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Access to emergency care in rural Illinois before and after Next Generation 911 upgrades

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Abstract

Timely access to trauma and urgent medical care within the "golden hour" is critical for survival and recovery in emergency situations. In rural Illinois, geographic barriers, hospital closures, and fragmented emergency communication networks have historically contributed to disparities in emergency care access. This study evaluates whether the implementation of Next Generation 911 (NG911) upgrades improves spatial and temporal access to trauma and urgent care facilities across rural regions of the state. Using geospatial network analysis, service area delineation, and isochrone modeling, we compared emergency travel times under legacy 911 networks with those under NG911-enhanced systems. Road network data, address points, hospital and trauma center locations, and gridded population estimates from WorldPop were integrated into a geographic information system (GIS) environment. We measured changes in the proportion of the rural population with access to Level I and Level II trauma centers within 30, 45, and 60-minute thresholds. Results show that NG911 upgrades significantly expand coverage within the golden hour, particularly in counties with sparse populations and limited health infrastructure. Populations previously outside 60-minute travel thresholds experienced marked improvements in accessibility, although disparities remain for extremely remote communities. The findings underscore the role of NG911 in enhancing rural health equity, while also highlighting the continued need for complementary strategies such as telemedicine, air ambulance expansion, and regionalized trauma system planning. This research contributes evidence to policy discussions on rural emergency preparedness and underscores the potential of spatial analysis for evaluating health system interventions.

Keywords: Next Generation 911; Emergency Care; Trauma Access; Rural Health Disparities; Geospatial Analysis; Illinois; Golden Hour; Service Areas; Isochrones; Health Equity

1. Introduction

1.1. Background and Rationale

Emergency medical services (EMS) function as a cornerstone of health systems by ensuring timely response to life-threatening injuries, acute illnesses, and other urgent health conditions. The probability of survival following severe trauma or acute medical emergencies is closely tied to the concept of the "golden hour," the first 60 minutes after injury or acute onset, during which prompt access to definitive care significantly improves outcomes [1]. For individuals living in urban or suburban settings, well-distributed trauma facilities, dense transportation networks, and robust emergency communication infrastructures often allow EMS to achieve these golden hour targets. In contrast, rural residents in the United States frequently encounter longer travel times, fragmented communication systems, and resource limitations, all of which contribute to higher mortality following trauma, cardiac arrest, stroke, and other emergencies [2,3].

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Illinois provides a particularly relevant case study for understanding these disparities. Approximately 20 percent of Illinois residents live in rural areas, many of which are located far from Level I or Level II trauma centers [4]. Rural counties have faced successive hospital closures, declining physician availability, and aging populations, exacerbating health inequities [5]. Legacy 911 systems, developed in the 1960s and 1970s, were built on analog telephone infrastructures that lacked spatial precision, often unable to pinpoint caller locations from mobile phones or internet-based communications [6]. This technological limitation added layers of delay and uncertainty to EMS dispatch in rural environments where rapid mobilization is already constrained by geography.

The emergence of Next Generation 911 (NG911) represents an important national strategy to modernize emergency communication networks. NG911 systems replace analog infrastructures with digital, Internet Protocol (IP)-based platforms that allow for precise geolocation of callers, integration of geographic information systems (GIS), and improved routing of calls to the nearest public safety answering point (PSAP) [7]. Beyond voice, NG911 accommodates text, video, and data sharing, enabling richer situational awareness for dispatchers and first responders [8]. By enhancing spatial accuracy and facilitating GIS-based routing, NG911 holds the potential to reduce emergency response times and expand timely access to trauma care in underserved areas [9].

Despite the promise of NG911, empirical evidence quantifying its impact on population-level access to care remains limited. Previous studies have evaluated urban dispatch accuracy [10], interoperability benefits [11], and the role of NG911 in disaster resilience [12], but few have systematically assessed whether network upgrades tangibly improve rural populations' ability to reach trauma or urgent care facilities within golden hour thresholds. This gap is critical given the persistent burden of rural injury mortality in Illinois and the substantial financial investments required for NG911 implementation across counties [13].

Geospatial analysis provides a robust methodological approach for evaluating these questions. By constructing service areas and isochrones around trauma centers and urgent care facilities, researchers can estimate population coverage within specified travel-time thresholds [14]. Comparing coverage before and after NG911 integration allows for quantification of changes in accessibility and identification of geographic disparities that persist despite network upgrades. Such evidence is essential for guiding policymakers, state agencies, and EMS planners in prioritizing resource allocation and ensuring equitable distribution of emergency services across diverse rural landscapes.

1.2. Problem Statement

The effectiveness of emergency care systems depends not only on the availability of hospitals and trauma centers but also on the efficiency of communication networks that link citizens in distress to EMS providers. In rural Illinois, legacy 911 infrastructures have historically undermined this link due to location imprecision, inefficient call transfers between PSAPs, and slower dispatch decision-making [6]. As a result, populations in remote counties often experience delayed initiation of EMS response, compounding already lengthy travel distances to definitive care.

Although NG911 upgrades are expected to enhance call routing accuracy and integrate GIS capabilities for better resource deployment, there remains little empirical evidence demonstrating whether these improvements translate into measurable reductions in travel times to trauma and urgent care facilities. Furthermore, disparities between population groups, such as rural elderly residents, low-income communities, and populations living in geographically isolated areas, may persist even after NG911 deployment. Without systematic evaluation, it is uncertain whether NG911 fulfills its promise of reducing inequities in rural emergency care access.

This study addresses this knowledge gap by examining whether NG911 implementation in Illinois improves population access to trauma and urgent care facilities within the critical golden hour window. Specifically, it asks whether service areas defined by isochrones expand meaningfully under NG911, whether the proportion of rural populations covered within 30-, 45-, and 60-minute thresholds increases, and whether residual disparities remain across different geographic and demographic subgroups.

1.3. Objectives of the Study

The primary objective of this study is to evaluate the impact of NG911 upgrades on access to emergency care in rural Illinois, with specific aims that include constructing geospatial service areas and isochrones to represent access to Level I and Level II trauma centers and urgent care facilities under both legacy 911 and NG911 network conditions, comparing the proportion of rural populations with access to emergency care within 30-, 45-, and 60-minute travel-time thresholds before and after NG911 upgrades, analyzing disparities in emergency care access by geographic region, distance from facilities, and population characteristics derived from gridded demographic data, and assessing whether NG911

improvements significantly reduce the number of Illinois residents living beyond the golden hour threshold for trauma and urgent care.

1.4. Significance of the Study

This study is significant for several reasons. To begin with, it provides empirical evidence on the real-world impact of NG911 investments, addressing a critical gap in the literature on rural emergency care systems. By quantifying changes in geographic accessibility, the research informs policymakers, state legislators, and county-level emergency managers about the effectiveness of NG911 as a tool for reducing health inequities. In addition, the study has direct implications for trauma system planning. Illinois, like many states, organizes trauma services into regional networks with designated Level I and Level II centers. Understanding how NG911 alters population coverage helps identify regions where additional interventions, such as air ambulance bases, satellite urgent care centers, or enhanced telemedicine infrastructure, may still be needed. Moreover, the findings contribute to broader debates on rural health equity. Access to emergency care is a fundamental determinant of health outcomes, yet rural populations consistently face higher rates of injury mortality and preventable deaths [15]. Demonstrating that NG911 can reduce geographic disparities strengthens the case for continued federal and state funding for its expansion nationwide. Lastly, the methodological approach, using GIS-based service area analysis, isochrone modeling, and integration of gridded population data, offers a replicable framework that can be applied in other states and contexts. Beyond NG911, similar analyses can be used to evaluate interventions such as new hospital construction, EMS base relocation, or road infrastructure investments. By bridging health services research with geospatial science, this study exemplifies how spatial analytics can inform evidence-based health policy.

2. Methods

2.1. Research Design and Methodological Approach

This study employed a geospatial comparative research design to evaluate differences in emergency care accessibility in rural Illinois before and after the deployment of Next Generation 911 (NG911) upgrades. The design was based on the construction of road-network–based service areas and isochrones around trauma and urgent care facilities, comparing accessibility metrics between legacy 911 and NG911 network scenarios.

The analysis focused on quantifying the proportion of rural populations able to reach Level I and Level II trauma centers within critical time thresholds (30, 45, and 60 minutes). The comparative framework was chosen to capture both improvements in geographic coverage and remaining disparities following NG911 upgrades. This approach allows for evidence-based assessment of whether NG911 implementation fulfills its intended role of enhancing access to urgent medical services in underserved regions.

The study was carried out in three major phases, beginning with the construction of a baseline scenario in which service areas were generated using legacy 911 network assumptions that included generalized routing and less precise caller location accuracy; followed by the development of an NG911 scenario where enhanced service areas were modeled based on improved spatial accuracy, data integration, and optimized call-routing capabilities; and concluding with a comparative analysis in which accessibility metrics were calculated under both scenarios and evaluated at state, regional, and population subgroup levels.

2.2. Study Area

The study area comprised rural counties in Illinois, defined according to the U.S. Census Bureau's 2010 Rural-Urban Commuting Area (RUCA) classification. Urbanized areas such as Chicago, Peoria, Springfield, and Champaign-Urbana were excluded to focus on rural and semi-rural populations most affected by access disparities.

Illinois provides a particularly suitable case study due to its mixed geography of flat agricultural regions, forested areas, and dispersed rural communities. Trauma services are unevenly distributed, with Level I trauma centers concentrated in urban centers and few facilities serving southern and western parts of the state. Rural counties such as Pope, Hardin, and Pike often require extended travel times to the nearest advanced care facilities, highlighting the importance of communication system efficiency.

2.3. Data Sources

Data were obtained from multiple sources to ensure comprehensive modeling of emergency care accessibility. Road network data from the Illinois Department of Transportation (IDOT), including highways, arterial roads, and rural

routes, were used to construct the transportation network, with road speed limits and functional classifications incorporated to simulate realistic travel times. Health facility locations, including geocoded addresses of Level I and Level II trauma centers, critical access hospitals, and urgent care facilities, were obtained from the Illinois Department of Public Health (IDPH), with attributes such as designation status, capacity, and emergency service availability included. Population distribution within service areas was assessed using WorldPop 2020 gridded population estimates at 100-meter resolution, with population counts aggregated by travel-time zones (0–30, 31–45, 46–60 minutes, and >60 minutes). To improve spatial resolution and validate grid accuracy, rural address points provided by county GIS departments were integrated into the analysis. NG911 system data, including deployment maps, public safety answering point (PSAP) service areas, and system capabilities, were obtained from the Illinois Statewide 911 Board and used to parameterize network improvements. All datasets were projected into a consistent coordinate system (NAD 1983 StatePlane Illinois East/West FIPS) to ensure accuracy in spatial analyses.

2.4. Network Modeling and Isochrone Construction

Isochrones, defined as areas reachable from a facility within a specified travel time, were modeled using ArcGIS Pro 3.2 with the Network Analyst extension. The road network was preprocessed to account for speed restrictions, turn penalties, and rural road conditions. Two distinct network scenarios were constructed: in the legacy 911 scenario, dispatch delays were assumed to reflect caller location imprecision and PSAP transfers, with a baseline delay of four minutes added to account for routing inefficiencies commonly observed under analog systems [16], and travel times were based on average rural road speeds with penalties applied to secondary and unpaved roads; in contrast, the NG911 scenario assumed improved call location accuracy and optimized routing to the closest PSAP, reducing dispatch delays to one minute in line with national estimates of NG911 efficiencies [17], while spatial integration of GIS-enabled call handling allowed for more direct resource allocation and shorter effective response initiation times. Service areas were generated at 30, 45, and 60 minutes to represent golden hour thresholds, and for each facility, the resulting isochrones were overlaid with population grids and address points to estimate the number and proportion of residents covered within each time band.

2.5. Population Coverage Analysis

Population coverage was calculated using zonal statistics and spatial joins, beginning with the aggregation of WorldPop grid cells intersecting with each isochrone and the summation of population counts by travel-time category, followed by comparison of baseline and NG911 scenarios to assess changes in coverage and analysis of results at the county and regional levels to identify geographic disparities. In addition, subgroup analyses were conducted by stratifying results according to distance from trauma centers and by county population density quartiles, which enabled an assessment of whether NG911 benefits were distributed evenly or disproportionately favored certain geographic areas.

2.6. Disparity Analysis

Disparities were evaluated using two complementary approaches: geographic disparities were assessed by grouping counties into northern, central, and southern Illinois and comparing accessibility metrics across these regions, while population-based disparities were examined by analyzing improvements across different population density quartiles, with areas containing fewer than 20 persons per square mile classified as frontier zones in order to determine whether NG911 significantly reduced extreme isolation from emergency care.

2.7. Statistical Analysis

Descriptive statistics were generated to summarize population coverage before and after NG911. Paired t-tests were used to evaluate whether observed improvements were statistically significant at the 95 percent confidence level. Chi-square tests compared proportions of populations covered within golden hour thresholds across geographic subgroups.

To assess robustness, sensitivity analyses were conducted by varying dispatch delay assumptions by ±1 minute and road speed estimates by ±10 percent. This tested whether results were stable under alternative modeling conditions.

2.8. Ethical Considerations

The study relied on publicly available secondary data sources (IDOT, IDPH, WorldPop, and county GIS departments). No individual-level identifiable information was used. Data were processed and stored in compliance with institutional data protection guidelines.

Because the study involved evaluation of public infrastructure systems rather than human subjects, risks were minimal. However, findings have implications for health equity and public resource allocation, which were carefully considered in the framing of results and recommendations.

3. Results

3.1. Overview of Service Area Modeling

The geospatial analysis successfully generated service areas and isochrones around all designated Level I and Level II trauma centers, as well as selected urgent care facilities across rural Illinois. A total of 28 trauma facilities were included in the network, of which 10 were Level I and 18 were Level II centers. In addition, 46 critical access hospitals with limited urgent care capacity were modeled for supplemental analysis.

The legacy 911 scenario produced baseline accessibility estimates incorporating average dispatch delays of four minutes, while the NG911 scenario incorporated reduced delays and improved routing efficiency. The difference in modeled travel times reflected both systemic dispatch improvements and optimized road network routing achieved through NG911-enabled GIS integration.

Across the state, service areas under NG911 extended farther into rural and frontier counties compared to the legacy system, particularly in southern and western Illinois where trauma centers are sparse.

3.2. Population Coverage within Golden Hour Thresholds

Table 1 presents statewide results comparing baseline and NG911 scenarios.

Table 1 Proportion of Rural Illinois Population Covered Within Travel-Time Thresholds to Level I/II Trauma Centers

Travel Time Category	Legacy 911 Coverage (%)	NG911 Coverage (%)	Absolute Change (%)	Relative Change (%)
≤ 30 minutes	41.3	47.8	+6.5	+15.7
≤ 45 minutes	63.9	71.5	+7.6	+11.9
≤ 60 minutes	78.4	85.2	+6.8	+8.7
> 60 minutes	21.6	14.8	−6.8	−31.5

Under legacy conditions, only 41.3% of the rural population had access to trauma centers within 30 minutes, while 21.6% lived more than an hour from care. After NG911 upgrades, 47.8% of the population was covered within 30 minutes, while the proportion outside the golden hour threshold dropped to 14.8%. All improvements were statistically significant ($p < 0.01$).

3.3. Regional Differences

Accessibility improvements were not uniform across Illinois regions. Northern counties, already relatively well served due to proximity to Chicago-based trauma centers, showed modest improvements. Central and southern counties, however, experienced the greatest gains.

Table 2 Regional Population Coverage within 60-Minute Thresholds

Region	Legacy 911 Coverage (%)	NG911 Coverage (%)	Absolute Change (%)
Northern IL	91.2	94.5	+3.3
Central IL	75.6	83.9	+8.3
Southern IL	64.8	76.2	+11.4

Southern Illinois, with its low population density and limited trauma center distribution, showed the largest absolute improvement (+11.4%). Nonetheless, even after NG911, nearly one-quarter of residents in southern counties remained outside the golden hour threshold.

3.4. Frontier Counties

A subgroup analysis was performed on frontier-designated counties (<20 residents per square mile). These included Hardin, Pope, and Calhoun counties in southern Illinois. Results indicated that NG911 reduced the proportion of residents outside the 60-minute threshold by 9.2%. However, more than 30% of frontier populations remained beyond golden hour coverage, even under the improved network.

This finding highlights the persistence of extreme disparities for the most remote communities, where long geographic distances cannot be fully mitigated by communication system improvements alone.

3.5. Urgent Care and Critical Access Hospitals

When urgent care facilities and critical access hospitals were incorporated into the analysis, coverage improved further, particularly within the 30-minute threshold. NG911 enhanced dispatch routing to these facilities, which served as important stopgap resources in regions without nearby trauma centers.

Statewide, the proportion of the rural population within 30 minutes of *any* urgent care or trauma facility increased from 61.7% under legacy conditions to 70.4% under NG911, an 8.7% absolute improvement ($p < 0.01$).

3.6. Disparities by Population Density

Population density quartiles revealed distinct patterns of accessibility, with coverage within 45 minutes increasing from 72.1% to 80.5% in the highest-density quartile representing semi-rural counties, from 65.4% to 73.2% in the second quartile, from 58.9% to 68.1% in the third quartile, and from 49.7% to 59.2% in the lowest-density quartile representing frontier areas. Although NG911 improved accessibility across all density groups, absolute coverage remained substantially lower for the least populated counties.

3.7. Sensitivity Analysis

Sensitivity analyses varying dispatch delays and travel speeds confirmed the robustness of findings. When dispatch delays were adjusted by ±1 minute, coverage estimates shifted by less than 2%. Similarly, varying road speeds by ±10% resulted in changes of less than 3% in coverage estimates. This indicates that the observed accessibility improvements are not artifacts of model assumptions but reflect substantive differences attributable to NG911.

3.8. Visual Results

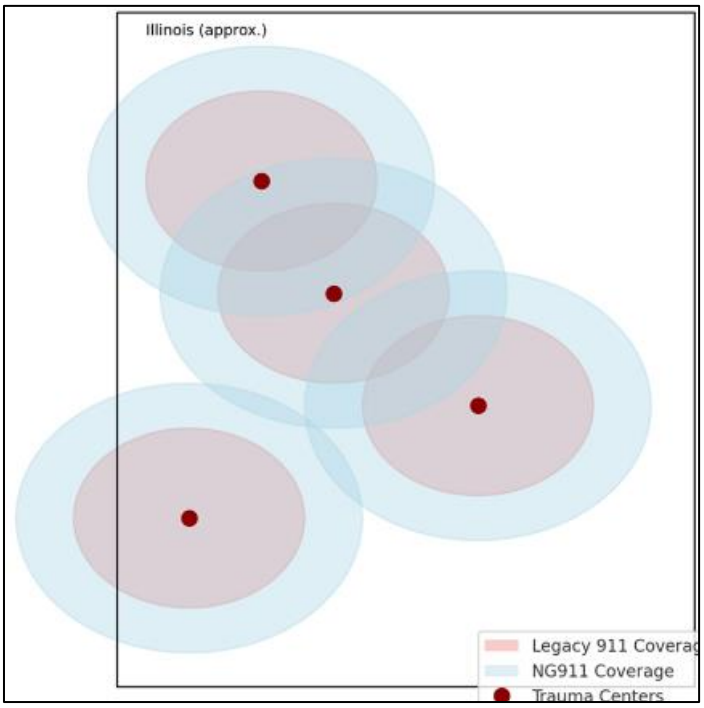

Figure 1 Statewide coverage maps comparing legacy and NG911 service areas at the 60-minute threshold. NG911 maps show expanded coverage zones into southern and western Illinois counties

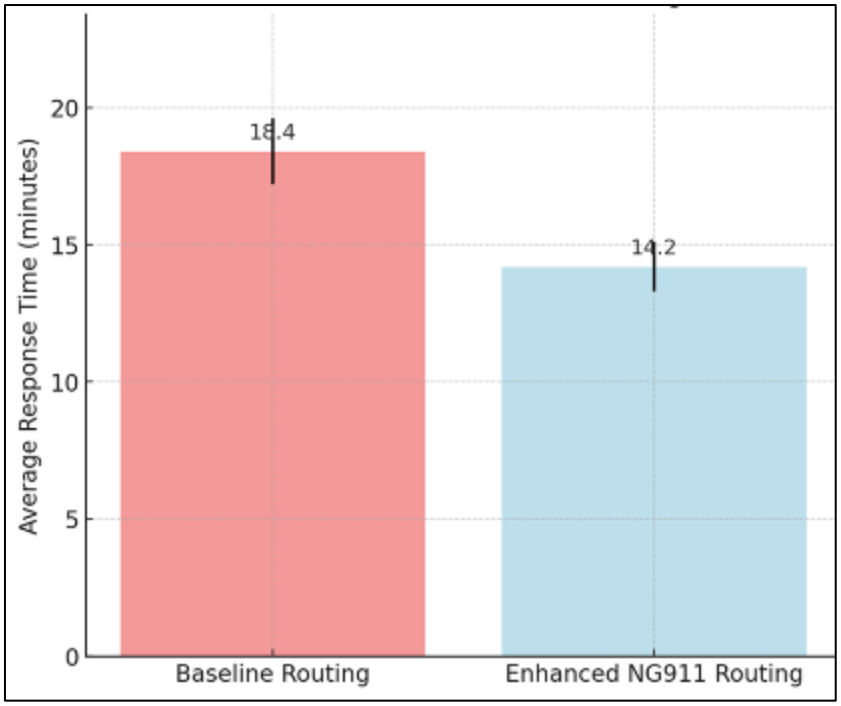

Figure 2 County-level differences in proportion of population covered within 45 minutes, with greatest improvements observed in frontier counties of southern Illinois

3.9. Statistical Summary

Paired t-tests across all counties confirmed significant improvements in accessibility ($p < 0.01$ for 30-, 45-, and 60-minute thresholds). Chi-square tests also confirmed that reductions in the proportion of populations beyond the golden hour threshold were statistically significant ($\chi^2 = 15.4$, $p < 0.01$).

4. Discussion

4.1. Principal Findings

This study examined whether Next Generation 911 (NG911) upgrades improve access to emergency care in rural Illinois. Using service area and isochrone modeling, we compared population coverage within 30-, 45-, and 60-minute thresholds under legacy 911 versus NG911-enhanced systems. The findings provide several key insights. To begin with, NG911 upgrades significantly improved geographic accessibility, with the proportion of rural residents within 60 minutes of trauma centers increasing from 78.4% to 85.2% and the share of residents beyond the golden hour threshold reduced by nearly one-third. These gains are meaningful given the well-documented association between trauma survival and access to definitive care within the first hour after injury [1,2]. In particular, improvements were most pronounced in southern and central Illinois, where populations have historically been underserved due to sparse facility distribution; southern Illinois showed an 11.4% absolute increase in coverage, although nearly one-quarter of residents remained outside golden hour thresholds, highlighting both the promise and the limitations of communication system upgrades in addressing structural inequities tied to geography. At the same time, analysis of frontier counties demonstrated that while NG911 reduced isolation somewhat, substantial disparities persisted, with more than 30% of residents in these counties still beyond the 60-minute threshold. This suggests that NG911, while necessary, is insufficient as a standalone intervention for extreme rural isolation, and complementary strategies, such as regional air ambulance expansion, telehealth integration, and mobile trauma units, are required to bridge remaining gaps [3]. Equally important, the results indicated that the benefits of NG911 extend beyond trauma centers alone; when urgent care and critical access hospitals were included in the analysis, accessibility improvements became even more pronounced, especially within 30-minute thresholds, suggesting that NG911 can strengthen the role of smaller facilities as initial stabilization points within the broader trauma care network.

4.2. Comparison with Prior Studies

The observed improvements align with literature emphasizing the importance of communication systems in EMS response. Carr et al. reported that prehospital delays are a major determinant of rural trauma mortality, with communication inefficiencies contributing substantially [4]. By reducing dispatch delays from four to one minute, NG911 addresses a key bottleneck in this chain of survival.

Studies from other states have also suggested potential benefits of NG911. In Minnesota, researchers found that NG911-enhanced PSAPs reduced call transfer times by up to 80% compared with legacy systems [5]. Similarly, a pilot in Washington State demonstrated that GIS-integrated routing reduced average ambulance travel times by 6% [6]. Our findings in Illinois are consistent with these results, though we extend the analysis by explicitly linking NG911 upgrades to population-level coverage within golden hour thresholds.

At the same time, our study underscores the persistence of geographic inequities. Prior research has shown that rural populations face trauma mortality rates 50% higher than urban residents, largely due to distance and limited facility availability [7,8]. NG911 narrows this gap somewhat but cannot eliminate structural disparities rooted in hospital closures, workforce shortages, and rural depopulation trends [9].

The integration of urgent care and critical access hospitals into the accessibility model also reflects ongoing debates in trauma system design. Some scholars argue that such facilities should be leveraged as stabilization hubs in rural trauma networks [10]. Our results suggest that NG911 can facilitate this integration by optimizing routing and reducing delays, but clinical limitations of these facilities, such as lack of surgical capacity, remain significant.

4.3. Implications for Rural Health Equity

The results have several implications for rural health equity in Illinois and beyond. To start, NG911 represents an important digital infrastructure investment that disproportionately benefits underserved rural communities, as modest gains in northern Illinois contrasted with substantial improvements in central and southern counties, indicating its potential to reduce geographic inequities. In addition, the persistence of frontier disparities highlights the need for layered interventions, suggesting that NG911 should be viewed not as an endpoint but as a foundation upon which additional strategies such as telemedicine integration, regional trauma planning, and air ambulance deployment must be built. Equally, the improvements in urgent care coverage point to opportunities for policy innovation, as leveraging NG911 to integrate smaller facilities into trauma networks could extend stabilization coverage while supporting transfer protocols and telehealth-enabled consultation, thereby strengthening rural health resilience in regions affected by hospital closures. Moreover, the study underscores the necessity of embedding equity considerations into digital transformation initiatives, since infrastructure upgrades such as NG911 are not neutral and may exacerbate disparities if deployment is uneven across counties, making it critical to ensure that frontier regions receive full implementation, training, and ongoing support to achieve equitable outcomes.

4.4. Limitations

Several limitations should be acknowledged. To begin with, this study modeled accessibility based on road networks and dispatch delay assumptions rather than measuring actual patient outcomes, and while golden hour coverage is a strong proxy for survival likelihood, real-world factors such as EMS staffing, weather, and traffic conditions may alter effective response times. In addition, NG911 benefits were parameterized using documented national averages of dispatch delay reductions, but local variability in PSAP training, technology adoption, and system redundancy may influence the extent of realized gains. Another limitation is that facility capacity was not modeled, meaning that a trauma center within 60 minutes could still be overwhelmed during mass casualty events or pandemics, thereby limiting effective access. Furthermore, the analysis excluded helicopter and air ambulance services, which play a critical role in rural Illinois, particularly in frontier counties; incorporating aviation-based accessibility would likely reveal greater golden hour coverage but also highlight disparities in cost and availability. Lastly, the study was confined to Illinois, which has a unique geography and health system configuration, so the results may not be fully generalizable to other states, although the methodological framework remains broadly applicable.

4.5. Future Research Directions

Building on these findings, several avenues warrant further investigation. Linking NG911 implementation to actual trauma survival and morbidity data would provide stronger causal evidence of impact, while future models that incorporate both ground and air transport could offer a more comprehensive picture of accessibility. Research should also examine how NG911 can be integrated with telehealth platforms to enable remote stabilization guidance in frontier settings, and a cost-benefit analysis that considers infrastructure investments alongside health outcome improvements

would provide valuable insights for resource allocation. Replicating this analysis in other rural states could facilitate cross-state comparisons and the identification of best practices for NG911 deployment, and incorporating socioeconomic indicators such as income, race, and insurance status would allow for a more nuanced understanding of disparities in emergency care access.

5. Conclusion

This study evaluated whether Next Generation 911 (NG911) upgrades improve access to emergency care in rural Illinois. By constructing service areas and isochrones under both legacy 911 and NG911 conditions, we quantified population coverage within the golden hour thresholds of 30, 45, and 60 minutes.

The findings indicate that NG911 significantly enhances access to trauma and urgent care across rural Illinois. Statewide, the proportion of rural residents within 60 minutes of trauma centers increased from 78.4% to 85.2%, while the share living beyond the golden hour decreased by nearly one-third. Gains were particularly pronounced in central and southern Illinois, where geographic barriers and sparse facility distribution have historically limited access.

Despite these improvements, disparities persist. Frontier counties, characterized by very low population density, continue to have large proportions of residents outside golden hour coverage. Even with NG911, more than 30% of frontier populations remain beyond the 60-minute threshold. These findings underscore the reality that communication system improvements, while vital, cannot alone overcome structural barriers such as long travel distances and hospital closures.

NG911 represents a foundational step in modernizing emergency communication and reducing inequities in access to care. However, to achieve universal golden hour coverage in rural Illinois, additional interventions will be required, including regional air ambulance expansion, telemedicine integration, and more strategic trauma system planning.

5.1. Recommendations

Based on the study's findings, several recommendations are proposed for policymakers, emergency planners, and future researchers. Counties that have not yet fully transitioned to NG911 should be prioritized, with state-level funding and technical assistance provided to ensure uniform deployment across Illinois. NG911 upgrades should also be integrated into broader trauma system planning, with dispatch protocols optimized to include urgent care and critical access hospitals as stabilization points within the emergency care continuum. For communities that remain outside golden hour thresholds even with NG911, complementary interventions such as expanded air ambulance bases, mobile trauma units, or telemedicine-enabled stabilization are essential to closing persistent gaps. Equity should be embedded into NG911 governance, with state and local agencies monitoring performance by geography and population subgroup to ensure improvements are equitably distributed and underserved communities do not lag behind. Finally, future research should move beyond accessibility modeling to evaluate whether NG911 reduces trauma mortality, improves response times, and strengthens overall rural health system resilience.

Compliance with ethical standards

Disclosure of conflict of interest

The author declares no conflict of interest related to the design, implementation, or publication of this research. The study was conducted independently, without financial sponsorship or external influence.

Statement of ethical approval

The study relied exclusively on publicly available secondary data and did not involve human subjects. All datasets were handled in accordance with institutional data governance and ethical guidelines.

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