Examining How Social Risk Factors Are Integrated Into Clinical Settings Using Existing Data: A Scoping Review

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ABSTRACT

PURPOSE Integrating social care into clinical care requires substantial resources. Use of existing data through a geographic information system (GIS) has the potential to support efficient and effective integration of social care into clinical settings. We conducted a scoping literature review characterizing its use in primary care settings to identify and address social risk factors.

METHODS In December 2018, we searched 2 databases and extracted structured data for eligible articles that (1) described the use of GIS in clinical settings to identify and/or intervene on social risks, (2) were published between December 2013 and December 2018, and (3) were based in the United States. Additional studies were identified by examining references.

RESULTS Of the 5,574 articles included for review, 18 met study eligibility criteria: 14 (78%) were descriptive studies, 3 (17%) tested an intervention, and 1 (6%) was a theoretical report. All studies used GIS to identify social risks (increase awareness); 3 studies (17%) described interventions to address social risks, primarily by identifying relevant community resources and aligning clinical services to patients' needs.

CONCLUSIONS Most studies describe associations between GIS and population health outcomes; however, there is a paucity of literature regarding GIS use to identify and address social risk factors in clinical settings. GIS technology may assist health systems seeking to address population health outcomes through alignment and advocacy; its current application in clinical care delivery is infrequent and largely limited to referring patients to local community resources.

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INTRODUCTION

There is increasing recognition of potential roles that health care delivery systems can play to identify and address social determinants of health—the social, economic, and environmental factors that influences a person's physical and mental well-being—within clinical care. This approach of identifying adverse social determinants of health affecting an individual, or social risk factors, is often referred to as social care (Table 1).[1,2] In 2019, the National Academies of Sciences, Engineering, and Medicine (the National Academies) issued a report, *Integrating Social Care Into the Delivery of Health Care*, that recommends 5 activities to address social needs: awareness, adjustment, assistance, alignment, and advocacy (Table 2).[1]

Integrating social care into health care delivery faces considerable implementation barriers, including time constraints, inadequate or untrained staff, and lack of knowledge about available social resources.[3,4] Leveraging existing health data and digital tools represents a potential strategy to overcome these barriers.[1] One example of such a resource is the geographic information system (GIS), a computer system designed for gathering, storing, managing, analyzing, and mapping geographic health data. Examples of potential relevant GIS data include maps of social services or green spaces relative to an individual patient's residence, or maps examining mortality rates for chronic diseases among panels of patients by neighborhood. Although GIS has potential to integrate social care into the clinical setting, there is little prior research using it in clinical settings to identify and intervene on social risk factors. Our objective for this scoping review was to identify best practices for the use of GIS within clinical contexts to identify and address social risk factors classified according to the National Academies' 5 social care integration activities.

METHODS

Study Design

We performed a literature review following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension for Scoping Reviews (PRISMA-ScR) guidelines.[5] We selected search terms using (1) search terms used in a prior, related research article,[6] (2) terminology recommended by experts in social determinants of health (M.S.G., S.D.P., M.J.O), in GIS (A.J.C.), and in library sciences (J.P.), and (3) medical subject headings and key phrases from formative references. We also ensured interrater reliability between reviewers, reviewed titles and abstracts for eligibility, finalized sources, and extracted data. A scoping synthesis was conducted, rather than a meta-analysis, because we anticipated a lack of consistent effect size. The final protocol was registered prospectively with the Northwestern University Institutional Review Board as an exempt study.

We conducted an initial literature search in December 2018. A team of medical librarians and researchers identified EMBASE and PubMed as the 2 key databases that would yield the most comprehensive list of sources in the preceding 5 years. After reviewing formative articles, including a comprehensive review by Davenhall and Kinabrew,[7] we chose 5 years as the cutoff to identify the most contemporary approaches to integrating GIS approaches within the clinical care setting. Our final search results were exported into EndNote X8 (Clarivate Analytics) and duplicates were removed. The resulting search strategy for EMBASE can be found in Supplemental Appendix 1. In addition to performing electronic searches, we identified relevant articles from the references section of the included articles during the data extraction processes and reviewed them for eligibility.

Eligibility Criteria

To be included in our review, articles needed to (1) incorporate geospatial data or GIS programs, (2) use GIS to identify and/or address social risks, (3) describe GIS use with clear clinical applications, (4) describe work based in the United States, and (5) be written in English. Articles were excluded if they (1) were published before December 2013, (2) did not use GIS, or (3) reported studies that did not occur within a primary care clinical system or could not be applied to a primary care setting (Supplemental Appendix 2).

Article Selection

We uploaded all retrieved abstracts to Rayyan (Qatar Computing Research Institute), a reference management software program used to conduct systematic reviews, and screened them

Table 1. Key Terms Related to the Integration of Social Care Into the Delivery of Health Care

Term	Definition
Social determinants of health	The conditions in which people are born, grow, work, live, and age that affect a wide range of health, functional, and quality of life outcomes and risks
Social risk factors	Social determinants that may be associated with negative health outcomes, such as poor housing or unstable social relationships
Social needs	A patient-centered concept that incorporates a person's perception of his or her own health-related needs
Social care	Activities that address health-related social risk factors and social needs
Social services	Servs ices, uch as housing, food, and education, provided by government and private, profit, and nonprofit organizations for the benefit of the community and to promote social well-being

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Table 2. Activities for Integrating Social Care Into the Delivery of Health Care

Activity	Definition	Transportation-Related Example
Awareness	Activities that identify the social risks and assets of defined patients and populations; the foundation on which all other activities are built	Ask people about their access to transportation
Adjustment	Activities that focus on altering clinical care to accommodate identified social barriers	Reduce the need for in-person health care appointments by using other options such as telehealth appointments
Assistance	Activities that reduce social risk by providing assistance in connecting patients with relevant social care resources	Provide transportation vouchers so that patients can travel to health care appointments; vouchers can be used for ride-sharing services or public transit
Alignment	Activities undertaken by health care systems to understand existing social care assets in the community, organize them to facilitate synergies, and invest in and deploy them to positively affect health outcomes	Invest in community ride-sharing or time-bank programs
Advocacy	Activities whereby health care organizations work with partner social care organizations to promote policies that facilitate the creation and redeployment of assets or resources to address health and social needs	Work to promote policies that fundamentally change the transportation infrastructure within the community

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for duplicates. De-duplicated citations were retrieved for full-text review and reviewed again for inclusion criteria by pairs, and discrepancies were adjudicated by a separate reviewer.

Data Extraction

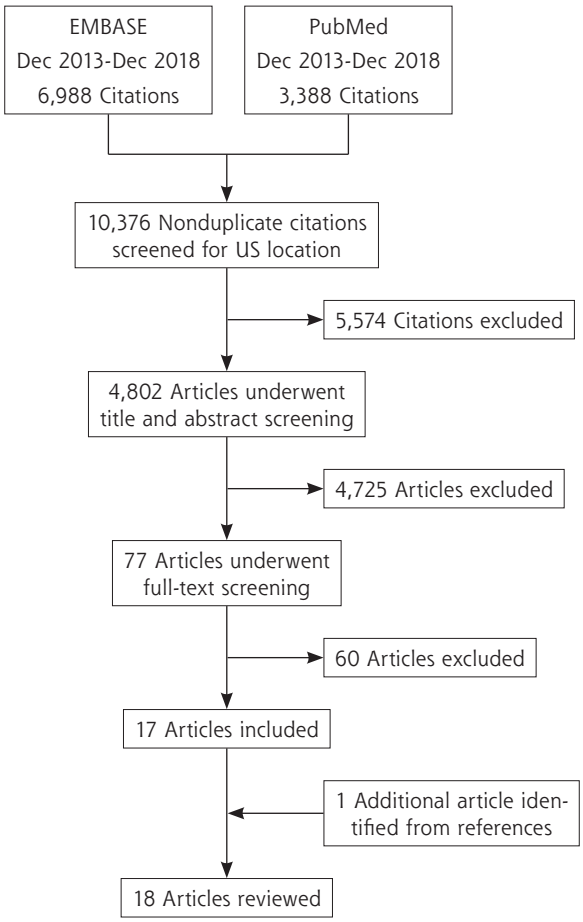
We developed a standardized data extraction form that was pilot-tested, revised, and applied to all eligible articles (Supplemental Appendix 3). We extracted data for the following domains: study characteristics, health care delivery setting, GIS approach, social risk domains, interventions, and outcomes. Study characteristics included whether the study was a theoretical report (eg, a perspective piece about how GIS can be used), descriptive (eg, describing how GIS was used), or intervention based (eg, GIS was used in an intervention; authors reported outcomes or evaluations).

RESULTS

Article Selection

A total of 6,988 and 3,388 citations were retrieved from EMBASE and PubMed, respectively (Figure 1). Of these, 5,574 citations (53.7%) were of US origin and underwent additional review. After title and abstract review, 77 abstracts (1.4%) were deemed eligible for full-text review. Final full-text review determined that 17 studies (22.1%) met all eligibility criteria for data extraction.[4,8-23] An additional 11 articles were identified from reference sections, of which 1 met the inclusion criteria for full-text review.[24] This process yielded a total of 18 articles eligible for data extraction.

Figure 1. Summary of the literature search and review process.



Article Characteristics

Table 3 summarizes the characteristics of the 18 articles reviewed and the studies they describe. Of the 18 articles, 14 (78%) were descriptive studies,[4,8,11-16,18-23,25-30] 3 (17%) reported an intervention,[10,17,24,31,32] and 1 (6%) was a theoretical report.[9] Seven articles (39%) were published between 2013 and 2015,[8-12,16,20] while the remaining articles (61%) were published between 2016 and 2018.[4,13-15,17-19,21-31,33] Sixteen articles (89%) specified the timeline in which GIS data were captured.[8,10-24] Of these 16 articles, 14 (88%) examined data collected within the past 10 years before publication[8,10-12,14,16-24] and 2 (13%) examined data from the past 11 to 20 years.[13,15] The clinical setting varied across studies.

Data Sources and GIS Methodologies

A wide range of social risk data were collected in each of the 18 studies, including those for sociodemographic characteristics, depression, financial resource strain, social isolation, and intimate partner violence (Table 4). The majority of studies (12, 67%) extracted data from the US Census and from

Table 3. Article Characteristics (N = 18)

Characteristic	Articles, No. (%)
Type	
Descriptive study	14 (78)
Intervention-based study	3 (17)
Theoretical report	1 (6)
Publication date	
2013-2015	7 (39)
2016-2018	11 (61)
Recency of data collection	
Last 10 years (2003-2013)	14 (78)
Last 11-20 years (1993-2013)	2 (11)
Clinical setting	
Internal medicine	4 (22)
Family medicine	3 (17)
OB/GYN	3 (17)
Pediatrics	4 (22)
Other	10 (56)
Outcomes reported?	
Yes	3 (17)
No	15 (83)

GYN = gynecology; OB = obstetrics.

sources categorized as "other" (9, 50%) to identify and address social needs, respectively.

Methods by which GIS was used to integrate social care into the clinical setting varied (Table 5). In several studies, patient addresses and health data from electronic health records (EHRs) were converted into neighborhood-level density maps for spatial analyses/visualization of social risk factors. A majority of studies derived data sets using geocoding efforts, a process whereby home addresses, EHR data, and data from publicly available resources are converted into geographic coordinates, typically to the level of a county, ZIP code, or census tract.

Table 4. Studies' Collection of SDOH Data and Use of Data Sources to Identify and Address Social Needs (N = 18)

Aspect of Data Collection	Studies Identifying Social Needs, No. (%)	Studies Addressing Social Needs, No. (%)
SDOH data collected		
Demographics	13 (72)	5 (28)
Household income	7 (39)	1 (6)
Health insurance status	2 (11)	1 (6)
Tobacco use and exposure	1 (6)	0 (0)
Depression	2 (11)	0 (0)
Education and learning	3 (17)	1 (6)
Financial resource strain	1 (6)	0 (0)
Intimate partner violence	0 (0)	1 (6)
Physical activity	3 (17)	1 (6)
Social connections and social isolation	2 (11)	0 (0)
Other	11 (61)	15 (83)
Personnel responsible for eliciting SDOH data		
Data analyst	8 (44)	2 (11)
Medical residents	1 (6)	2 (11)
Registered nurses	0 (0)	1 (6)
Social workers	2 (11)	2 (11)
Other	10 (56)	13 (72)
Data sources used		
Census data	12 (67)	6 (28)
Community-level data	6 (33)	2 (11)
Table surveys	1 (6)	1 (6)
Paper questionnaire methods	4 (22)	4 (22)
In-person interviews	2 (11)	2 (11)
Other	7 (39)	9 (50)
Were GIS or geospatial data used?		
Yes	15 (83)	3 (17)
No	3 (17)	15 (83)

GIS = geographic information systems; SDOH = social determinants of health.

Social Care Integration Activities

We identified articles exemplifying each of the 5 social care integration activities with the exception of adjustment; findings are detailed below. All 18 articles described using GIS and geospatial data to bring awareness to social risk factors in the clinical setting. Summaries of each article are included in Supplemental Table 1.

Awareness

One study sought to better understand the relationship between maternal morbidity, birth outcomes, and social risk factors associated with neighborhood characteristics—mainly poverty and crime.[22] Using individual-level birth certificate data linked to neighborhood-level data from the US Census Bureau's American Community Survey, the study team (1) generated visual representations of maternal and infant health metrics in the 19 neighborhoods they examined and (2) learned more about maternal health and birth outcomes based on the neighborhoods where mothers lived. These methods helped to raise awareness about local health needs and assess maternal and infant health in a racially segregated and understudied city.

Assistance

One article described an intervention at an inpatient pediatric unit. Using existing knowledge about social needs among local communities, researchers developed and implemented a neighborhood-focused resident curriculum (the Geomedicine Curriculum) to promote sharing of neighborhood-specific advice during clinical visits.[17] Thirty-minute group teaching sessions focused on helping trainees address (1) resolving housing problems, (2) obtaining healthy food, (3) locating safe places to play, (4) locating pharmacies, and (5) assisting families with transportation. The curriculum included interactive module presentations consisting of didactics, simulations, discussions, and other online learning activities and games, rather than any individual online system dedicated to linking patients to community resources. This method was used to teach pediatric residents ways to provide assistance in connecting patients with relevant neighborhood resources.[17,24]

Alignment

In one descriptive study, researchers used EHR data to determine optimal locations for offering telehealth services.[21] By geocoding individual-level EHR data of patients seeking care at a developmental pediatrics clinic, the authors calculated average travel distance for 18 possible telehealth sites, thereby aligning the placement of health care resources with community needs.

Advocacy

In one descriptive study, researchers created a series of hot-spot density maps to identify areas of health disparities, inform community engagement and advocacy efforts around health disparities in North Central Florida, and deploy mobile outreach clinics in neighborhoods with the greatest needs.[12] Maps were created to specifically visualize spatial trends in juvenile justice referrals, Medicaid births, teen births, low birthweight, domestic violence incidents, child maltreatment reports, and unexcused school absences. Descriptive statistics and geocoded birth data were obtained from publicly available national, state, and local data systems, including the US Census Bureau, and from the Florida Department of Health, respectively. Finally, hot-spot density maps were widely distributed for the purpose of community engagement, resulting in increased advocacy efforts, new public-private partnerships, a new family resource center, and a mobile clinic.[12]

Potential Clinical Outcomes

Few studies reported clinical outcomes related to using GIS tools for mitigating social risk factors.[17,24] One reported that trainees in the Geomedicine Curriculum reported increased competency in providing neighborhood-specific information to patients. Another demonstrated that families perceived resident recommendations on local resources helpful.[17] Several studies suggested potential clinical and health outcomes from the use of GIS tools and EHRs to achieve social health integration[11,14,17,24]; however, most did not directly observe or measure these outcomes.

DISCUSSION

To our knowledge, this is the first review to describe the use of GIS data to identify and address social risk factors within health care delivery systems. The findings of this scoping review indicate a paucity of published research using GIS within clinical care settings, as demonstrated by our identifying of only 18 studies for inclusion in our review. Primary use of GIS has largely focused on health system–level interventions, such as increasing awareness of social risk factors or aligning health care services with community needs and resources. Fewer studies promoted the use of GIS to support advocacy activities. In contrast, use of this technology at the point of care has been minimal; we found that the greatest use of GIS at the individual patient level was connecting patients to relevant local social care resources.

Implications

Our review highlights the lack of evidence describing the effectiveness of leveraging GIS use in clinical practice to improve outcomes. Although many studies included in this review describe the potential for GIS to increase awareness of social risks, adjust clinical plans, assist with linkages to community services, align clinical and community services with patient needs, and enhance advocacy efforts, none have measured these effects directly. Without robust outcome evaluations in the literature, best practices in this area remain elusive.

Some studies currently underway, however, have the potential to provide such evidence. OCHIN, originally known as the Oregon Community Health Information Network, is a nonprofit health center–controlled network that hosts and manages an Epic EHR (Epic Systems Corp) for 440 primary care community health centers across 18 states. Guided by the National Academies' recommendations for integrating social determinants of health into EHRs, OCHIN and collaborators developed a conceptual framework that integrates point-of-care data (for individual patient care) and geocoded community-level social determinants of health data (for populations of patients) from publicly available sources into primary care workflows to subsequently trigger automated support and action responses from care teams.[34] These responses include referrals to social services, patient engagement, and clinical and social services coordination. This ongoing initiative will also explore how to efficiently and effectively leverage geospatial data while incorporating them into EHR interfaces for use in panel management or at the point of care. It will also directly evaluate the impact of such efforts on patient experiences, population health outcomes, and health care costs.[34]

Table 5. Studies' Use of GIS Methodologies for Each Integration Activity

GIS Methodology	Awareness	Adjustment	Assistance	Alignment	Advocacy
Geocoded (or obtained geocoded) data from publicly available resources	Yes[4,12]	No	No	Yes[12]	Yes[12]
Geocoded (or obtained geocoded) data and aggregated patients' residency addresses to census data	Yes[10-16,18,19,21-23]	No	No	Yes[12,22]	Yes[12]
Used GIS tools for spatial visualization of EHR and publicly available data	Yes[8,10,12,13,18-23]	No	No	No	No
Created a geospatial data repository of neighborhood-specific online resources	Yes[17,24]	No	Yes[17,24]	No	No
Used data analysts to elicit SDOH data	Yes[4,13-15,17,18,22-24]	No	No	No	No
Engaged social workers to elicit SDOH data	Yes[8]	No	No	No	No

EHR = electronic health record; GIS = geographic information systems; SDOH = social determinants of health.

The studies we reviewed also mentioned potential challenges to adopting GIS technologies to support social care integration activities in the clinical setting: technical challenges, cost, large time investment, difficulty scaling approaches, need for highly trained personnel, and confidentiality concerns.[4,8,17,21,24] For example, adopting GIS in clinics would require specialized personnel who would be able to link relevant EHR data to a GIS program, and patient outreach efforts would need to be coordinated by those with appropriate clinical skills.[20] Clinical workforces are rarely trained or incentivized to implement these efforts in their everyday practices.[1] Furthermore, home addresses that are manually entered in the EHR may be incomplete, inaccurate, or outdated, leading to information gaps and the misidentification of individuals living in areas with a high prevalence of social risk factors.

From a medical education perspective, use of GIS technologies necessitates an assessment of and investment in physicians' knowledge, attitudes, and skills related to using geospatial data to address patients' social risks at the point of care. Studies that have implemented a neighborhood-based curriculum to enhance these skills among primary care residents identified a need for additional research to inform effective neighborhood-based recommendations to families in busy clinical settings.[17,24] Lastly, transporting EHR data from health care systems to GIS programs requires additional security efforts that are in compliance with the Health Insurance Portability and Accountability Act to ensure confidentiality.[1,4,9]

Limitations

It is important to consider the results of this review in the context of its limitations. Our search was restricted to articles published between December 2013 and December 2018, which possibly excluded some studies. The publication timeline was limited to 5 years to ensure that we captured the most contemporary strategies of GIS integration into clinical settings. Broadening the inclusion timeline, however, was unlikely to capture additional GIS processes based on our review of seminal publications preceding and postdating our search years. An additional limitation was that we were not able to systematically assess study quality given the small yield of included studies and their heterogeneous methods.

Future Directions

Several uncertainties remain on the efficiency, effectiveness, and sustainability of GIS-informed, clinically based social care. To date, no good data have been published regarding effective use of GIS within clinical delivery settings to improve outcomes; however, this is a potentially valuable area for future studies. Identifying and disseminating exemplary practices, such as those related to selecting GIS technologies and training staff in their use, can provide valuable guidance to health systems seeking to integrate social care. Additional benefits of disseminating effective, scalable methods of addressing social needs relate to training primary care physicians. Clinicians in training generally report not screening or addressing social risk factors in clinical encounters.[35] The ability to use GIS-informed local, accessible resources for addressing social needs can help enhance skills and self-efficacy in incorporating health-related social care into everyday clinical practice. Furthermore, building capacity within the EHR to collect and analyze granular, patient-level geospatial data can guide health systems to identify and address the likely social needs affecting their patient populations.

Conclusions

The application of GIS to integrate social care into clinical practice holds promise. To date, GIS has been used to identify gaps in access to care; however, there are numerous barriers to its implementation, efficacy has not been proven, and best practices remain elusive. Nonetheless, great potential remains for its use as a tool within the clinical setting, requiring further investigation.

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Key words: geographic information systems; geospatial data; geography, medical; social determinants of health; social risk factors; disparities; needs assessment; health information technology; population health; vulnerable populations

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Supplemental materials

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