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The Association between Social Vulnerability and Fragmented Readmissions: An Analysis of the Florida State Inpatient Database

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2017

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An abstract of
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Abstract

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By Hiroki Kyo

Research Objective: Fragmented readmissions, when a patient is readmitted to a different hospital than they were originally discharged from, are associated with lower quality of care. The goal of this analysis was to measure the association between the Social Vulnerability Index (SVI), a proxy for social determinants of health, and interhospital care fragmentation.
Study Design: This was a cross-sectional study of the Healthcare Cost and Utilization Project's State Inpatient Database for Florida in 2018. We fit unadjusted and adjusted logistic regressions to determine the association between SVI quartiles and the odds of a fragmented readmission.
Population Studied: All patients 18 years and older with one or more readmissions in the year.
Principal Findings: There were 759,371 readmissions, of which 34% were fragmented. Compared with patients who were the least socially vulnerable (SVI in the lowest quartile), patients who were the most socially vulnerable were 7.0% more likely to have a fragmented readmission (AOR 1.07, 95% CI 1.06, 1.09) after adjusting for patient demographics and social characteristics. Patients in the second most vulnerable group had a 16% increased odds (AOR 1.16, 95% CI 1.14, 1.18), and patients in the second least vulnerable group had a 25% increased odds (AOR 1.25, 95% CI 1.23, 1.26). Sensitivity analyses using sub-components of the CDC's SVI as the exposure variables, such as minority status, language proficiency, and access to transportation being significant factors, revealed that the most socially vulnerable group had the highest increase in the odds of a fragmented readmission.
Conclusions: The results indicated that, when using the composite SVI score as the exposure, the second least socially vulnerable group had the largest increase in the odds of a fragmented readmission, followed by the second most socially vulnerable group. Sensitivity analyses showed that specific social vulnerability components, such as minority status, language, and transportation had the linear effects on the odds of fragmented readmissions.
Implications for Policy or Practice: Further examination of which social determinants of health and components of the SVI score are associated with fragmented readmissions are necessary to optimize care for all.

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Introduction

Healthcare in the United States continues to face significant challenges related to access, quality, and disparities in outcomes. Social vulnerability, defined as the susceptibility of specific populations to adverse health outcomes due to underlying social, economic, and environmental factors, has been identified as a critical contributor to these disparities.[1] One aspect of healthcare that may be particularly impacted by social vulnerability is care fragmentation, which occurs when patients have uncoordinated care spread across different providers or settings of care. Fragmented care has been linked to longer average length of stay, increased healthcare costs, increased in-hospital mortality, and a higher risk of future readmissions.[2,3,4,5] Kaltenborn and colleagues also reported that care fragmentation was more common among vulnerable populations, including those who were admitted for chronic disease management, psychiatric illness, and substance abuse.[6] In this study, a fragmented readmission or interhospital fragmentation was defined when a patient was readmitted to a different hospital than the one they were previously discharged from.

Despite extensive research on the association between social vulnerability and healthcare disparities[7,8,9] little is known about the association between social vulnerability and care

fragmentation. The Centers for Disease Control and Prevention's (CDC) Social Vulnerability Index (SVI) is a composite measure of social vulnerability that incorporates indicators of socioeconomic status, race/ethnicity, housing and transportation, and healthcare access.[10] The original SVI's motivation was to identify communities at risk for poor outcomes following natural disasters in order to effectively direct aid resources,[11] but it has since been widely applied as a proxy for social determinants of health.[12,13,14]

The goal of this study is to assess the association between social vulnerability and fragmented readmissions. The findings from this research have the potential to inform policies and interventions aimed at reducing care fragmentation and improving health outcomes for vulnerable patients.

Methods

Data Sources

This was a cross-sectional study of the Agency for Healthcare Research and Quality (AHRQ) Healthcare Cost and Utilization Project's (HCUP) 2018 Florida State Inpatient Database (SID). Each year of the SID contains information on all nonfederal discharges in a

single state, and contains clinical and nonclinical information related to a patient's hospitalization, including patient demographics, insurance payer, hospital characteristics, admission and discharge status, and diagnoses and procedures[15] While the unit of observation in the SID is a hospital discharge, several SIDs, including Florida, have a variable that allows researchers to link patient admissions and readmissions within the dataset. We used a single year as the readmissions across years and states cannot be linked to SID data of other years or states.

CDC's Social Vulnerability Index (SVI) is a composite measure of social vulnerability that incorporates indicators of socioeconomic status, race/ethnicity, housing, transportation, and healthcare access.[10] The SVI has been validated as a predictive measure of fatalities and property damages after natural disasters[16], but its applications have been expanded to include its use as a proxy for social determinants of health.[12,13,14,17] The SVI is publicly available from the CDC's Agency for Toxic Substances and Disease Registry (ATSDR)[18] Geographic information used in all statistical analyses was based on patient zip codes identified in the Florida SID, which were linked via crosswalk files to census tracts used by the SVI.

Patients

The analysis included all patients with a hospitalization and subsequent readmission. Observations with missing dates of admission, readmission, or missing hospital IDs were excluded. Hospital-to-hospital transfers were excluded to focus our analysis on fragmented readmissions that were unplanned.

Primary Exposure: SVI Score

The SVI categorizes 15 metrics of social vulnerability taken at the census level into four broad categories: socioeconomic status, household composition/disability, minority status/language, housing/transportation (Table 1). SVI data were collected at the census-tract level according to the 2000 Census. Then, percentile ranks of each of the 15 metrics for a census tract were calculated to show the relative vulnerability of a location within the United States compared to all census tracts. For example, if a tract is in the 90th percentile for the "Minority Status and Language" metric, it means that 90% of census tracts in the United States have lower SVI scores than this location for this specific metric. In other words, this location is more socially vulnerable than 90% of the census tracts in the United States for the "Minority Status and Language" metric.

Finally, percentile ranks were summed across all 15 variables for each census tract, resulting in the overall SVI ranking percentile, a score between 0 and 100. In general, a lower SVI score represents lower social vulnerability (Figure 1). Using the overall SVI ranking percentile, the SVI scores of admission-readmission pairs were categorized into quartiles to generate a categorical predictor variable: the 0-25th SVI percentiles (the least socially vulnerable), the 25th-50th SVI percentiles (the second least socially vulnerable), the 50th-75th SVI percentiles (the second most socially vulnerable), and the 75th-100th SVI percentiles (the most socially vulnerable).

Primary Outcome: Fragmented Readmissions

The main outcome of interest was the odds of a fragmented readmission. A fragmented readmission was defined as a readmission to a hospital different from the hospital of the initial admission. Each hospital in the SID has an AHA-specific identifier; if the hospital identifiers were different between two hospitalizations, the readmission was coded as fragmented.

Covariates

Several patient-level covariates were included. These included age, sex, race, homelessness status, the expected primary payer (Medicare, Medicaid, private insurance, etc.), whether the admission was classified as an emergency, urgent, elective, or for trauma, and the zip code income quartile for the patient's zip code. HCUP determines the zip code income quartile by estimating the median household income for the state by using zip Code demographic data. The assignment of estimated income for an observation is based on the median income of the patient's zip Code. The quartiles are identified by values of 1st (lowest median income) to 4th quartile (highest median income). Additionally, the urban-rural status of the patient's zip code was measured based on Core-Based Statistical Areas (CBSA). CBSA partitions counties into three categories: Metropolitan, Micropolitan, and Outside CBSA. Counties with cities or urbanized areas of over 50,000 residents are classified as Metropolitan, while counties with urban areas of 10,000 to 49,999 residents are classified as Micropolitan. Outlying counties are added to one of these urban classes when they are adjacent and when at least 25 percent of their resident labor force commutes to them.

Analytic Approach

First, we identified how patient demographic characteristics and socioeconomic status varied across SVI quartile groups by using chi-square and one-way ANOVA. For the main analyses, we fit unadjusted and adjusted logistic regression models to compare the association between SVI quartiles and the odds of a fragmented readmission using the least socially vulnerable group (0^{th}-25^{th} SVI percentile) as the reference. Adjusted models included several potential confounders of the fragmentation-outcome relationship available in the SVI. We first adjusted demographic (age, sex, race, payer) covariates and then added in social factors (homelessness, income, admission type when hospitalization, location type) as variables to establish fully-adjusted models.

Sensitivity Analyses

To test the robustness of our findings, we conducted severed sensitivity analyses. First, we stratified the analysis by patient insurance status (Medicaid, Medicare, and Private payers), admission type (Emergency or Elective), and diagnosis of sepsis (based on DRG). By stratifying the data based on insurance status, we expected to identify any potential disparities or differences in disease outcomes among patients with different types of insurance which could provide

insight into potential barriers to accessing healthcare services. By stratifying the analysis by emergency versus elective admission type, we can discern if the relationship between SVI and fragmented readmissions differs across readmission type, as there is some evidence that ambulance use is associated with fragmented readmissions, and ambulance use may be more common in emergency admissions.[19] By examining sepsis readmissions, we can begin to identify whether the odds of a fragmented readmission is affected by the clinical characteristics of the specific diagnosis.

We then conducted a sensitivity analysis where we used select granular components from SVI categories as the exposure, rather than the overall SVI score. The selected SVI components were "Unemployment" from Category 1: Socioeconomic status, "Single parent households" from Category 2: Household Composition/Disability, "Speak English 'less than well,'" and "Minority" from Category 3: Minority Status/Language, and "No vehicles" from Category 4: Housing/Transportation. This was done to investigate if specific SVI components were more or less strongly associated with the outcome of fragmented readmissions than the overall SVI score.

All analyses were performed using SAS, version 9.1.3. (SAS Institute Inc., Cary, NC, USA). Two-

tailed p-values less than 0.05 were considered statistically significant. This study was deemed exempt from review by the Emory University Institutional Review Board.

Results

Sample Development & Descriptive Analysis

The Florida SID contains 2,855,604 discharges; after creating admission-readmission pairs, 1,516,918 pairs remained. After removing admissions and readmissions with missing dates and/or missing hospital ID numbers, 759,371 admission-readmission pairs remained in the final analytic sample (Figure 2).

Table 2 includes descriptive statistics of the admission-readmission pairs as well as the distribution of SVI percentiles. The mean age was 62.3 years old, and 51.2% of admission-readmission pairs were for patients 65 years old or older. 64.9% (n=490,545) of admission-readmission pairs were for white patients, 18.5% (n=140,191) were for Black patients, and 14.4% (n=109,056) were for Hispanic patients ($p<0.0001$). The zip codes associated with 24.3% of readmissions for Black patients and 20.9% of readmissions for Hispanic patients were

categorized into the most socially vulnerable group, while 52.5% of zip codes for white patients were categorized into the most vulnerable group ($p<0.0001$).

When the primary payer was Medicaid, more patients' readmissions were in the higher SVI/more socially vulnerable categories (distributed 17.1%, 13.7%, 11. 1%, and 11.6% from the most vulnerable to the least vulnerable, $p<0.0001$). Although 1.0% of admission-readmission pairs were identified as homeless in the least socially vulnerable group, 1.7% of pairs were homeless in the most socially vulnerable group ($p<0.0001$). SVI scores tracked closely with zip income quartile: in the lowest income zip codes, 40.9% of admission-readmission pairs were in the most vulnerable SVI group (vs. 28.9% in the least vulnerable group, $p<0.0001$), and in the highest income areas, 21.9%of admission-readmission pairs were in the least vulnerable group (vs. 14.4% in the most vulnerable group, $p<0.0001$).

Main Analysis

Overall, 34.0 % of readmissions were fragmented. In unadjusted models, readmissions in the second least socially vulnerable group had a 24% increase in the odds of fragmented readmission (AOR 1.24, 95% CI 1.23-1.26). Pairs in the most socially vulnerable group, on the

other hand, had a 9% increased odds of a fragmented readmission (AOR 1.09, 95% CI 1.08-1.10). Pairs in the second most socially vulnerable group had a 17% higher odds of a fragmented readmission (AOR 1.17, 95% CI 1.15-1.19) compared to the least socially vulnerable group. In models adjusting for patient demographic and social characteristics, compared to readmissions in the least socially vulnerable group, readmissions in the second least socially vulnerable group had a 25% higher odds of fragmented readmission (AOR 1.25, 95% CI 1.23-1.26), while pairs in the most socially vulnerable group had a 7% higher odds of a fragmented readmission (AOR 1.07, 95% CI 1.06-1.09). Pairs in the second most socially vulnerable group had a 16% higher in the odds of a fragmented readmission (AOR 1.16, 95% CI 1.14-1.18) compared to the least socially vulnerable group (Table 3).

Sensitivity analysis

Analyses stratified by insurance payer had similar results to the main analysis, with admission-readmission pairs in the second least socially vulnerable group having the greatest odds of a fragmented readmission (Table 4). When the analyses were stratified by readmission type, the most socially vulnerable group had a 10% lower odds of a fragmented readmission for

elective hospitalization (AOR 0.90, 95% CI 0.87-0.93) compared to the least socially vulnerable group. Conversely, when readmissions limited to those for sepsis, the most socially vulnerable group had the highest increase in the odds of fragmented readmissions (AOR 1.23, 95% CI 1.16-1.31).

When specific SVI components were used as the exposure, the results were similar to the main analysis for unemployment and single parent household statuses (Table 5). However, when "speaks English 'less than well'" was used as the exposure, the largest odds of a fragmented readmission was observed in the most socially vulnerable group (AOR 1.24, 95% CI 1.22-1.26) compared to the least socially vulnerable group; the second least socially vulnerable group had a 5% lower odds of a fragmented readmission (AOR 0.95, 95% CI 0.94-0.96) compared to the least socially vulnerable group. In addition to this result, when exposures were "Minority" and "No Vehicle", the most socially vulnerable group had the highest increase in the odds of a fragmented readmission. The pair which belong to minority groups had largest increase of 8% in the odds of a fragmented readmission (AOR 1.08, 95% CI 1.07-1.1), and the pairs with no access to vehicles had largest increase in the odds of a fragmented readmission, 5% (AOR 1.05, 95% CI 1.03-1.6) compared to the least socially vulnerable group (Table 5).

Additional results of sensitivity analysis indicate that readmissions in the most socially vulnerable group of households with no vehicle available were more likely to experience fragmented care, as evidenced by a higher odds (AOR 1.05, 95% CI 1.033, 1.061) after adjusting for various demographic and clinical factors. The OR for care fragmentation was found to be the smallest in the second least vulnerable group (AOR 0.92, 95% CI 0.907, 0.934), which was in contrast to the previous analysis of the SVI overall score. (Table 5)

Similar trends were observed for the variables "Speak English 'less than well'" and "Minority", where readmissions in the most socially vulnerable group had the highest increase in odds of a fragmented readmission (AOR 1.27, 95% CI 1.222, 1.258), and the 2nd least vulnerable group had a decrease in the odds of a fragmented readmission (AOR 0.95, 95% CI 0.938, 0.963). (Table 5)

Conversely, when utilizing the variable "Single parent households," which reflects the parent status of households, no clear trend of fragmentation was detected between groups other than the result that the least vulnerable group was the least likely experience fragmented care. (Table 5)

Discussion

This analysis of the relationship between social vulnerability and the odds of a fragmented readmission in Florida found an unexpected result—that while in general, social vulnerability was associated with higher odds of fragmented readmission, it wasn't the most socially vulnerable group that had the largest odds. Rather, the second least socially vulnerable group had the largest odds, followed by the second most socially vulnerable group.

There are several potential reasons for these findings. First, they may be reflective of the nature of social support in the United States, e.g., that many policies and programs designed to address components of social vulnerability are means-tested. The implication here is that perhaps patients in the most socially vulnerable group have access to government-provided support that lead to fewer fragmented readmissions that patients in the middle quartiles of social vulnerability do not have access to because they are not "vulnerable enough." Because this was a single-state analysis in a single year, we cannot test the impact of policies such as Medicaid expansion on the association between social vulnerability and fragmented readmissions. Another potential reason for these findings is that specific components of the SVI may be more strongly associated with increased odds of fragmented readmissions than others, and by using the

composite SVI score, we may be masking the differential effects of individual SVI components. This is reflected in the findings of our sensitivity analyses where we used individual SVI components as the exposure in our regression models. Individual SVI components such as "car ownership" and "language fluency," which are both directly tied to access to care[20,21], showed trends that are more in line with our expected outcomes—that the odds of fragmented readmissions would be higher along with more social vulnerability. These results highlight an important finding of this analysis—that not all SVI components influence health outcomes equally. Future studies should disaggregate the SVI into specific indicators within the SVI, to avoid missing trends that are masked by the composite score.

While care fragmentation is generally associated with negative outcomes,[2,3,4,5] there may be situations where it is necessary, unavoidable, or even potentially beneficial. For example, in complex medical cases that require specialized care from multiple providers, having care shared across providers may benefit the patient. Additionally, some patients might prefer to receive care from different providers or in different settings, which can also lead to fragmentation of care. We attempted to investigate this by stratifying the analysis by emergency versus elective admission type, which showed that, among the second least socially vulnerable

group, there was a 25% increased odds of fragmentation for emergency admissions and a 65% increased odds of fragmentation in elective readmissions (emergency AOR 1.25, 95% CI; elective AOR 1.65, 95% CI). This may be reflective of the patients' decision to seek care at a different hospital based on their preferences. In the case of vulnerable populations, care fragmentation may be expected be more common among both emergency and elective readmissions. Further analyses are needed to assess the relationship between care fragmentation and specific types of admission across different groups of patients.

This analysis has several limitations. As the study utilized a cross-sectional design, it is not possible to establish a causal relationship between SVI and the odds of a fragmented readmission. The arbitrarily-defined quantile group also might influence our results since we divided the overall SVI or its components based on their percentiles and used it as a categorical predictor variable. Additionally, fragmented readmissions are driven by numerous patient-, hospital-, and healthcare system-level factors, many of which were not included in the data. The results may also not reflect the true social vulnerability of individuals (ecological fallacy) since the SVI is a population level estimate.

Overall, this study revealed that social vulnerability is associated with fragmented readmissions, a previously unexamined relationship. However, the unexpected trend of the findings, with individuals in the middle quartiles of social vulnerability having the highest odds of a fragmented readmission, indicates a need for further examination of which social determinants of health and components of the SVI score are associated with fragmented readmissions in order to optimize care for all.

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