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Network Analysis To Understand Regional Patient Flow

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Study Objectives: Consolidation of health care systems in the United States has created integrated enterprises with large geographical reach and complex interacting components. Specialty services vary among sites, and patients often need to travel between facilities for different aspects of care. Network science is an established method employed to investigate these complex systems, and can be used to identify bottlenecks, opportunities to increase value and patient-centeredness in health care. The COVID-19 pandemic changed care demand patterns unexpectedly. We wanted to investigate if network analysis would allow us to better understand these changes and challenges - where our patients receive hospital-based care, what services they used and how far they travelled. We focused this analysis on a multispecialty, tertiary care academic center emergency department ("AC_ED"), with 70,000 patient visits annually.

Methods: We extracted patient location information from electronic health records, including originating location and level of care, to create a network representation of all care pathways that passed through our ED. The volume of transfers between nodes and the distance travelled were encoded as weighted/colored edge attributes, with edges between nodes in closer proximity being darker. Nodes include: communities within our service area, EDs, and academic center units, and an outcome of mortality. They are sized/colored by betweenness centrality, reflecting the importance of the node in the integrity of the network.

Results: The figure shows the overall network structure was similar for pre- and post-pandemic onset with some changes in details. AC_ED receives patients from many home locations and referring hospitals. A large proportion of visits come from the local area reflected by M16 and M12. There are many patients who travel far to access emergency care at AC_ED, bypassing local EDs though the average distance travelled to access care reduced from 114 to 85 miles. During the pandemic there was more traffic to the AC_ED from the local area (M16), fewer connections to surrounding hospitals and disproportionately reduced visits from distant areas (O and OT). Low ED volumes and restricted outpatient clinic availability during the pandemic time frame likely affected this. Inter-hospital transfer volumes declined overall, several sites transferred very few patients to AC_ED post-pandemic start, and other sites increased their transfer rate (eg, CAH13).

Conclusions: Looking at hospital systems through the lens of network science can reveal changes in patterns of referrals, allows for identification of unexpected results by presenting data visually and can assist identifying crucial components of a health care system. Application of this methodology to other variables has the potential to identify new areas of improvement to increase value, outcomes and services to improve patient-oriented care.

Progression of COVID-19 from Urban to Rural Areas in the Southwest: A Spatiotemporal Analysis of Prevalence Rates

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Background: COVID-19 emerged in the United States on January 20, 2020 and has rapidly proliferated across the nation affecting more than 15 million individuals. Case incidence rates vary at the local, county, and state levels and it is unclear if a difference exists in the incidence of new COVID-19 cases among urban or rural counties. Due to county population density and geographic progression of the virus over time, COVID-19 may demonstrate variable incidence rates among urban and rural population centers.

Study Objective: The present study examines whether temporal differences in the incidence rate of diagnosed cases of COVID-19 exist between urban and rural counties in the Southwest United States.

Methods: Daily COVID-19 cases from Arizona, California, Oklahoma, Texas, and Utah were retrospectively tabulated on a county basis using publicly accessible...
state health department data from March 1, 2020 to November 28, 2020. Counties were classified as rural or urban using the current classification by the Federal Office of Rural Health. Daily incident cases and prevalence per 100,000 persons were analyzed as continuous variables. Linear regression was used to assess the temporal relationships between new cases and county type. Descriptive statistics summarized the data.

Results: A total of 400 counties were analyzed with the majority of counties being rural (n=262, 65.5%). No difference was detected in the prevalence of COVID-19 cases per 100,000 people between rural and urban counties (3616.4 Rural vs 3387.6 Urban; p=0.117) but there was a linear increase in total cases per 100,000 over the calendar year (p<0.001). Rural counties demonstrated a significantly higher COVID-19 incidence rate in October (587.2 Rural vs 414.4 Urban; p<0.001) and November (919.0 Rural vs 771.6 Urban; p<0.001) than urban counties (Figure). However, no difference was observed in the incidence rates for March through September (p>0.05).

Conclusions: Temporal data from this epidemiologic study show that the largest increases in COVID-19 cases during the "second wave" were attributed to rural counties. Despite its limitations as a geographic and population-based survey, this data indicates that continued efforts to prevent the rural spread of COVID-19 are warranted.

![Graph: Covid-19 cases per 100,000 among all states, urban vs rural](image)

**Figure:** New cases per 100,000 in Southwest urban (blue) and rural (red) counties by month.

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**65 Interviews With Emergency Physicians on Telehealth During COVID-19 and its Role in Caring for Older Americans**

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**Study Objectives:** To explore United States (US)-based emergency medicine (EM) physicians' perspectives with providing telehealth during the COVID-19 pandemic, with a particular focus on meeting the needs of older (>64 years old) EM patients who may have unique challenges with technology use and increased vulnerability to COVID-19.

**Methods:** We used purposive sampling through social media and listserves to recruit emergency physicians, from all geographic regions and practice settings, who cared for older patients during the pandemic. We conducted 30-minute semi-structured interviews and offered incentives for participation. Initial interview questions elicited general experiences with telehealth during the pandemic, while later questions focused on special considerations for older patients. Interviews were recorded, transcribed and de-identified. We created a codebook a priori, double-coded the interview transcripts, and used framework matrix analyses to identify themes and subthemes.

**Results:** We interviewed from July to November 2020. Participating physicians (n=15; academic 10/15, community 5/15) practiced in all US regions. Practice locations included metro (7/15), suburban (6/15), and rural areas (2/15). Physicians reported using telehealth in the outpatient setting and within the emergency department (ED), especially during personal protective equipment (PPE) shortages. Several themes emerged: (1) telehealth as a public health tool, (2) its suitability for EM patients, (3) special considerations for older patients, and (4) the future of telehealth.

Physicians noted that telehealth was a valuable public health tool, providing access to accurate, timely information about COVID-19. This assistance was considered integral to providing public health information, in addition to low acuity care and patient satisfaction. We aim to determine the impact of COVID-19 on Tandem, a home-based community paramedicine program (HBCPP) that provides comprehensive care for geriatric patients with high acuity conditions, nurses, and social workers.

**Methods:** This was a retrospective cohort analysis of elderly patients (>65 years) who triggered emergency medical services (EMS) dispatch with urgent medical calls over a two-year study period within the Grand Rapids metropolitan out-of-hospital area. HBCPP members were compared to non-members (control group) in terms of demographics, Charlson Comorbidity Index (CCI), presenting complaints, out-of-hospital interventions, transport to the emergency department (ED), and length-of-stay (LOS). Chi-squared and t-tests were used to compare the two study groups across key demographic and outcome variables.

**Results:** During the two-year study period, there were nearly 4500 EMS calls from elderly patients with high acuity conditions which include: fever, altered mental status, fall, dysuria, cardio-pulmonary complaints, and fatigue/weakness. The average age was 79.4 ± 9.7; 49.1% were female. A total of 969 and 471 urgent HBCPP assessments were completed in 2019 and 2020, respectively. In both years, HBCPP members had increased comorbidities compared to control population: hypertension (61% vs. 14%), diabetes mellitus (39% vs. 19%), and congestive heart failure (17% vs. 4.0%). In 2019, members had reduced ED transport compared to control (15.0% vs. 73%) (p<0.001) with higher admission rates (51.7% vs. 20.4%) and identical length of stay (LOS) (4.6d vs. 4.6d) (p<0.001). In 2020, Tandem patients had reduced ED transport (11.7% vs. 88.3%) with increased average LOS (5.4d vs. 5.0d). For HBCPP patients not transported to the ED they had a 17% chance of ED evaluation within seventy-two hours in 2019 and 13% in 2020. Our home-based community paramedicine program experienced decreased emergency department utilization rates during the COVID-19 pandemic in 2020 compared to 2019 (11.7% vs. 15.0%) with a subsequent increased LOS. Program members evaluated in the home but not transported to the ED also had decreased 72-hour ED utilization rates. One limitation from this work is that we had nearly 50% reduction in the number of urgent assessments completed in the home during 2020.

**Conclusion:** Our HBCPP was started as a solution for at-risk seniors who have difficulty navigating the health care system to get the care they need. During the COVID-19 pandemic, our results suggest that the HBCPP program reduced ED utilization during 2020 but had longer LOS. Further research into the safety, associated and comparative LOS, and expansion of such programs will be informative on large scale generalizability of such programs.