Using GIS mapping to improve access to prescription medications in rural Minnesota

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Abstract

Introduction: In 2023, 339,000 Minnesota residents (3.8% of the state's population) lacked healthcare insurance. In that same year, approximately 32% of 1,400 Minnesota residents surveyed who earned less than US$50,000 indicated that they did not get a prescription filled, split tablets, or skipped doses due to the cost of their medications. RoundtableRx, Minnesota's medication repository program regulated by the Minnesota Board of Pharmacy, receives unopened, in-date, no-longer-needed medications donated by healthcare facilities and individuals. These medications are distributed to local RoundtableRx partner repositories (pharmacies or clinics), repackaged and dispensed at low cost/no cost to patients unable to afford the medication. As of the time of this report, of RoundtableRx's 42 local repositories, 16 are located in Minnesota's 49 rural counties. RoundtableRx desired to expand its services to additional rural counties, particularly areas of the state defined as Pharmacy Deserts, located 10 or more driving miles (16 kilometers) from the nearest pharmacy. Most local repositories are recruited through in-person visits by RoundtableRx leaders. To efficiently plan visits to potential repository partners in Minnesota's most socially vulnerable rural areas, interactive Geographic Information System (GIS) mapping was employed to identify existing rural RoundtableRx partner repositories, rural pharmacies not currently participating with RoundtableRx, rural pharmacy deserts, and clinics within those rural pharmacy deserts.

Methods: RoundtableRx partnered with University of Minnesota's (UMN) U-Spatial, two UMN first-year (PGY1) pharmacy residents and the UMN College of Pharmacy to generate a map of pharmacy deserts in socially vulnerable Minnesota rural counties. Community and hospital pharmacies located in rural Minnesota were identified through a list from the Minnesota Board of Pharmacy. Pharmacy deserts were defined as rural areas either 10 miles (16 kilometers) by road or 30 minutes driving time from the nearest pharmacy. Outlets of national chain pharmacies were included in identifying pharmacy deserts; however, these pharmacies were not considered as potential partners due to lack of corporate responsiveness to earlier RoundtableRx overtures to recruit repository sites in either rural or urban communities. Clinics located within rural pharmacy deserts were identified through an internet search for primary care clinics in Minnesota. The University of Wisconsin's Area Deprivation Index (ADI) was used to determine an area's level of social vulnerability instead of the USA Centers for Disease Control and Prevention's (CDC) Social Vulnerability Index (SVI). The ADI more explicitly addresses measures of socioeconomic status than does the SVI. Staff from U-spatial incorporated each of the above data sets as individual layers in a web-based interactive GIS map that the team used to interrogate the data.

Findings: The resulting GIS map was used by RoundtableRx leaders to efficiently plan driving trips to rural pharmacies or clinics that might be recruited as RoundtableRx local repositories in Minnesota's most socially vulnerable counties.

Conclusions: GIS mapping enabled Minnesota's prescription drug repository program to efficiently plan in-person visits to potential RoundtableRx local repositories in socially-vulnerable rural communities. The map also suggests that a mail-order pharmacy option would further increase prescription drug access for patients living in rural Minnesota's medically-underserved pharmacy deserts.

Keywords: access, geographic information system, medicines, Minnesota, rural

Introduction

Minnesota comprises 87 counties with a population totaling more than 5.76 million people. Of these 87 counties, 49 are categorized as "rural" by the State Demographer, i.e., counties that have Rural Urban Commuting Area (RUCA) ratings of 7-10.[1]

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Approximately 73% of the state's residents live in the 7-county Twin Cities (Minneapolis and St. Paul) Metropolitan Area. "Greater Minnesota" is defined as all counties outside of the Twin Cities metro area. Approximately 15% of Greater Minnesota residents live in communities of fewer than 10,000 people, half of those residing in communities of fewer than 2,500.[2]

Residents in rural communities tend to be poorer,[3] older, face more health challenges and are less likely to have healthcare insurance than their urban counterparts.[4] The Minnesota Department of Health reported that in 2023 about 339,000

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Minnesota residents (3.8%) lacked healthcare insurance.[5] At the same time, a 2023 Altarum Healthcare Value Hub survey of more than 1,400 Minnesota adults found that 32% of respondents earning less than US$50,000 reported not getting a prescription filled, splitting tablets, or skipping doses due to the cost of their medications.[6] Meanwhile, each year Minnesota's 325 long-term care facilities dispose of approximately US$16 million worth of safe, unexpired medications[7] that could be used by people who cannot otherwise afford these medications.

Repositories for Donated Drugs

One solution to the challenges described above is to establish a drug repository program. Unopened, unexpired prescription medications that are no longer needed may be redistributed at low or no cost to patients who qualify, particularly patients from underserved populations. Iowa established the first general prescription drug repository program in 2001, and as of December 2024, drug repository programs operate in 31 states (Figure 1).[8] A few of these programs redistribute oncology medications only.[9]

The Minnesota Medication Repository Program (RoundtableRx) was born out of an idea from University of Minnesota College of Pharmacy (UMNCOP) students. These students were committed to making a positive impact on the environment while addressing health inequities, specifically around medication access & affordability. Ultimately, they found their solution in a general medication repository, based on similar programs in other states in the U.S. The students started their work on this initiative in 2017,[10] including helping Minnesota legislative staff craft the statutory language that created the program. The enabling legislation was enacted in 2018, and RoundtableRx began business in December 2020 when the Minnesota Board of Pharmacy selected the nonprofit to operate the medication repository program for the state. RoundtableRx serves residents of the state only, similar to drug repository programs in other states.

Headquartered in Minneapolis, Minnesota, RoundtableRx is a federally-registered 501(c)3 nonprofit organization that relies on grants and monetary donations for funding. Its mission is to offer safe and affordable medication to Minnesotans in need, providing continuity of care and reducing waste by redistributing unused medications. RoundtableRx's vision is a future where no medications are wasted unnecessarily, and Minnesotans receive continuity of care without exception.

The mission-driven work of RoundtableRx is detailed in Figure 2. Donations of unused and unexpired medications are accepted at RoundtableRx's central collection site from Minnesota healthcare facilities and individuals, and inspected for quality and safety. RoundtableRx is licensed by the Minnesota Board of Pharmacy as a wholesaler only; therefore, it is unable to dispense medications directly to patients. Instead, RoundtableRx relies on a network of clinic and pharmacy partners who order these no-cost medications from RoundtableRx, then provide the medications directly to uninsured or underinsured Minnesota patients. As of early 2025, RoundtableRx had provided nearly 183,000 days of medication to patients valued at nearly US$804,000.[10]

Pharmacy Deserts

The term "pharmacy desert" is defined as a population center located 10 miles (16 kilometers) or more from the nearest pharmacy.[11-13] As a practical example, if the only pharmacy in one rural northern Minnesota community would close, that town's residents would need to travel 22 miles (35 kilometers) or more to the next nearest pharmacy. Such travel could prove to be particularly difficult in the middle of a Minnesota winter with 12 inches (30 centimeters) or more of snow on the roads, temperatures well below zero degrees Fahrenheit (F) (-18 Celsius (C)), and windchills approaching -40F (-40C). Loss of this local health resource would also have detrimental effects on the health of area residents as well as the local economy.[14]

Nearly 400 independently-owned community pharmacies in Minnesota have closed in urban and rural areas throughout the state since 1996,[15] nearly half of those closures having occurred since 2017.[16] In 2023 alone, 24 pharmacies closed.[17] In addition to independent community pharmacies, 20% of chain pharmacy outlets in Minnesota have also closed since 2018.[18] It is unlikely, therefore, that any additional pharmacies will be opening in Minnesota's current pharmacy deserts. The closures of these pharmacies leave clinics located in the resulting pharmacy deserts as the most likely candidates to be recruited as RoundtableRx local repositories. Unfortunately, over the last few years several primary care clinics in rural Minnesota communities have also closed.[19-21]

As of June 2025, RoundtableRx had 42 repository partners (local pharmacies, clinics, or independent prescribers) operating throughout Minnesota, 16 of which were located in rural counties. None of the clinic-based repositories were located in pharmacy deserts. RoundtableRx leadership was interested in expanding services to Minnesota's most vulnerable rural counties, and recruiting many of its local repositories through in-person visits. This paper describes how Geographic Information System (GIS) technology was employed to create a map to facilitate planning these in-person recruiting visits.

Goal and Objectives

The goal of the current project was to create a GIS map to efficiently identify potential local repository sites in Minnesota's most socially vulnerable counties where new RoundtableRx Local Repositories might have the greatest impact.

Objectives:

1. Partner with the University of Minnesota GIS unit (U-Spatial) to create an interactive map of Greater Minnesota containing the following layers:
    a. High need rural areas
    b. Public access pharmacies not currently participating with RoundtableRx as a Local Repository
        i. Including independent and regional chain pharmacies
        ii. Excluding closed-door and national chain pharmacies
        iii. Excluding pharmacies restricted to select populations (i.e. tribal members)
    c. Pharmacy Deserts (Townships located greater than 10 miles from the nearest community pharmacy)
    d. Primary care clinics within a pharmacy desert
    e. Participating RoundtableRx Local Repository sites
2. Use the interactive map to identify high need areas in Greater Minnesota
    a. … that have a community pharmacy not currently participating as a RoundtableRx Local Repository
    b. … that are located within a pharmacy desert and have a primary care clinic not currently participating as a RoundtableRx Local Repository
3. Utilize Personal Selling in an effort to recruit non-participating public access pharmacies, or primary care clinics located in pharmacy deserts in rural Minnesota counties as RoundtableRx Local Repository partners

Methods

As medication repository programs such as RoundtableRx have the potential to enable patients to receive medications they could not otherwise afford, RoundtableRx sought to expand its network of local medication repositories in geographically-isolated rural Minnesota communities. In the current project, pharmacy deserts were defined as any rural area that was either at least 10 miles (16 kilometers) by road or 30 minutes driving time from the nearest pharmacy. Although large national chain pharmacies were included in identifying pharmacy deserts, rural outlets of these chains were not considered as partner candidates due to a lack of corporate responsiveness to RoundtableRx's earlier overtures to recruit repository sites in either rural or urban locations.

A list of community and hospital pharmacy locations in Minnesota as of August 2025 was obtained from the Minnesota Board of Pharmacy. Rural pharmacies from this list were identified by using the Rural Information Hub's *Am I Rural? - Tool*.[22]

Locations of clinics located within pharmacy deserts were identified through an internet search for primary care clinics in rural Minnesota. Although the Minnesota Department of Health (MDH) lists the locations for all primary care clinics in Minnesota, MDH does not indicate whether these clinics are located in rural communities, let alone within pharmacy deserts.

The investigators debated whether to determine an area's social vulnerability using the University of Wisconsin's racially-neutral Area Deprivation Index (ADI),[23,24] or the USA Centers for Disease Control and Prevention's (CDC) more recent Social Vulnerability Index (SVI) that includes minority status as a variable.[25] Created in 2003, the ADI assesses area deprivation at the neighborhood level, measuring variations in socioeconomic status.[24] The SVI, first released in 2011, is intended to identify vulnerable communities at the census tract level that would most likely need support in the case of natural disaster, environmental hazard event or disease outbreak.[25] Differences between these two indices[26] are summarized in Table 1. The investigators decided to utilize the ADI, as the underlying intent of the ADI better aligned with the intent of the current project than did the SVI. In addition, the ADI appeared to more explicitly address measures of socioeconomic status that would directly relate to a person's ability to access affordable prescription medications.[26]

Table 1. Comparison of Area Deprivation Index and Social Vulnerability Index Domains[26]

Area Deprivation Index[23,24] (University of Wisconsin)	Social Vulnerability Index[25] (Centers for Disease Control and Prevention)
Income (4 items)	Income (2 items)
Employment (2 items)	Employment (1 item)
Education (2 items)	Education (1 item)
Housing Costs/Value (4 items)	Housing Costs/Value (0 items)
Household Characteristics (4 items)	Household Characteristics (5 items)
Housing Type (1 item)	Housing Type (4 items)
Minority Status/Language (0 items)	Minority Status/Language (2 items)

Staff from U-Spatial incorporated each of the above data sets as individual layers in a web-based interactive GIS map in order for the team to interrogate the data. Additional maps were derived from GIS data.

Ethics approval

The University of Minnesota IRB determined that this project did not constitute human research (STUDY00019154).

Results

The resulting interactive map illustrating the primary map layers from the web-based application is shown in Figure 3.

The ADI colors identify the degree of social disadvantage for each census tract in the rural counties of interest. The map was used by RoundtableRx leadership to identify rural areas of the state where recruiting the next RoundtableRx local repositories might have the greatest impact on medication inaccessibility. At the time of this report, the map has helped RoundtableRx leadership to recruit two new repository partners in rural Minnesota communities.

Driving times from Minneapolis to selected pharmacy deserts with the greatest degrees of social-vulnerability are shown in Table 2. The two closest most disadvantaged pharmacy deserts, one having a clinic and the other lacking a clinic, are both 1.5 hours from Minneapolis. The furthest most disadvantaged pharmacy desert that has a clinic is a 4-hour drive from Minneapolis, while the furthest most disadvantaged pharmacy desert lacking a clinic is 5.75 hours away. Each of these selected pharmacy deserts have pharmacies within 15 miles (24 kilometers); however, at the time of this study none of these pharmacies currently participate as RoundtableRx local repositories.

Table 2. Driving Times from Minneapolis, Minnesota† to Selected Most Socially Vulnerable Minnesota Census Tracts on GIS map (See Figure 3)

Selected Map Location	Closest Non-participating Pharmacy to Selected Pharmacy Desert	Driving Time: Minneapolis to Selected Map Location
Closest pharmacy desert lacking a clinic	14.8 miles (23.8 Km)	1.5 hours
Closest pharmacy desert having a clinic	12.7 miles (20.4 Km)	1.5 hours
Farthest pharmacy desert lacking a clinic	12.4 miles (20.0 Km)	5.75 hours
Farthest pharmacy deserts having a clinic	10.6-11 miles (17.1-17.7 Km)	Both 4 hours in different directions

†Location of RoundtableRx main office

Discussion

Medication repository programs such as RoundtableRx have the potential to enable patients to receive medications they could not otherwise afford; therefore, RoundtableRx sought to expand its network of local medication repositories in geographically-isolated rural Minnesota communities. The magnitude of such an undertaking reinforced the importance of RoundtableRx amplifying its existing partnership with the University of Minnesota.

That partnership began when RoundtableRx was conceptualized by University of Minnesota College of Pharmacy (UMNCOP) students, who laid much of the groundwork for the establishment of this medication repository program.[7] After RoundtableRx was up and running as a non-profit, non-governmental organization, UMNCOP post-graduate year 1 pharmacy residents helped with plans to evaluate and expand the RoundtableRx program, increasing RoundtableRx's human resource capacity to undertake this project. The University of Minnesota's U-Spatial unit provided the GIS expertise for generating the maps used in the project. UMNCOP provided financial support for the current project. UMNCOP faculty continue to advise RoundtableRx operations, with a UMNCOP faculty member serving as an observer on the RoundtableRx Board of Directors. RoundtableRx serves as an advanced clinical training site for UMNCOP and precepts UMNCOP students. The University of Minnesota strives to partner with private sector organizations to serve the entire state, and other University of Minnesota departments are actively working on parallel research projects using GIS mapping to address patient access to pharmacies and pharmacist services in low-income urban neighborhoods as well as in geographically-isolated rural communities.

GIS enables disparate data sets to be superimposed onto one another in a single map, allowing researchers and policy-makers to compare, combine and examine the interactions between different themes for the same geographical area.[27] This capability paints a more complete picture for examining complex, multifaceted research questions regarding a specific geographical area than would separate maps each addressing individual aspects of the research question. Departments or Ministries of Health could partner with universities[28] or governmental GIS agencies (e.g., CGIS in Canada)[29] to examine whether social vulnerability of an area is associated with health-related issues such as healthcare workforce shortage, mental health deserts, low vaccination rates, the incidence and prevalence of specific diseases or conditions, varying performances on standardized educational tests, and health outcomes associated with environmental changes.

As noted earlier, RoundtableRx leadership recruits many new local repositories by making in-person visits to potential sites. What is not apparent from Figure 1 is the record keeping that goes on behind the scenes at the RoundtableRx headquarters and at the local repositories. Repositories must maintain records of the RoundtableRx prescriptions dispensed to patients, a responsibility that can consume a fair amount of staff time. These expectations are described in detail to prospective local repositories during RoundtableRx recruiting visits. These recruiting visits also require significant commuting time from RoundtableRx headquarters in Minneapolis to the pharmacy deserts. For example, from RoundtableRx headquarters to the nearest clinic located in a highly disadvantaged pharmacy desert would require about a 90-minute drive (Table 2). Driving time to the two furthest

clinics located in highly disadvantaged pharmacy deserts, northeast and northwest of the Twin Cities metro area, would be four or more hours for each. The interactive GIS map not only aids in identification of potential partners but also aids in planning recruiting trips to these outlying rural communities. Indeed, the first use of the resulting GIS map assisted RoundtableRx leadership in planning a day-long trip that resulted in the recruitment of two additional local repositories in rural communities.

Licensed by the Board of Pharmacy only as a wholesaler and not as a pharmacy, RoundtableRx must rely on clinic and pharmacy partners to identify under-resourced patients and order no-cost medications from RoundtableRx to dispense to these patients. Unfortunately, as rural Minnesota pharmacies (and to a lesser extent, clinics) continue to close at an alarming rate, under-resourced patients in additional rural areas of the state will soon lack local access to affordable prescription medications. Combined with the number of geographically-isolated pharmacy deserts scattered throughout Minnesota that also lack clinics, and the low likelihood that either new pharmacies or clinics will open in these communities, the map suggests that a RoundtableRx mail-order pharmacy option might be the best possible course of action for RoundtableRx to further increase prescription drug access for patients living in rural areas of the state.

The United States Postal Service provides local mail delivery to every community in the country, yet at the time of this writing, Wyoming's medication donation program, started in 2007, appears to be the only state repository program that mails donated medications to patients in need.[30] RoundtableRx becoming additionally licensed by the Board of Pharmacy as a mail-order pharmacy could improve access to affordable medication for rural Minnesota patients lacking access to a local repository. RoundtableRx leaders are in conversation with the Minnesota Board of Pharmacy about this possibility. As part of the mail order pharmacy service, RoundtableRx is proposing to utilize telepharmacy to interact with patients, consistent with Minnesota Board of Pharmacy Regulations governing mail order pharmacy services.[31] Once RoundtableRx establishes a mail order pharmacy, they would still need to identify areas of the state in which to focus their outreach activities to educate residents of these communities about the program.

A RoundtableRx mail order pharmacy service would not likely adversely impact community pharmacies, as RoundtableRx serves only patients who cannot otherwise afford these medications. It is unlikely that community pharmacies outside of the RoundtableRx partner network would be willing to provide these medications at a substantially reduced or no fee to needy patients as most community pharmacies are already operating at slim margins on prescription drugs.[14] Nor would a RoundtableRx mail order pharmacy service adversely impact existing repositories, as RoundtableRx would target only rural areas that are geographically far removed from any existing repository. These existing repositories may be reluctant to incur additional unreimbursed expenses from adding a mail order service to their existing medication repository operations.

The question might also be asked if RoundtableRx can connect people to the nearest community pharmacy where the person can receive full-spectrum pharmacist services? This is really a, "Which came first, the chicken or the egg?" question. If a person does not know that RoundtableRx exists in the first place, they would not know to contact RoundtableRx to learn where the next closest pharmacy is located that might be able to meet their needs. A person in a rural community may indeed be able to learn from neighbors where the nearest pharmacy is located, but not necessarily the nearest RoundtableRx partner where the patient could obtain their expensive prescription medications at reduced or no charge.

Limitations

GIS maps are only as useful as the quality of the data available. For example, in creating the map for the current project, it was subsequently discovered that some of the pharmacies mapped using the Board of Pharmacy list had actually gone out of business[16] or turned out to be "closed shop" pharmacies (i.e., pharmacies that provided medications to nursing home patients only and were not otherwise open to the public). Similarly, a clinic in a rural pharmacy desert originally included on the map subsequently closed.[32]

In addition, reduced pharmacy operating hours due to staffing shortages can contribute to the creation of "temporal" pharmacy deserts at certain times of the day or night.[33] Simply mapping pharmacies' physical locations alone, therefore, may not provide a complete picture of the pharmacy desert landscape. Adding such temporal considerations to the current map was beyond the scope of the current project, but would be worthy of further research.

Conclusions

GIS mapping was helpful in identifying Minnesota's rural pharmacy deserts with the highest social vulnerability as well as identifying primary care clinics located within those pharmacy deserts. The interactive map facilitated planning in-person recruiting visits to potential local repository partners for the Minnesota Medication Repository Program (RoundtableRx), and led to the recruiting of additional repositories in rural communities.

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employment, gifts, stock holdings or options, honoraria, consultancies, expert testimony, patents, and royalties.

Treatment of Human Subjects: The University of Minnesota IRB determined that this project was classified as non-Human Subjects Research.

Disclaimer: The statements, opinions, and data contained in all publications are those of the authors.

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Figure 1. Map of State Drug Repository Programs (as of December 2024)

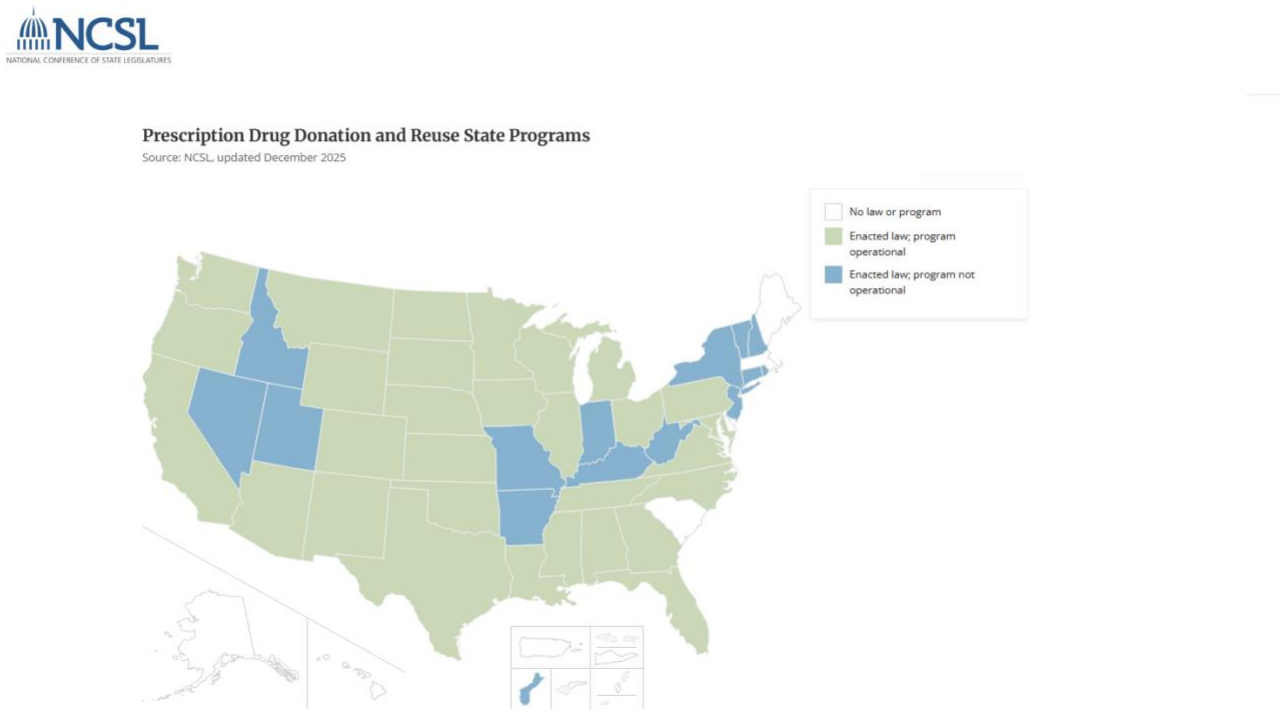

Figure 2. How the RoundtableRx Program Works

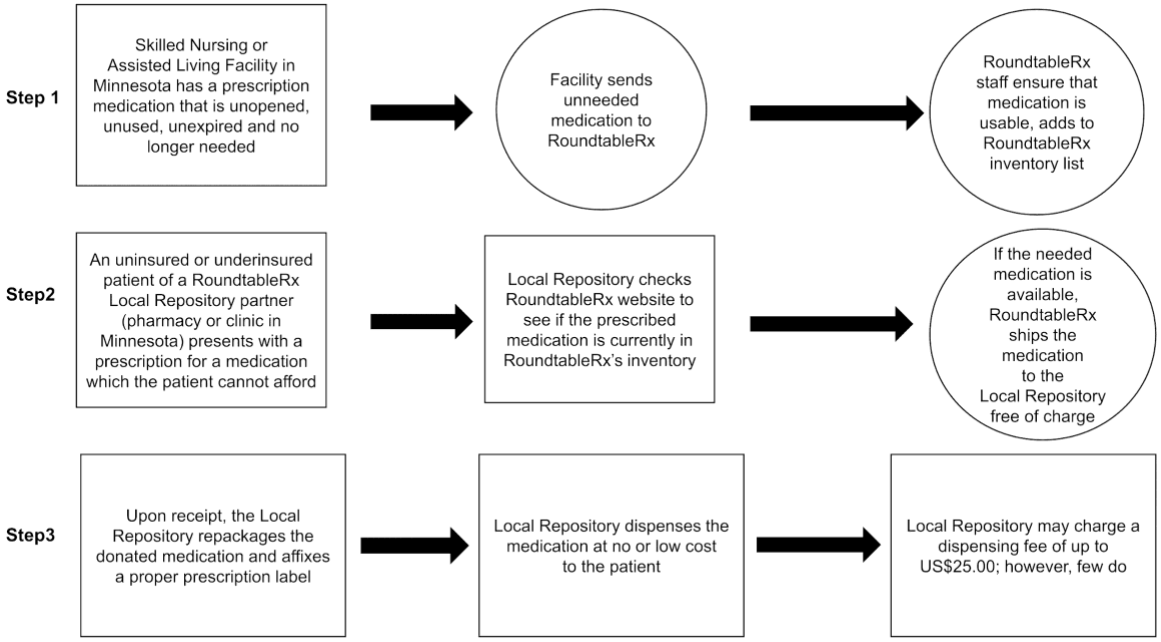

Figure 3. Minnesota Pharmacy Deserts, Clinics and RoundtableRx Repository Partners