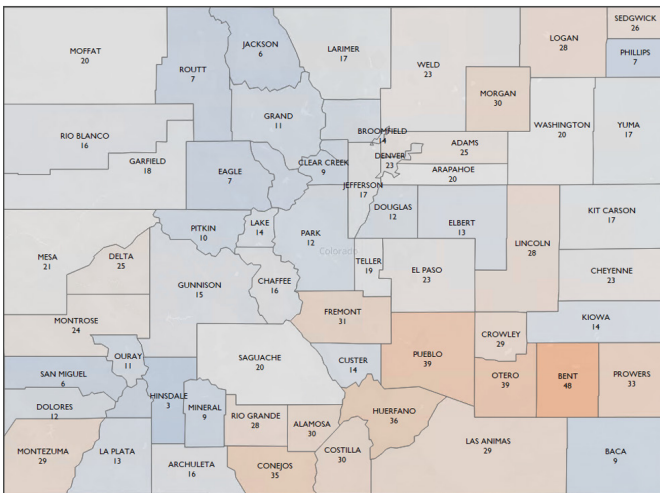

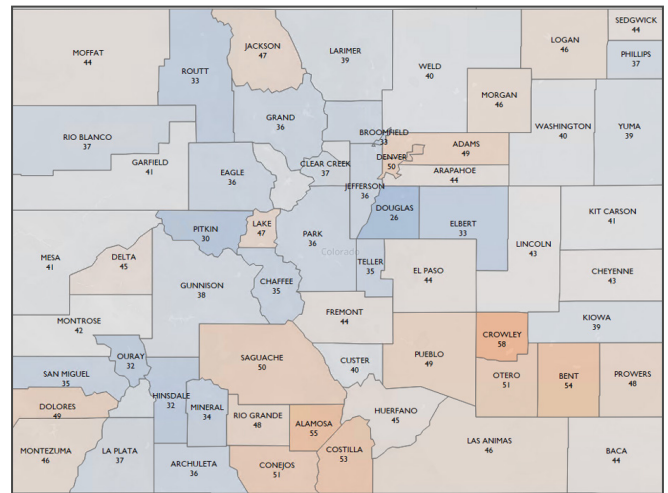Figure 1: ED Super-Utilzers per Thousand
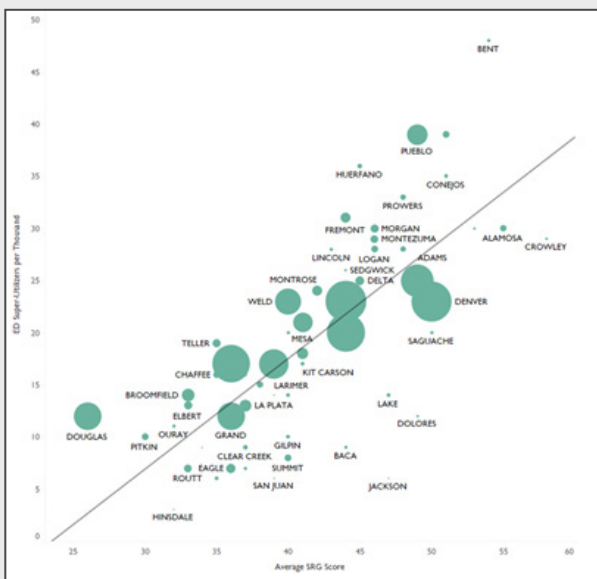

Figure 2: Average SRG Score by County

Figure 3: Average SRG Score and ED Super-Utilizers per Thousand by County

Figure 3 demonstrates the correlation between ED super-utilizer rates and average SRG scores. As the SRG score increases, so does the rate of ED super-utilizers.

SDoH are driving unnecessary ED utilization, and can drive up cost for everyone.
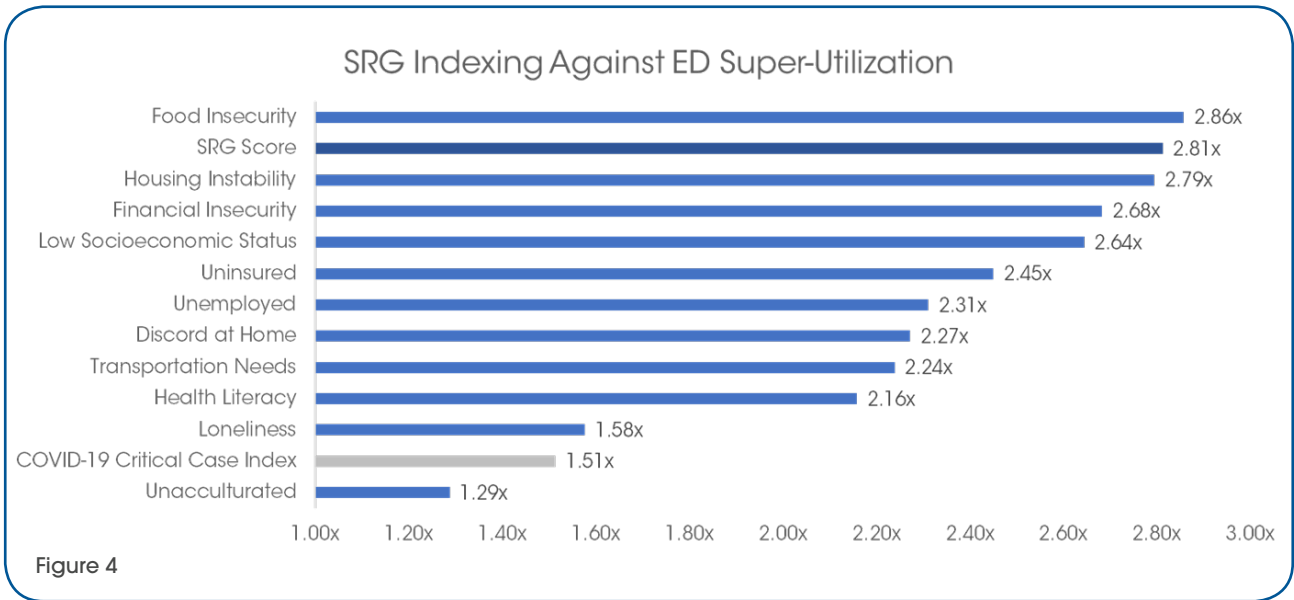Addressing underlying SDoH is necessary to reduce the total cost of care.

KEY:
- Chart: $R^2=0.53$, P-value < 0.0001
- The size of the circle indicates the relative population size of each county.

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BREAKING DOWN THE SRG COMPONENTS

Figure 4 shows the correlations between high risk for various SRG components and observed ED super-utilization. For example, individuals in the top decile of risk for food insecurity (defined as the inability to pay for or access healthy food options) super-utilized the ED at 2.86x the rate of the general population.

SRG Indexing Against ED Super-Utilization

Component	Value
Food Insecurity	2.86x
SRG Score	2.81x
Housing Instability	2.79x
Financial Insecurity	2.68x
Low Socioeconomic Status	2.64x
Uninsured	2.45x
Unemployed	2.31x
Discord at Home	2.27x
Transportation Needs	2.24x
Health Literacy	2.16x
Loneliness	1.58x
COVID-19 Critical Case Index	1.51x
Unacculturated	1.29x

Figure 4

Using the Chronic Illness & Disability Payment System (CDPS) demographic risk score (based on age and gender) to predict ED super-utilization produces an area under the curve (AUC) value of 0.567. **Adding in the SRG score, the AUC climbs to 0.689, an overall predictive lift of 21.5%.**

ED SUPER-UTILIZER REGRESSION USING CDPS & SRG MODELING

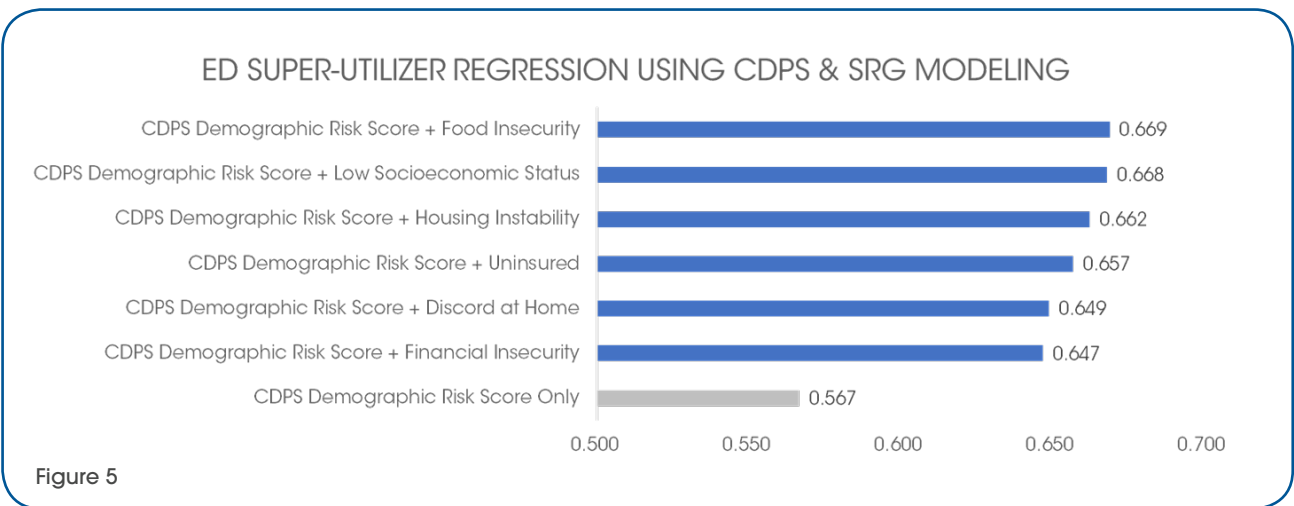| Model	AUC
CDPS Demographic Risk Score + Food Insecurity	0.669
CDPS Demographic Risk Score + Low Socioeconomic Status	0.668
CDPS Demographic Risk Score + Housing Instability	0.662
CDPS Demographic Risk Score + Uninsured	0.657
CDPS Demographic Risk Score + Discord at Home	0.649
CDPS Demographic Risk Score + Financial Insecurity	0.647
CDPS Demographic Risk Score Only	0.567

Figure 5

Figure 5 shows that the highest single factor concordance impact value of the SRG components in a logistic regression model. Adding just Food Insecurity to CDPS boosts the AUC to 0.669, an improvement of 18%.

READMISSION

Readmission is another core utilization metric for which SDoH presents a potential area for improvement. As previously defined, readmission is the rate of adult acute inpatient stays followed by an unplanned acute readmission for any diagnosis within 30 days after discharge. This quality metric has been identified by Colorado's Medicaid payer as a key metric that hospitals will be measured on and, ultimately, reimbursed for over the next five years under the value-based program known as Colorado's Hospital Transformation Program.

SDoH are often exacerbated within the Medicaid population. SDoH identification tools such as Carrot MarketView are therefore valuable in helping to quantify risk and identify opportunities for strategic program design, community outreach, and interventions. The improvement of this measure is directly tied to the Colorado's Medicaid payment program, making the optimization of quality programs paramount to member hospitals.

The Hospital Transformation Program shows the importance of identifying appropriate patient populations and planning intervention methods to improve patient care and experience. Through CHA and Carrot Health's partnership, it is possible to visualize and highlight the relationship between readmissions and SDoH, and to determine the appropriate guidance for member hospitals seeking improvement in their quality efforts. The goal of this dashboard (Figure 6) was not only to identify patients who have been readmitted within 30 days, but also to identify which SDoH were contributing to overall risk for readmitted patients. Using the Microsoft PowerBI platform, CHA was able to build an interactive dashboard for member hospital use in understanding their specific patient population.
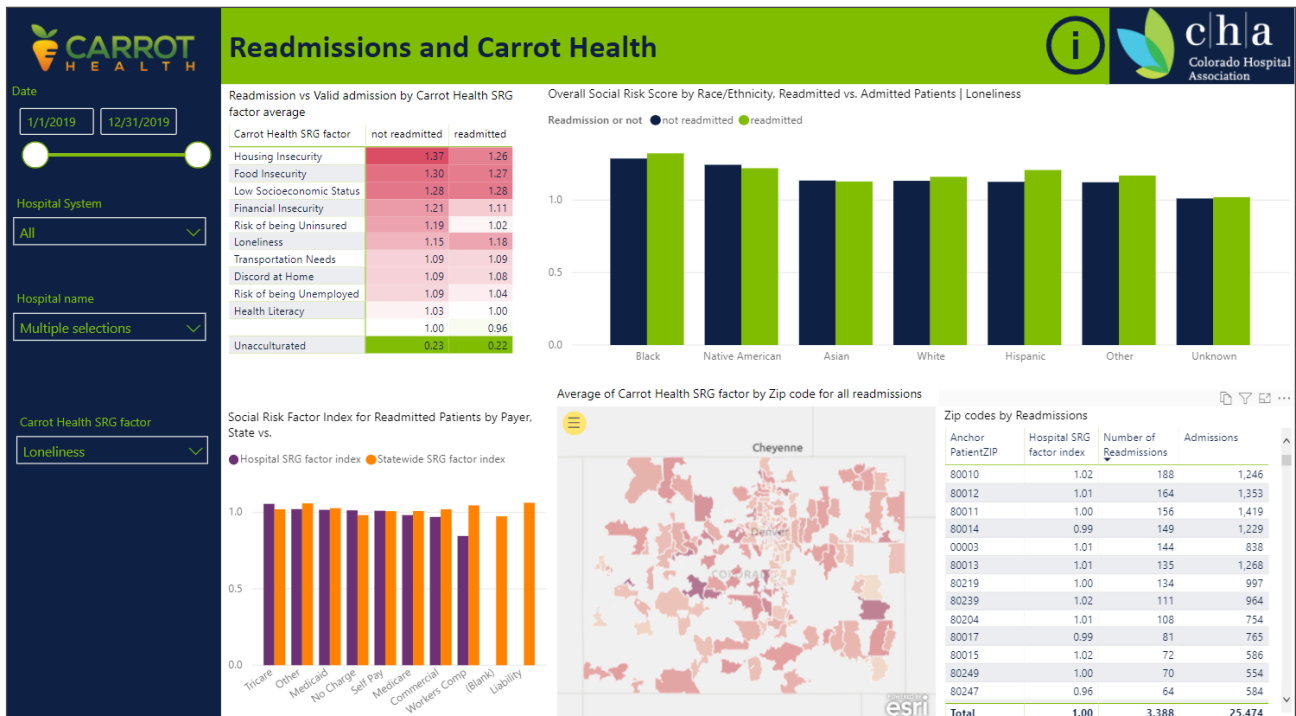
CHA was able to identify areas of increased social risk for these patients by comparing readmitted patients against those not readmitted. This dashboard allows CHA member hospitals and health systems to examine patient populations by ZIP Code, payer, race/ethnicity and Carrot Health's social risk groups and draw insights within each population. Hospitals know their patients best, and by providing the right data tools to members, hospitals can ask the right questions.

For example, utilizing this interactive dashboard allows hospitals to contextualize readmissions through the lens of SDoH. Hospitals can identify their specific service areas and quickly determine by map areas where there is increased social risk (darker red) vs. lower risk (lighter red), as shown in Figure 6. Hospitals can also compare against other hospitals, identify risks by specific geographies, payers, ethnicity and more. Users can then evaluate risk and identify improvement opportunities within their patient population.

Within the context of Colorado's Hospital Transformation Program and Medicaid readmissions, SRG scores can help identify the most exacerbated issues across the state within Medicaid populations. For example, if we select Medicaid and Food Insecurity on the dashboard, we can tell which ZIP Codes and race/ethnic groups are at an increased risk for a negative health outcome due to their social risk group. This granularity allows hospitals to understand their vulnerable patient population and determine appropriate next steps.

With this dashboard, CHA hopes to provide member hospitals the capability to identify an area of focus and allocate appropriate resources to address social risk factors within their own communities. Acknowledging that each hospital and community is unique, each can create their own individualized interventions.

Average of Carrot Health SRG factor by ZIP Code for all readmissions

Readmission vs Valid Admission by Carrot Health SRG Factor Average

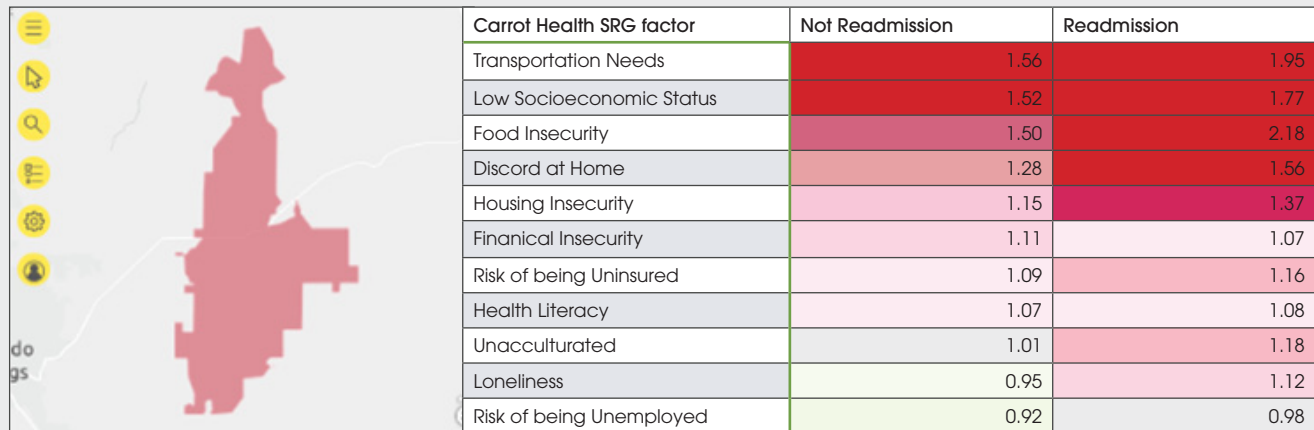| Carrot Health SRG factor	Not Readmission	Readmission
Transportation Needs	1.56	1.95
Low Socioeconomic Status	1.52	1.77
Food Insecurity	1.50	2.18
Discord at Home	1.28	1.56
Housing Insecurity	1.15	1.37
Finanical Insecurity	1.11	1.07
Risk of being Uninsured	1.09	1.16
Health Literacy	1.07	1.08
Unacculturated	1.01	1.18
Loneliness	0.95	1.12
Risk of being Unemployed	0.92	0.98

Figure 7

In Figure 7, we highlight another prevalent example featuring ZIP Code 80808, just outside of Colorado Springs. We can see clearly exacerbated SDoH needs within this community, but through observation of the Readmission vs. Not Readmission populations, we can identify significantly higher social risks. The readmitted population in this ZIP Code have 45% higher food insecurity, 25% higher Transportation Needs Index, and 19% higher housing instability risk.

While community programs addressing transportation needs, food insecurity, and housing would likely benefit many, the process of **obtaining this information at the individual level allows hospitals to strategically prioritize, outreach and impact individuals most at-risk for negative health outcomes due to their SDoH needs within their communities.**

Hospital systems with coverage in this ZIP Code may consider the full breadth of social issues when developing and executing on community outreach initiatives.

SOCIAL DETERMINANTS OF HEALTH: IMPACTS ON UTILIZATION

Looking at individuals or communities in greater detail, data reveals that the SDoH barriers that consumers face in leading their healthiest lives are not evenly distributed. In fact, every individual and each population carry a unique 'fingerprint' of risk.

The impact of this fingerprint on ED utilization and hospital readmission is not uniform. Where one cohort may need food security, another may benefit more from housing stability.

In this analysis, specific subsets of the population were more likely to show a greater correlation and predictive power between social determinants and adverse health outcomes. In this case, younger individuals (aged 18-35), and those not on Medicare insurance plans, are most impacted.

One possible explanation is that social determinants have already manifested into clinical risk and chronic diseases among older consumers on Medicare, and thus highlight lower social risk when compared to younger populations with higher social determinant scores.

Investments in SDoH that reduce the overall SRG risk decrease the likelihood of being an ED super-utilizer. And certain locations and populations in Colorado will see an even larger impact.
This unique fingerprint of risk, applied to an individual and a community, can help identify where the highest opportunity is for intervention, and which efforts will produce the greatest return on investment.

Assessing the risk of a community before investing in a one-size-fits-all intervention can help justify the appropriate investment, and the potential savings opportunity.

At-a-glance: Analyzing for Bias and Health Equity

Carrot Health evaluates every model and analysis for bias and equity. Every dataset is prone to bias, and every result is impacted by race/ethnicity, income, and other factors which create inequity. Therefore, it is important to go beyond population 'averages' and viewing data as a whole, and instead look at it at the individual or community level.

For example, we can see a clear differentiation by racial classification showing the relationship between the SRG factor to admissions and readmission counts in the CHA analysis.

As indicated in Figure 8, Black, Indigenous and people of color (BIPOC) individuals in Colorado face significant barriers to health when compared with white individuals in the same community. In this case, we see significant risk for discord at home, financial insecurity, and most notably, food insecurity. For example, a Black adult with a hospital readmission in the analysis timeframe had a 1.6x risk of food insecurity, compared to the white adult rate of 1.07x. For reference, the state population baseline risk is normed to 1.0.

Incorporating SDoH data models into the risk identification and stratification process at an individual level creates more equity and opportunity for all consumers. Identifying needs, even if not being treated, is particularly important for those who are more vulnerable or disenfranchised.

Addressing food insecurity within these populations, could prevent and reduce hospital readmissions.

Carrot Health SRG factor	Readmitted	Not Readmitted
Discord at Home	1.06	1.06
Asian	1.07	1.12
Black	1.25	1.26
Hispanic	1.28	1.28
Native American	1.23	1.19
Other	1.15	1.16
Unknown	1.08	1.02
White	1.01	0.98
Financial Insecurity	1.09	1.19
Asian	1.21	1.41
Black	1.37	1.49
Hispanic	1.21	1.64
Native American	1.37	1.38
Other	1.45	1.60
Unknown	1.07	1.11
White	0.94	0.98
Food Insecurity	1.23	1.23
Asian	1.17	1.32
Black	1.64	1.66
Hispanic	1.48	1.58
Native American	1.58	1.55
Other	1.52	1.56
Unknown	1.24	1.06
White	1.07	1.03
Health Literacy	1.00	1.02
Asian	0.99	1.05
Black	1.05	1.07
Hispanic	1.03	1.19
Total	1.01	1.04

Figure 8

CREATING SUSTAINABLE IMPACT

This information, available to CHA member hospitals and health systems through the CHA ODHIN data platform, can be utilized to help evaluate the relationship between SDoH and key utilization metrics, and where to strategically apply interventional resources to help curb costs.

More broadly, this process establishes a blueprint for the healthcare industry, showing how it is possible to combine results from consumer behavior and healthcare data to increase the accuracy of risk prediction, and identify appropriate avenues for investment upstream of the healthcare system to reduce the cost of health and improve lives, equitably, for everyone.

For example, Carrot Health worked with a regional health plan, using similar information to help identify, outreach, and address member needs during the COVID-19 pandemic. Using the Carrot MarketView Health module, COVID index and SRG scores, analysis we were able to assess SDoH risk for the entire member population at the individual level. Together we identified 7,676 members for telephone contact and successfully reached 3,226 members (42%). In addition, 2,032 members were provided community navigation to direct meal benefits, and 58 members, identified as high-risk, were enrolled in other programs. Member response and feedback was overwhelmingly positive.

Shining this bright light of data on disparities faced by members in our community will help align investment and shift the burden off the healthcare system. **By identifying the root cause of inequity, we can invest upstream to prevent many of the illnesses from occurring in the first place, allowing people to live their longest, healthiest lives, while making healthcare more affordable for everyone.**

CONCLUSIONS

SDoH factors are driving unnecessary ED visits resulting in higher healthcare costs for communities and patients. As an individual's SRG score rises, so does the risk for ED super-utilization. As hospitals and healthcare organizations aim to improve health and healthcare costs in their communities, then addressing SDoH factors and implementing interventions is critical.

Identifying significantly higher risk populations at the individual level (e.g., ZIP Code) allows hospitals to strategically prioritize, begin outreach and impact individuals most at-risk within their communities.

Understanding and applying the unique fingerprint of risk across patient populations can help identify where optimal intervention opportunities lie, and which efforts will produce the greatest return on investment.

Assessing community risk prior to investing in a one-size-fits-all intervention can help justify the opportunities for appropriate investment and potential savings.

Addressing barriers, such as food insecurity, within at-risk populations can reduce hospital readmissions.

Increasing the accuracy of risk prediction and identifying appropriate intervention opportunities improves lives and reduces the cost of healthcare.

To gain a 360-degree view for each individual in your population and to understand underlying SDoH risks, get in touch with our team!

Contact us at info@carrothealth.com for pricing information or check out our website at CarrotHealth.com for further details.

Colorado Hospital Association