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Relationship between Telemedicine Use and HPSA Scores in Rural California Areas

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Walden University
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Abstract

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MHA, West Coast University, 2017

BS, Notre Dame University, 1997

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Healthcare Administration

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Abstract

It is the purpose of this quantitative study to determine whether telemedicine has improved healthcare coverage in rural California as measured by HPSA scores, and especially for intensive care units (ICUs). This study examined the relationship between ICU length of stay, telemedicine use among ICU providers, and HPSA scores in rural California areas. This study explored whether there is a significant relationship between HPSA score of hospitals in rural California areas and ICU length of stay and if there is a significant relationship between HPSA score of hospitals in rural California areas and ICU telemedicine use. This study was guided by the four level healthcare system developed by Ferlie and Shortell, which examines the impact of internal and external variables on healthcare access; technology is considered a central element of the model. The method of analysis was Pearson's *r* correlation analysis. The p-value for the first research question indicated that there was a 46% probability of that these results were due to chance, compared to a 5% probability of rejecting the null hypotheses. Consequently, for the second research question, no significant correlation was found and the null hypothesis could not be rejected. The results of the analysis were partly consistent with the literature, as the nonsignificant correlation indicated that the HPSA scores are not directly related to the length of stay in ICUs. The study's findings may be used by administrators for positive social change as they consider the use of telemedicine in the future.

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Section 1: Foundation of the Study and Literature Review

Introduction

There are some parts of the United States (U.S.) where the availability of critical intensive care is limited. Further, rural and small hospitals require staff who are properly qualified to use telecommunication methods.

Health provider shortage areas (HPSA) impact rural areas and patient outcomes. The HPSA indicates the need for healthcare systems to develop innovative approaches for managing shortages of healthcare providers while ensuring that populations in rural areas are provided quality care. One approach that is effective in some settings is telemedicine. Telemedicine may serve to partially address HPSAs by ensuring that care is delivered in rural areas regardless of presence or lack of medical staff (Zachrison et al., 2020). Telemedicine services might address or partially mitigate HPSAs by ensuring that medical expertise is delivered to rural communities.

The specific research problem that is addressed through this study is whether or not telemedicine use has improved healthcare coverage as measured by HPSA value in rural areas of California, especially for intensive care units (ICUs). As such, the purpose of this quantitative study was to examine the relationship between ICU length of stay, ICU telemedicine use among ICU providers, and HPSA scores of hospitals located in rural areas of California. HPSA scores (range 0–25) denote hospitals with the greatest needs based on their population to provider ratios, percentage of populations below the 100% federal poverty level, infant health index, and travel time to nearest source of care. The literature review provided in this section is a succinct review and synthesis of related

articles and studies. Sections of this study include the background, purpose of the study, research questions and hypotheses, theoretical framework, nature of the study, literature review, definitions, assumptions, scope and delimitations, significance, and a summary and conclusion. The background of this study is presented in the following section.

Background

Telemedicine is useful for addressing barriers to patient access and care. In addition, there are multiple noted benefits of telehealth, such as cost reductions, care quality, and reduced length of stay in ICUs (Barnett et al., 2018; Dorsey & Topol, 2020). Conversely, barriers exist related to telehealth medicine, such as provider buy-in, cost, and technological limitations. Nevertheless, implementation may positively impact care services, especially in rural areas (Annaswamy et al., 2020; Chen et al., 2017; Zobair et al., 2020).

There is a critical need to employ telemedicine as a means of addressing patients across the US. In particular, patients in rural regions can greatly benefit from telemedicine, but barriers remain in terms of implementing these approaches.

There is a lack of consideration regarding how telemedicine has improved healthcare coverage as measured by HPSA values in rural areas, especially for ICUs. The purpose of this quantitative study is to examine the relationship between ICU length of stay, ICU telemedicine use among ICU providers, and HPSA scores of hospitals located in rural areas in California.

Purpose of the Study

The purpose of this quantitative study is to examine the relationship between ICU length of stay, telemedicine use among ICU providers, and the HPSA score of hospitals located in rural areas of California.

Research Questions and Hypotheses

The following research questions and hypotheses guides this study:

RQ1: Is there a significant relationship between HPSA score of hospitals in rural California areas and ICU length of stay?

$H_0 1$: There is not a significant relationship between HPSA score of hospitals in rural California areas and ICU length of stay.

$H_a 1$: There is a significant relationship between HPSA score of hospitals in rural California areas and ICU length of stay.

RQ2: Is there a significant relationship between HPSA score of hospitals in rural California areas and ICU telemedicine use?

$H_0 2$: There is not a significant relationship between HPSA score of hospitals in rural California areas and ICU telemedicine use.

$H_a 2$: There is a significant relationship between HPSA score of hospitals in rural California areas and ICU telemedicine use.

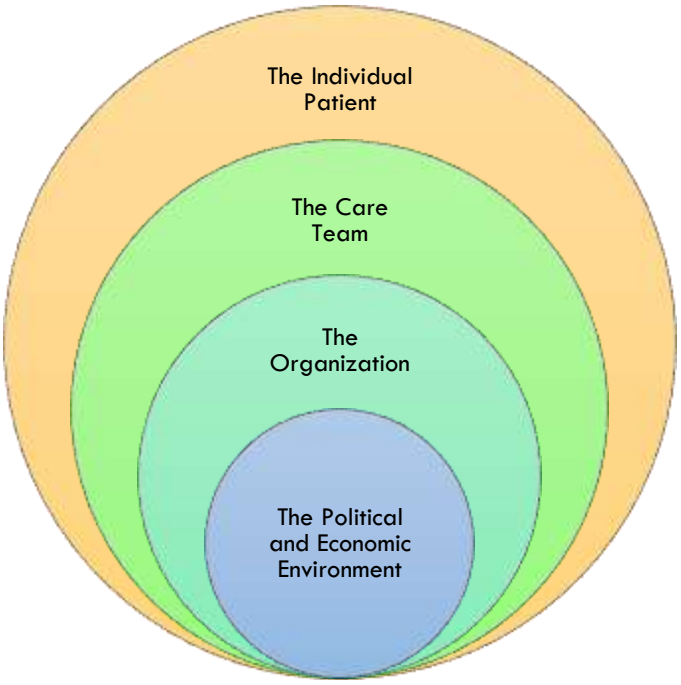
Theoretical Framework

The theoretical framework that guided this study was the four level healthcare system created by Ferlie and Shortell. In particular, technology is a central element of the model, which is important to the current study.

There are four constructs of the model, which are: (a) the individual patient, (b) the care team, (c) the organization, (d) the political and economic environment. In the healthcare industry, technology is also central to all levels of the healthcare system (see Figure 1).

Figure 1

Four Level Healthcare System



Note. Adapted from Ferlie and Shortell (2001).

This model aids in providing the best care to patient and guiding models which healthcare professionals use to deliver care to patients. The four level healthcare system was expanded to include reliance upon technology, which includes reliance on tools such as telemedicine.

This model is important for the current study as it will aid in framing exploration of telemedicine as used by ICU providers to address the issue of healthcare provider shortages in rural areas of California. The model involves focusing on technology and related variables in terms of ICU telemedicine use and length of stay in rural parts of California. I addressed these findings by considering how healthcare providers (e.g., the team) and healthcare organizations (e.g., the organization), can utilize technology (e.g., economic environment) to provide telemedicine services to individuals in rural technology (e.g., the individual patient).

Nature of the Study

The purpose of this quantitative study is to examine the relationship between ICU length of stay, telemedicine use among ICU providers, and HPSA scores of hospitals located in rural areas of California. The quantitative approach was ideal for this study as it allowed gathering secondary data which can be used to analyze the relationships between variables through *t*-test analyses. The study variables were HPSA scores, ICU length of stay, and telemedicine use . HPSA scores denote hospitals with the greatest needs based on their population to provider ratio, percentage of population below the federal poverty level, infant health index, and travel time to nearest sources of care. Data included that were gathered from the California Health and Human Services Open Data Portal. The secondary data were pre-deidentified to ensure confidentiality. Variables related to ICU length of stay, telemendicine utilization, and HPSA score were exported as an Excel sheet. After export, data analysis was conducted using multiple *t*-tests to assess for relationships between these three variables.

Search Strategy

Keywords were: *ICU telemedicine*, *HPSA*, *patient outcomes*, *critical care delivery*, *rural ICU telemedicine*, *critical care delivery telemedicine*, *patient outcomes*, and *telemedicine*. The following databases were accessed to obtain relevant literature: TRIP, Science.Gov, PubMed, JSTOR, Web of Science, and EBSCOHost. All sources were English-only text to reduce translation bias and peer-reviewed studies that presented empirical data regarding key variables. Doctoral dissertations and conference proceedings were not included in this review, as peer-reviewed literature was accessible for discussion. The literature review includes a total of 83 peer-reviewed resources published between 2017 and 2020.

The literature review is framed by key variables of the study. Use of telemedicine and key studies regarding benefits and outcomes are presented. Tele-ICU interventionists are briefly defined according to previous studies. Also, HSPA, rural areas of California, and the implementation and benefits of telemedicine are reviewed. Finally, implications for telehealth are discussed. I summarize key concepts in terms of the current study and proposed research design.

Literature Review Related to Key Variables and/or Concepts

HPSA

HPSAs are a critical concern in the US. According to the Association of American Medical Colleges (AAMC, 2021), there is an ongoing shortage of medical providers across the US. There are 54,100 to 139,000 shortages of HPSA primary and specialty care physicians. According to the AAMC (2021), these shortages critically

impact vulnerable populations across the US. Individuals over 65 are more likely to require critical and specialty care. Further, the population of individuals over 65 in the U.S. is estimated to grow by at least 10% by the year 2035.

A secondary issue is the aging of current physicians within the job market. An increased number of doctors are likely to reach retirement age by the year 2032 (Sylvester et al., 2021). This will increase burnout among other working professionals, which will continue to impact the decline in healthcare providers.

HPSA in rural areas is linked with reduced care and outcomes for adolescents. Leniaar et al. (2021) said in rural areas, there were 7.8 births per 1000 females between the ages of 15 and 19 , compared to 7.13 per 100 in urban areas.

Mental healthcare outcomes are also reduced for individuals in rural areas. Ku et al. (2021) said mental health rates in HPSAs were correlated with increased suicide rates compared to urban areas.

In HPSAs, pharmacy access is also limited for patients. According to Look et al. (2021), individuals in rural areas are more likely to have drive more than 30 minutes to access a pharmacy, while individuals in urban areas only needed to drive 10 minutes to reach a pharmacy. Access to care and services, as well as pharmacy needs, are limited for populations in rural areas.

Telemedicine Use

Telemedicine is growing across the US. Zachrison et al. (2018) said a sample population of 4,031 hospitals either did not (42%) or did use telemedicine (48%). Data also indicated that 4% of hospitals used both telemedicine and staff services. Kichloo et

al. (2020) said telemedicine grew after the impact of COVID-19. Kichloo et al. said benefits of telemendicine included cost-effectiveness and healthcare providers' ability to improve the level of care provided.

Some benefits of telemedicine include betterment of health services for patients and hospitals. Chen et al. (2017) said telehealth services are positively associated with ICU mortality reduction, reduction of hospital mortality, and ICU length of stay. These results indicate that when telehealth services are present, mortality and ICU length of stay are reduced. Implementation of telemedicine procedures was associated with an average cost of $75,000 per ICU bed. Bajowla et al. (2020) said the cost of direct-to-consumer cost of telehealth is falling. Implementation in hospitals is rising due to the need to reconfigure beds and staff policies as well as general administration policies regarding telehealth. Feasibility of telehealth for ICUs may be reduced based on barriers. There is a need to further explore if the cost of implementation is outweighed by benefits for patients in underserviced rural areas.

Tele-ICU Interventionists

Tele-ICU interventionists provide essential services for patients as well as working relationships between medical staff. Tele-ICU interventionists can provide comparable care for patients when compared to bedside staff (O'Shea et al., 2017). Fusaro et al. (2019) said tele-ICU implementation was associated with reductions of ICU mortality rates.. Becker et al. (2020) said tele-ICU medicine was positively associated with improvements in terms of standardization of care and decreased ICU hospital mortality and length of stay.

Training for telehealth can also impact implementation and availability of the service. Trombley et al. (2020) said Medicare spending per episode across 12 large inpatient hospitals in Atlanta was significantly reduced with usage and implementation of tele-ICU care. Additionally, 60-day readmission rates were reduced due to availability of home healthcare through telemedicine. Tele-ICU care can benefit staff and patients when training is implemented (Ho et al., 2021; Subramanian et al., 2020; Venkataraman & Ramakrishnan, 2019). There remains a need to implement similar explorations in terms of rural healthcare and HPSA.

While usage is increasing in large-scale and complex hospitals, these are lacking in rural areas (Chandra et al., 2020; Griffiths et al., 2020; Kosminsky et al., 2019).

Telemedicine Implementation Outcomes

Inclusion can improve staff and patient satisfaction due to reduced burdens. McHugh et al. (2020) said implementation decreased length of hospital stay by 2.5 hours and increased patient satisfaction. Additionally, staff members felt that the program was successful in terms of reducing burdens and improving patient satisfaction. Telehealth is valuable for addressing issues regarding recruitment and retention of staff in rural areas (Goedken et al., 2017). Telehealth was ideal for providing staff support during critical time periods such as evening, night, and weekend shifts. Additionally, Goedken et al. (2017) said telehealth was considered essential for reducing staff transfers and improving standardization of care. There remains a need to understand how such implementation outcomes are achieved despite barriers in rural settings in terms of HPSAs.

Hynes et al. (2019) said patient outcomes due to telehealth implementation might most critically impact rural areas that are experiencing HPSAs. In rural settings, 90% of patients are uninsured, and 50% are privately insured, which prevents their ability to gain care in local or urban hospitals. However, with telemedicine, these individuals could locate healthcare providers that meet their insurance needs or provide options for noninsured low-income patients. Romano et al. (2016) said school-based healthcare centers that used telehealth doubled their usage across rural areas.

Students in rural areas were more likely to receive followup care for asthma as well as specialist appointments through telemedicine implementation. Portoney et al. (2016) said asthma-focused telehealth implementation in rural settings in South Carolina led to a 21% decrease in emergency room visits among families with children of asthma. In Rochester, New York, students who were provided telehealth options were also more likely to have a decreased risk of hospitalization or emergency room visits for asthma (Halterman et al., 2018). For children in rural areas, implementation of telemedicine may be central in terms of better morbidity and mortality rates.

Healthcare expenditures in the US were estimated at 3.3 trillion USD in 2016, which was 17% of the country's gross domestic product.

Use of telehealth could reduce this spending. Chen et al. (217) said telehealth implementation significantly reduces spending and ICU and hospital mortality, and shortens length of ICU stay. It was not clear if telehealth was positive in terms of hospital length of stay.

Telemedicine implementation positively impacted and reduced the ICU length of stay in rural areas and led to bettered rates for mortality and morbidity among these vulnerable populations.

Lilly et al. (2017) said a case volume increased from 4,752 to 5,753 after implementation. This led to a direct contribution margin from $7,921,584 to $37.688,512 after telemedicine. Use of telehealth leads to shorter length of stay in ICUs and increased revenue for hospitals. Ekeland et al. (2012) said telemedicine was likely to increase benefits for hospitals and outcomes for patients, which is ideal for both provider and organizational outcomes.

The efficacy of implementation is partially challenged by the availability of medical context and implementation efforts across the US. Jain et al. (2020) explored telemedicine services at US hospitals in 2018. A total of 4400 respondents indicated two key themes: (a) telehealth consultation and office visits are used partially and, (b) tele-ICU is used through an audio-visual approach using remote critical care specialists. Mars et al. (2019) argued that implementation is also largely composed of spontaneous usage in rural hospitals when needed or through ICU approaches using remote specialists. In some cases, telehealth is used for specialty review, such as in terms of the treatment of musculoskeletal specialists (Helleman et al., 2019). However, despite the benefits, there remains a growing need to closely consider how specific contexts, such as rural location, impacts implementation and the outcomes upon patients for HPSA.

Rural Areas

Rural areas are poised to be critically impacted by HPSA. According to the AAMC (2021), rural areas have a high demand for physicians but lack facilities and willing individuals to work in such secluded areas. The barriers to reaching these rural populations may arise according to the AAMC (2021), which stated that there is a shortage of 74,1000 to 145 500 physicians need for these areas alone. COVID-19 additionally impacted rural areas more than urban areas. The current data demonstrate that rural areas are likely to continue to experience lacking care and facilities due to the growing shortage that was created by wide-ranging deaths during the pandemic (AAMC, 2021).

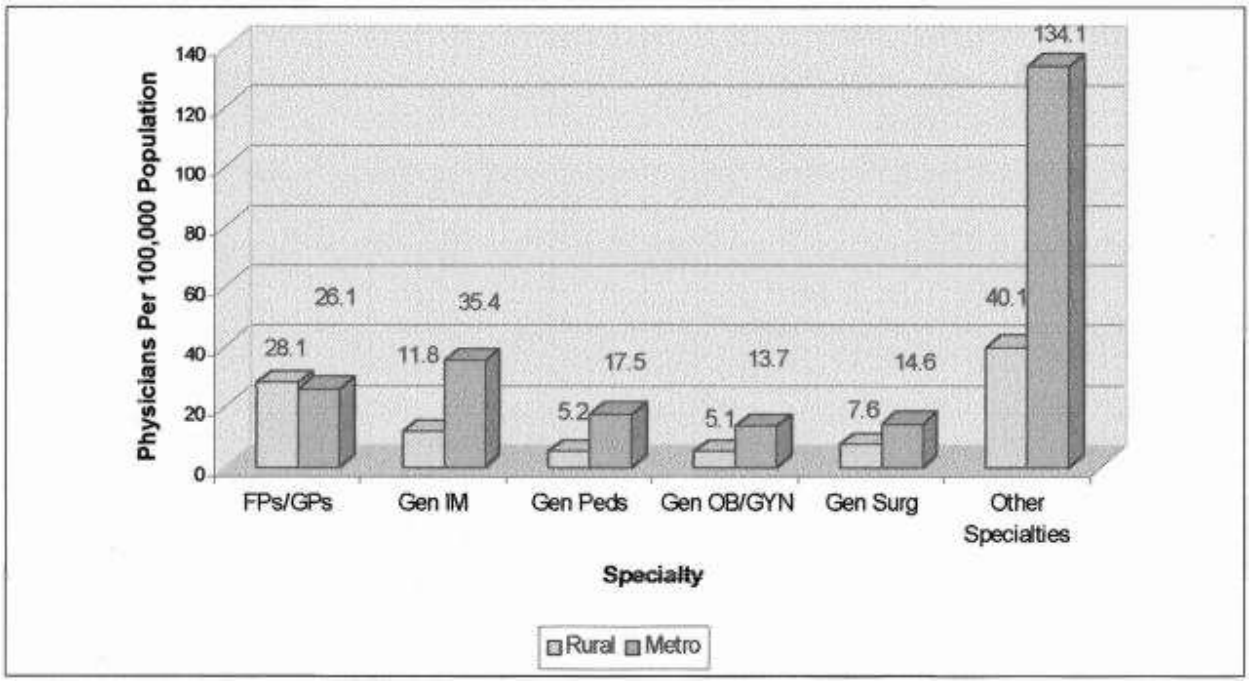
The AAMC (2021) categorized three factors that relate to HPSA in rural areas (a) primary medical, (b) dental, and (c) mental health. The current federal recommendations note that in all populations, there is a specific population to provider ratio, which for example, for primary care, is 3,5000 to 1. Most of the rural populations face a significant lacking primary, dental, and mental health care (AAMC, 2021). There is an issue noted among researchers in terms of retaining physicians within these areas. Pathmn et al. (2011) examined physician retention in rural areas within the framework of HPSA. For the assessment, a nationally representative survey of physicians was gathered and compared in non-HPSA to HPSA regions. The findings indicated that there was an increased risk of physicians leaving rural areas for urban areas. Reasons for leaving varied but included pay increase as well as the need to be in urban areas to continue their personal education or to be within more extensive social and economic benefits in urban

settings (Pathman et al., 2011). Thus, while HPSA is a continued concern, it appears that retention of physicians is a critical issue to consider when addressing how to best meet the needs of these patients.

There are currently multiple issues that populations in rural regions face. These include issues regarding ICU Length of Stay, as well as lacking specialty care that is available in these geographic settings. Rosenblatt and Hasrt (2000) discussed the HPSA in rural areas and noted that 20% of the United States population, or a total of 50,000 people living in rural areas. Of this number, only 9% of the countries' available physicals are located in these rural areas. One of the issues that contribute to this shortage is the proportion of specialist physicians in comparison to the total rural population. Physicians with specialist degrees are less likely to move and stay within rural areas than family care doctors. Figure 2 demonstrates the patient to physician care by the specialist in the relationship of rural to the metro area and specialist physicians.

Figure 2

Patient Care Physicians per 100,000 Population by Location and Specialty



Note. Publicly available data.

In terms of ICU length of stay in rural areas, there is an increased risk of reliance on emergency room departments and local hospitals in rural areas due to the HPSA. For example, Raatiniemi (2015) examined short-term outcomes and differences between rural hospitals. Hall and Owings (2014) noted that rural hospitals provide inpatient care, emergency departments, outpatient departments, long-term care, and health coordination. These hospitals are often low-volume and do not typically include an influx of specialist physicians to treat patients. As a result, some patients may remain in ICUs longer in rural areas to meet the care needed versus if they lived in metro or urban areas (Hall & Owings, 2014).

Rural areas face differing barriers to healthcare than populations in urban areas. For example, in rural areas lacking medical specialists leave patients requiring either to forgo care or travel a significant period of time. For many of these individuals, the cost of travel is too high to make trips monthly to meet their specialized treatments (Hall & Owings, 2014; Hafiz et al., 2021). Other barriers include the inability to locate an adequate connection speed, which can reduce the ability of telemedicine implementation to address HPSA in rural areas. In 2017, Microsoft attempted to address this issue by providing telehealth connections in rural areas at a reduced cost (Hall & Owings, 2014). This large-scale implementation of technology requires further support and resources to ensure that physicians are able to adequality use and implement these tools to support rural populations (Hall & Owings, 2014).

Healthcare outcomes when comparing rural and urban areas also demonstrate the disparities in care that are a result of HPSA. Weihol and Gurnter (2018) examined rural and urban differences in patient satisfaction with primary care and found the reduction of patient care due to the need for many rural patients to drive to urban areas. These patients found that the inequality in care reduced their ability to develop interpersonal relationships with physicians, which Weihol and Gurtner (2018) noted is a critical variable in improving patient communication regarding diagnosis and concerns with physicians. Hendrx (2008) also noted that mental health outcomes are reduced for patients in rural areas. Hendrx (2008) examined health disparities in rural Appalachian areas, which hold large geographic ranges that are difficult to traverse for travel. Further, patients in these regions often lack the financial ability to travel to urban areas to receive

treatment. In comparison with urban and rural areas of Appalachia, patients were more likely to experience decreased mental health outcomes as well as accessibility to treatment. The work of Wieihold and Gurnter (2018) and Hendryx (2008) illustrate critical issues that impact rural areas both in terms of their patient satisfaction and mental health outcomes.

Hospitalizations in rural areas account for 12% (35 million) of all hospitalizations (Hall & Owings, 2014). Further, higher percentages of patients in rural areas were over 65 years and older (51%) when compared to urban hospitals (37%). In these same rural hospitals, national data indicated that a higher percentage of patients in rural areas (7%) were transferred to short-term hospitals when compared to urban settings (3%; Hall & Owings, 2014). The data post-COVID-19 pandemic indicates that these numbers changed as hospitals volume increased 19 (Hafiz et al., 2021). In rural areas, hospital length of stay in 2020 was an average of 14.2 days, while ICU length of stay was an average of 9.6 days in rural areas 19 (Hafiz et al., 2021). Further, these same populations were most likely to face significant negative outcomes in the development of asthma and COPD during 2020, as well as a result of COVID-19 (Hafiz et al., 2021).

Providing care to rural regions through telehealth can also reduce disparities based on socio-economic and geographic location. Access to care for rural regions is a significant issue that can impact care quality and mortality and morbidity rates (Cohen et al., 2018; Greenberg et al., 2018; James et al., 2017; Singh et al., 2017). Lee et al. (2019) addressed the usage of telehealth in the rural population through an assessment of 3,618 rural patients in the 2015 California Health Interview Survey. Using logistic regression

analysis, Lee et al. (2019) found that patients with excellent to good health insurance used telehealth. As a result, patients with poor health and lacking or no health insurance served as a barrier to inclusion or the use of telehealth. Similarly, Khairat et al. (2019) explored tele-ICU care through an exploration of disparities between urban and rural settings. Khairat et al. (2019) assessed 5343 patient records as well as 2195 patients using geospatial analysis. The reviewed literature demonstrated that tele-ICU health did not equalize disparities between rural and urban centers but did increase accessibility in rural areas partially (Hirko et al., 2020; Jetty et a., 2018; Patel et al., 2020). Overall, there is a need to further examine how telehealth implementation in rural areas is effective for accessibility and reduction of disparities.

Researchers argue that despite the ability to use telehealth in rural areas that there is needed research regarding how implementation occurs and associated challenges. Jetty et al. (2018) explored telehealth usage through an assessment of urban and rural healthcare centers. For their assessment, data from a nationally representative randomly sampled survey of 5,000 family physicians was garnered and analyzed using logistic regression analysis. Jetty et al. (2018) found that 83% of family practitioners used telemedicine in urban areas as compared to 17% that was used in rural areas. According to Jetty et al. (2018), the findings illustrate that rural healthcare providers are less likely to use telehealth due to barriers such as cost, lack of implementation, and need for specialized expertise in telehealth usage. Similarly, Park et al. (2018) explored telehealth at the state level to address if state-level telehealth policies impact usage in terms of rural or disadvantaged populations. The research sample included a nationally representative

sample of 22,294 participants. Park et al. (2018) demonstrated that telehealth was perceived as effective, but in reality, was not implemented due to state-level policies. Researchers similarly illustrated that state-level policies, as well as internal policies, may impact the implementation of telehealth which ultimately impacts disadvantaged populations (Brody et al., 2020; Fischer et al., 2020; Tailbot et al., 2020; Tuckson et al., 2017; Trout et al., 2017). Overall, the barriers to telehealth may serve as a significant issue for bettering access to healthcare in rural areas; however, further research is required.

Telemedicine

Telemedicine implementation requires specific technology, which may be a burden to implementation in some rural areas. For example, the implementation of telemedicine requires a digital platform that can connect the patient to the doctor. It is also necessary to have high-speed internet and ethernet connection to avoid the lack of connection during the visit. There is also a need to include a digital stethoscope, otoscope, and an exam camera that will serve to connect the patient and the physical in real-time (Hynes et al., 2019). Though these can be initially expensive, there is an increase of federal grants designed to provide funding for rural areas as well as training for the implementation of telemedicine (Hyned et al., 2019; Romano et al., 2016).

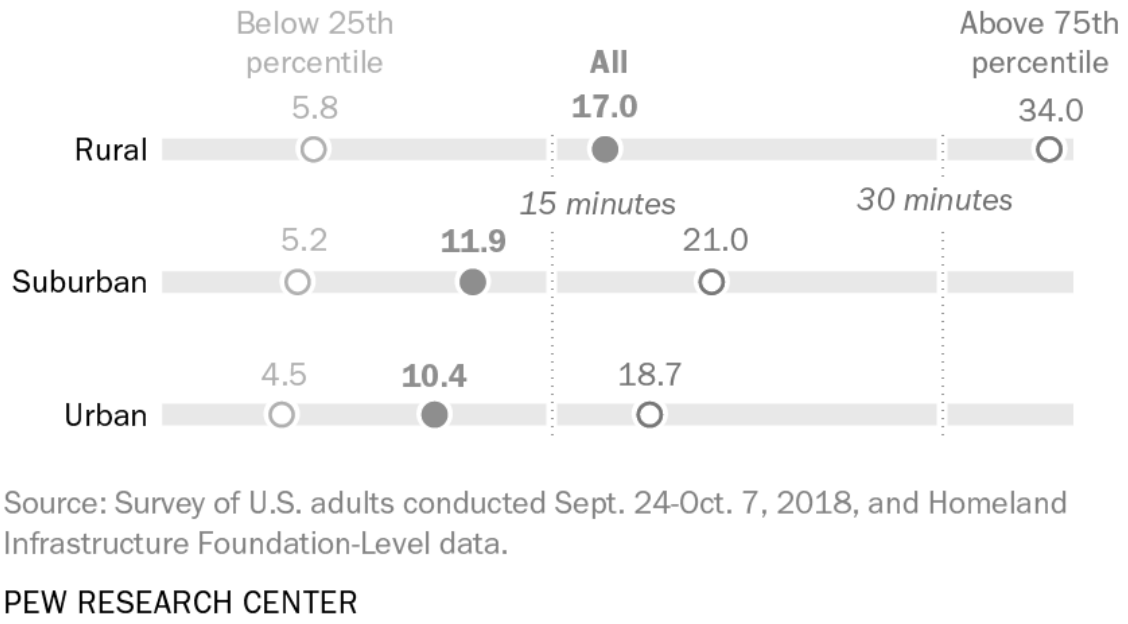
In the past five years, multiple benefits of telemedicine have been offered by researchers. Achenbach (2020) noted that the benefits of telemedicine included access to specialized care, reduced cost, as well as the ability to reduce mortality and morbidity rates in rural areas. The implementation of telemedicine in these rural areas is now

offered alongside specialized training. In North Dakota, the University of North Dakota offers specialized residents traying to use telemedicine to extend the use of psychiatry services to these rural areas (Achenbach, 2020). The programs offer teaching regarding how to use technology and provide monthly trips for face-to-face follow-up alongside telehealth. In South Dakota, some hospitals provide 100% telemedicine inclusion through webcam and no inpatient beds (Achenbach, 2020). The South Dakota rural hospital has bettered the use of telemedicine through emergency department visits with board-certified emergency physicians and nurses twenty-four hours a day (Achenbach, 2020). The program has better patient care as well as providing emergency room reduction of use due to telehealth programs (Achenbach, 2020).

The benefits of telemedicine inclusion are centrally the ability to reduce cost and increase access among patients. According to the Pew Research Center, the drive time to reach a hospital is a central issue for rural regions (Figure 23.

Figure 3

Travel Time for Rural Areas



Note. Public data from the Pew Research Center.

The data from The Pew Research Center demonstrates that 23% of Americans in rural areas have to travel to reach a hospital, which is compared to 9% of individuals in urban settings. This issue has been increased in complexity due to the COVID-19 pandemic, as well as the closure of many rural hospitals due to understaffing and

underfunding (Pew Research Center, 2018). There is also an increased distance for urban and rural populations based on the geographic setting. For example, individuals in the West North Central of the United States are likely to drive the longest to reach an acute care center. Further, patients that lack access to transportation or cannot afford to travel are less likely to receive care (Pew Research Center, 2018). Thus, increasing the need for telemedicine options to support these vulnerable populations (Pew Research Center, 2018).

Data from telemedicine implementation in Wyoming also offer positive results for patients and hospitals. In Wyoming, the Converged Management Application allows for a secure link to patients through an online portal. Patients can access mental health specialists, nursing homes, and cardiologists based on their needs (Achenbach, 2020). Rural regions are also benefiting through the Prison Health Services, which offers specialized series to rural prisons that would otherwise be faced with waiting for care or transportation of prisoners to larger urban settings. Idaho offers similar benefits through the St. Luke's Health System, which is a fully virtual hospital that provides specialists and emergency providers to rural areas across the state (Achenbach, 2020). Programs are now implemented in Idaho through tele stroke, telemedicine for behavioral health, tele pharmacy services, as well as newborn critical care (Achenbach, 2020). The examples provided from these states demonstrate a unique addition of services that are added to support the needs of rural patients.

Telemedicine is considered a possible solution to challenges present in providing care to rural areas and associated patients. Research such as Moeckli et al. (2021)

explored the perceived needs for the implementation of telemedicine in rural hospitals. A sample of 15 administration and 12 administrative physicians at 12-rural and low complexity veteran health administration's hospitals were interviewed. Participants reported benefits such as cost reductions, improved care quality, education, and a reduced sense of insularity. Barriers to implementation include buy-in, cost, and technological limitations. Similar findings are reported by Zobair et al. (2020), who argued that barriers could include a lack of patient-physician relationship as well as poor coordination and implementation in rural areas. Data also demonstrate that barriers associated with cost may include difficulty for administration to predict if telehealth services are effective or comprehensive for patient's needs (Scott-Kruse et al., 2018; Zachirson et al., 2020). As a result, there are some mixed perceptions regarding if telehealth is an effective solution for rural healthcare needs.

Summary of Literature Review

The use of telehealth medicine is considered effective, but there are barriers to usage in the healthcare setting. Barriers in rural areas vary but can include a lack of high-quality internet which reduces the likelihood of implementation for disadvantaged populations (Johnson et al., 2020; Lin et al., 2018; Nicol et al., 2020; Zulman et al., 2019). Muzammil (2020) assessed the geographic distribution of telehealth through a systematic review of the literature from 2018-2019. Muzammil (2020) found that telehealth awareness among physicians is lacking. Barriers also include patient's willingness to use telehealth, as some individuals are willing to use telehealth but may feel more comfortable with face-to-face appointments (Gordon et al., 2020; Peacock et

al., 2020; Slightam et al., 2020). Barriers to telehealth usage in rural areas are exacerbated by a lack of funding as well as training (Lin et al., 2018; Rhoads et al., 2020; Sisk et al., 2020). Further specialization services, such as genetic counseling or accessibility for differing disabilities, are lacking (Pellegrino, 2020; Rhoads et al., 2020; Valdez et al., 2021; Zhai, 2020). Overall, these current barriers require further consideration and research as a means of addressing the needs of rural populations.

Conclusion

The reviewed literature illustrates a growing need, as well as usage for telemedicine across the US (Contreras et al., 2020; Rimmer et al., 2018; Zachrison et al., 2018). In rural areas, researchers emphasize that inclusion can greatly benefit patients (Bajowla et al., 2020; Chen et al., 2017). The barriers that impact the inclusion of telehealth, such as cost, training, and lacking internet connection and quality, can impact telehealth in rural areas (Avidor et al., 2020; Bove et al., 2018; Lee & Lee, 2018; Philips et al., 2019). Previous assessments largely focused on barriers, benefits, and outcomes of implementation and staff and patient experiences (Clair et al., 2018; Gentry et al., 2021; Zimmermean et al., 2021).In the reviewed literature, there is lacking assessments that consider the usage of telemedicine has improved healthcare coverage as measured by the Health Professional Shortage Area (HPSA) value in rural areas, especially for ICUs.

Definitions

Health Provider Shortage (HSPA): A limitation of healthcare providers across the US (Maves et al., 2019). The limitation is most notable in rural regions that are displaced from urban centers (Mascha et al., 2020).

Telemedicine: The use of online platforms and tools to electronically visit a patient and provide care (Zachrison et al., 2020).

Assumptions

The first assumption of this study is that the data collected through the secondary database will serve to address the purpose of this study regarding the relationship between ICU length of stay, ICU telemedicine utilization among ICU providers, and the HPSA score of hospitals located in rural areas of California. To mitigate this assumption, the databases were examined prior to this study to ensure the necessary data was present.

Scope and Delimitations

The study scope is limited to ICU telemedicine utilization among ICU providers in the context of HPSA in California. The study is delimited to data from California for the purpose of this study. This delimitation was necessary to ensure that the gathered data was limited to a geographic context that would be feasible for me to manage. The second delimitation is the focus upon ICU telemedicine utilization among ICU providers in the context of HPSA, which was necessary to meet the gap identified in the literature and provide new information that may benefit healthcare interventions regarding telemedicine in rural areas.

Significance

Previous assessments indicated that telemedicine services might address or partially mitigate HSPAs by ensuring that medical expertise is delivered to rural communities (Calton et al., 2020; Elliot et al., 2017). This study is important to address as telemedicine may serve to partially address HSPAs by ensuring that care is delivered in

rural areas regardless of the current presence or lack of medical staff (Zachrison et al., 2020). Through this study, identifying if the usage of telemedicine has improved healthcare coverage as measured by HPSA value in rural areas, especially for ICUs, can delineate information regarding how to best improve telemedicine as well as coverage for these rural populations. Individuals in rural areas often face multiple barriers to receiving care and treatment. As such, addressing this study may provide new interventions that positively contribute to social change through addressing how telemedicine contributes to healthcare coverage in these rural regions.

Summary and Conclusion

Patients across the US lack access to intensive critical health care staff that are properly trained in rural areas and small hospitals (Calton et al., 2020; Elliot et al., 2017). The purpose of this quantitative study is to examine the relationship between ICU length of stay, ICU telemedicine utilization among ICU providers, and the HPSA score of hospitals located in rural areas of California. In this section, the guiding literature review, the purpose, and the research questions were identified. In the following section, the design and methodology that guide this study will be presented.

Section 2: Research Design and Data Collection

The purpose of this quantitative correlational study was to examine the relationship between ICU telemedicine use among ICU providers and length of stay as well as ICU telemedicine use among ICU providers and HPSA score of hospitals located in rural areas of California. The three study variables are ICU telemedicine use among ICU providers, ICU length of stay, and HPSA scores. ICU telemedicine use among ICU providers refers to annual hours spent using telemedicine among ICU providers. ICU length of stay refers to number of days in the ICU. HPSA score denotes hospitals' needs based on their population to provider ratio, percentage of the population below the federal poverty level, infant health index, and travel time to the nearest source of care. All variables were measured using secondary data gathered from the California Health and Human Service Open Data Portal, Health Resources and Services Administration, and Office of Statewide Health Planning and Development. Collected data involved using correlation analysis via Statistical Package for the Social Sciences (SPSS) for Windows version 27, and inferential and descriptive statistics were calculated.

Section 2 includes the proposed methodology of the study. The chapter includes the rationale for choosing the quantitative method and correlational research design. Furthermore, I examine the population of interest and how that population was sampled, instruments for data collection, the overall data collection approach, data analysis techniques, threats to validity, and ethical considerations. The chapter ends with a summary.

Research Design and Rationale

In this study, a quantitative approach was used. With correlational statistics, researchers are able to quantify and explain degrees of relationships between two or more variables (Pelosi et al., 2001; Warner, 2012). With the quantitative approach, variables or data are measured numerically or objectively, and statistical techniques are used to analyze relationships (Bryman, 2012). The quantitative approach is associated with the positivist paradigm; using quantitative techniques, it involves deriving objective measurements and drawing inferences from results of statistical analysis (Vogt, 2011), as well as providing empirical evidence in support of or in opposition to a hypothesis (Allwood, 2012; Cohen et al., 2002; Wisniewski, 2009). Therefore, quantitative studies are ideally suited for analyzing relationships between variables, which constitute the primary objective of this study.

In this study, results were analyzed using statistical tests based on data collected from secondary sources and telemedicine use rates among ICU providers, length of stay in ICU, and HPSA scores. Since variables in the study are clearly defined and measurable, the quantitative method was appropriate.

The intent of correlational research is to provide quantitative connections between numerically-measured variables (Curtis et al., 2016; Goodwin & Goodwin, 2017). The quantitative research design was selected for the study in order to establish potential relationships between study variables. The purpose of this study was to examine relationships between ICU telemedicine use among ICU providers, ICU length of stay, and HPSA score, which are numerically measured from secondary sources. Units of

analysis were hospitals located in rural areas in California. The correlational study design was best suited for this research.

Methodology

Population

In 2019, there were 570 hospitals in California (Official USA, 2019). Out of these, 122 were government hospitals, and 148 were private hospitals. The general population for this study is hospitals located in California.

Sampling and Sampling Procedures

The study included all hospitals in rural areas of California listed on the California Health and Human Services Open Data Portal, Health Resources and Services Administration, and the Office of Statewide Health Planning and Development. Therefore, no sampling strategy was used in the study. Analyses were only conducted for hospitals that had detailed information for all three variables.

Given the validity of statistical analyses is determined by the sample size, G*Power software was employed to determine the minimum sample size required to achieve 80% power and 95% level of significance. According to Haas (2012), power of test determines the chance of Type II errors, or failing to reject the null hypothesis, while significance level is correlated with probability of Type I errors, or failing to detect a correct result. Finally, in order to assess effect size (i.e., the extent of the association between predictor and criterion variables), Cohen's *d* was used, where values of 0.2, 0.5, and 0.8 indicated small, medium, and large effect sizes, respectively. There are usually three categories of effect size: small, medium, and large. The medium effect size is

commonly used in quantitative studies to enable a balance between restricting estimation of correlations between variables and managing them excessively (Berger et al., 2013).

In order to test study hypotheses and answer research questions, a two-pronged test was applied to two variables simultaneously. Using a 95% significance level, 80% power of test, medium effect size (ρ = .30), a minimum of 84 hospitals were included. Due to the accessibility of the population and representativeness of this population, the sample for this study consisted of all hospitals listed in the California Health and Human Service Open Data Portal, of which are 176 total hospitals are included.

Instrumentation and Operationalization of Constructs

There are three main data sources that were used for this study: California Health and Human Service Open Data Portal, Health Resources and Services Administration, and Office of Statewide Health Planning and Development.

Data for this study were freely accessible, and therefore there was no need to ask permission to gather data from the three government agencies. I extracted all relevant data from the three main data sources, which were exported into a Microsoft Excel spreadsheet. Specifically, data involved ICU telemedicine use among ICU providers, ICU length of stay, and HPSA score for all hospitals located in rural areas of California. The dependent variables were ICU telemedicine use among ICU providers and ICU length of stay. HPSA scores were the independent variable.

ICU Telemedicine Use Among ICU Providers

ICU telemedicine use among ICU providers refers to annual hours spent using telemedicine among ICU providers. The source for this data was the Office of Statewide

Health Planning and Development. Annual hours are collected through a physician survey, and physicians report the number of annual hours they spent on telemedicine by choosing one of seven options. The options are none (0 hours), 1-9 hours, 10-19 hours, 20-29 hours, 30-39 hours, and 40+ hours. Responses were recoded to 0-6 (0 hours to 40+ hours) to follow data requirements for correlation analysis.

ICU Length of Stay

The ICU length of stay refers to the number of days in the ICU. The source for this data will be the California Health and Human Service Open Data Portal. The length of stay will be in terms of the average number of days in the ICU of hospitals. No recoding will be needed as the reported data to be gathered follows an ordinal scale already.

HPSA Score

The HPSA score denotes hospital's need based on their population to provider ratio, percentage of the population below the 100% federal poverty level, infant health index, and travel time to the nearest source of care. The HPSA score will be collected from the Health Resources and Services Administration. California HPSA scores are reported as scores ranging from 0-25, where higher scores denote hospitals with the greatest need based on their population to provider ratio, percentage of the population below the 100% poverty level, infant health index, and travel time to the nearest source of care. No recoding will be needed as the reported data to be gathered follows an ordinal scale already.

Data Analysis Plan

SPSS is routinely used as a statistical tool by researchers working in the field of educational and social sciences. SPSS has the capability of exporting data directly to Microsoft Excel in addition to being user-friendly. The entire statistical analysis will be carried out using SPSS. Data pre-processing will be conducted. During preprocessing, outliers and missing data are removed, resulting in a clean data set. The analysis is restricted to hospitals with complete information on all variables. An entire case is excluded if one of the values is missing (list-wise deletion). Prior to performing the analyses, the dataset will be checked for completeness and any missing or incorrect data will be removed to ensure the reliability of the findings.

Analyzing the data will commence with an assessment of the participants' demographic information, which will be summarized using descriptive statistics. For categorical variables, frequency and percentage will be reported, while mean and standard deviation will be calculated for continuous normally distributed data. Survey responses will then be analyzed. The descriptive analysis will be accompanied by histograms.

The data plan includes inferential statistical analyses, specifically Pearson's *r* or Spearman's rho correlation analysis, which will explore the relationship between the variables. Pearson’s *r* correlation analysis will be conducted if the collected data follows a normal distribution. Otherwise, a Spearman rho correlation analysis will be performed. The skewness and kurtosis measures will be used to determine the normality of the data.

According to George and Mallery (2010), values for asymmetry and kurtosis between -2 and +2 are acceptable for proving the normality of univariate distributions.

A Pearson's *r* or Spearman's rho correlation analysis will be conducted to evaluate the objectives of the study, that is, to find if a relationship exists between ICU telemedicine utilization among ICU providers and HPSA score as well as between ICU telemedicine utilization among ICU providers and ICU length of stay. A correlation analysis is used to determine whether and how closely a pair of variables are related (Nikolić et al., 2012). If the study variables are at the interval level of measurement, the Pearson's r correlation analysis or Spearman's r correlation analysis should be applied (Rubin & Babbie, 2005). Since all study variables are measured at the interval level, correlation analysis is appropriate for the study.

Consequently, Pearson's *r* or Spearman's rho can be used to measure the degree (positive or negative) and strength of correlation between study variables, with values near +1 or -1 indicating high correlation. A negative *r* or rho represents an inverse relationship between two variables, whereas a positive *r* or rho represents a direct relationship. An inverse relationship means that the higher the result of another variable, the lower the result will be for the other variable and vice versa. In the correlation analysis, a level of significance of 0.05 will be used to evaluate the significance of the correlation. A statistical result is considered significant when the *p*-value is less than or equal to the significance level (Neuman, 2003).

Threats to Validity

A research study that is designed to address any of these issues must meet the criteria of construct, internal, and external validity. All relevant measures will be taken to eliminate any such threats. Moreover, according to O'Dwyer and Bernauer (2016), internal validity refers to the degree to which the study findings can be accepted as true (i.e., the degree to which any alternative explanations to the obtained results, relationships, and causal effects can be excluded). When threats are incorporated into a study, they reinforce the study, validate the research design method, and confirm that the study is measuring the variables it claims to measure.

In order to determine whether the findings of a study have internal validity, researchers should be able to determine whether the findings are accurate (Leedy & Ormrod, 2012 . This study addresses the issues of data normality and cofounding variables within the context of threats to internal validity in correlational studies (Whitley et al., 2013). In order to minimize the internal validity threat of instrumentation, only valid and reliable sources are used in this study. Furthermore, it will ensure that the data collected is accurate. Data will be derived from public websites which are owned and managed by government agencies, so the validity and reliability of the data should be acceptable.

Additionally, a study is considered to have adequate external validity if the results will be valid in multiple pertinent contexts, or if it can apply to research samples and settings with similar characteristics (O'Dwyer & Bernauer, 2016). This study's design restricts my ability to generalize results beyond the study population. In addition, an

external validity threat resides in the interaction between settings (rural areas) and the number of ICU beds within this study (Whitley et al., 2013). As stated by Whitney et al. (2013), interaction between relationships and setting questions whether a certain kind of relationship will hold if done in a different setting. Due to the fact that the population of this study was from rural areas in California, the interaction of setting and number of ICU beds may pose a threat to generalizing results to other locations.

Ethical Procedures

The most important element of this research is that it adheres to the key principles of the Belmont Report which are respect, justice, and beneficence. While the Belmont Report lays a vital ethical foundation, it is essential to realize new ethical considerations have revealed themselves since the Belmont Report was published. One of these ethical considerations is ensuring that the data of study participants are appropriately handled and protected. In order to protect this data, all data for this study, both in soft copies and hard copies, will be saved and kept either in a password-protected computer or locked cabinet to which I have sole access.

The risk for participants in this study is minimal to none because secondary data will be utilized. To ensure the integrity of this study, participants will be assured of complete anonymity, which means that no information or data pertaining to the hospitals will be collected. As a result, hospitals will be assigned pseudocodes (such as H01, H02, etc.) and participants will be given pseudonyms. However, as the information collected as part of this research will not be confidential, in the unlikely event that anonymity is compromised, this breach will not be expected to cause any harm.

To prevent such incidents from occurring, all gathered data will be safeguarded by me. Specifically, the hard copies of all documents gathered as a part of the investigation will be stored in a locked filing cabinet inside me personal office that is also locked when not in use. All data stored in electronic form will similarly be kept in a password-protected flash drive which will be in my possession at all times. Finally, seven years upon the completion of this study, all aforementioned records will be destroyed, whereby hard copies will be shredded and electronic files will be deleted after which the flash drive will be reformatted.

Summary

The purpose of this quantitative correlational study is to examine the relationship between ICU telemedicine utilization among ICU providers and ICU length of stay as well as ICU telemedicine utilization among ICU providers and HPSA score of hospitals located in rural areas of California. The three study variables are ICU telemedicine utilization among ICU providers, ICU length of stay, and HPSA score. All variables will be measured using secondary data gathered from the California Health and Human Service Open Data Portal, Health Resources and Services Administration, and Office of Statewide Health Planning and Development. All hospitals located in the rural areas of California and listed in the California Health and Human Service Open Data Portal, Health Resources and Services Administration, and Office of Statewide Health Planning and Development will be included in this study. Correlation analysis will be conducted to analyze the data using the SPSS for Windows Version 27.

Section 3: Presentation of the Results and Findings

Introduction

The purpose of this quantitative study was to examine the relationship between ICU length of stay, ICU telemedicine use among ICU providers, and HPSA scores of hospitals located in rural areas of California. Exploratory data analysis was performed to address characteristics of datasets. Correlation analysis was implemented to assess research questions. Assumptions of correlational analysis were tested. Linear regression analysis was performed for supplementary research.

Research Questions and Hypothesis

The following research questions and hypotheses guided the study:

RQ1: Is there a significant relationship between HPSA score of hospitals in rural California areas and ICU length of stay?

$H_0 1$: There is not a significant relationship between HPSA score of hospitals in rural California areas and ICU length of stay.

$H_a 1$: There is a significant relationship between HPSA score of hospitals in rural California areas and ICU length of stay.

RQ2: Is there a significant relationship between HPSA score of hospitals in rural California areas and ICU telemedicine use??

$H_0 2$: There is not a significant relationship between HPSA score of hospitals in rural California areas and ICU telemedicine use.

$H_a 2$: There is a significant relationship between HPSA score of hospitals in rural California areas and ICU telemedicine use.

Accessing the Data Set for Secondary Analysis

Three secondary data sets were obtained from the California Health and Human Service Open Data Portal, Health Resources and Services Administration, and Office of Statewide Health Planning and Development. The study variables were HPSA scores, ICU length of stay, and ICU telemedicine use among these providers. ICU telemedicine use among ICU providers refers to annual hours spent using telemedicine. ICU length of stay refers to number of days in the ICU. HPSA scores denote hospital needs based on their population to provider ratio, percentage of population below the federal poverty level, infant health index, and travel time to nearest source of care.

Initial screening took place to clean data in preparation for analysis. The cleaning process led to the removal of incomplete cases, missing values, and outliers. During the completion of the cleaning process, all three datasets were loaded to SPSS to complete analysis. The cleaned data were then aggregated by zip codes and counties. The initial HPSA scores dataset was filtered to keep only rural medical institutions. HPSA scores were converted to averages corresponding to counties where institutions were located. The initial ICU telemedicine use dataset had 12,979 not aggregated observations of activities recorded for each zip code. Annual hours they spent on telemedicine were recoded according to the data analysis plan. For the third dataset, the total number of discharge days was divided by the number of discharges. Finally, the three study variables were matched in terms of counties and zip codes, and the resulting dataset included 65 observations of medical institutions with the corresponding average days of stay, hours spent on telemedicine, and HPSA scores.

The average length of stay was 13.89 days (*SD* = 20.79 days) for all patients(see Figure 1). The minimum number of days was 2.17 in Fresno (zip code 93654), and the maximum number of days was 101.7 outside of Los Angeles (zip code 90704). Average annual hours spent on telemedicine was 0.71 (*SD* = 1 hour) per medical institution (see Figure 2). The minimum amount of time spent on telemedicine was zero for Riverside (zip code 92225) and San Bernardino (zip code 92252), and [COMPLETE LIST OF ALL OTHER COUNTIES YOU MEAN]. The maximum amount was 6 hours recorded for Fresno (zip code 93611). The average HPSA score was 12.52 (*SD* = 2.71) per county (see Figure 3). The minimum HPSA score was 7 in Lake (zip code 95453), and the maximum was 17 in Inyo (zip code 93514; see Table 1).

Table 1

Descriptive Statistics for Variables (n = 65)

Variable	Mean	Median	Mode	SD	Minimum	Maximum
Length of Stay per patient	13.89	4.63	2.17	20.79	2.17	101.70
Telemedicine	0.71	0.43	0.00	1.00	0.00	6.00
HPSA Score	12.52	12.40	16.54	2.71	7.00	17.00

Table 2

Descriptive Statistics for Variables (n = 65)

	Mean	Median	Mode	SD	Min	Max
Length of Stay per patient	13.89	4.63	2.17	20.79	2.17	101.70
Telemedicine	0.71	0.43	0.00	1.00	0.00	6.00
HPSA Score	12.52	12.40	16.54	2.71	7.00	17.00

Figure 4

Histogram of Length of Stay Per Patient

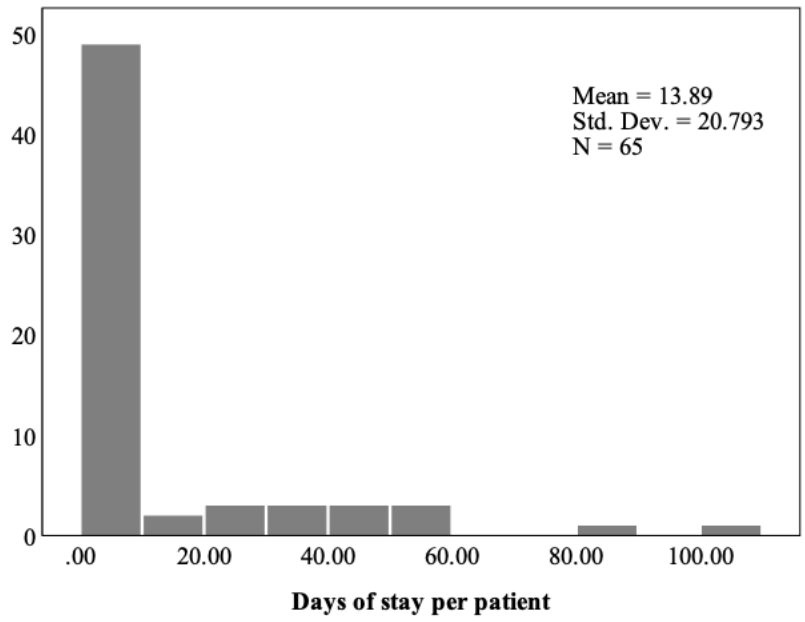


Figure 5

Histogram of Time Spent on Telemedicine

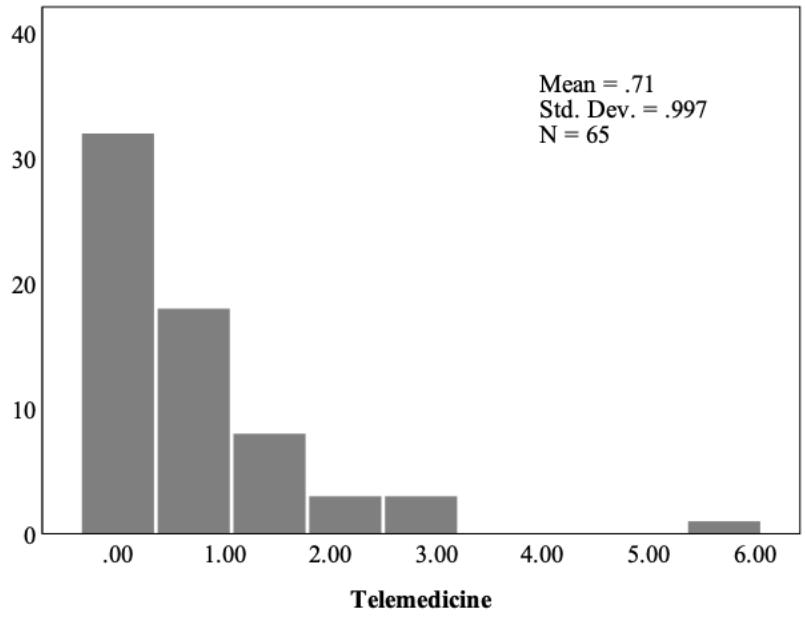
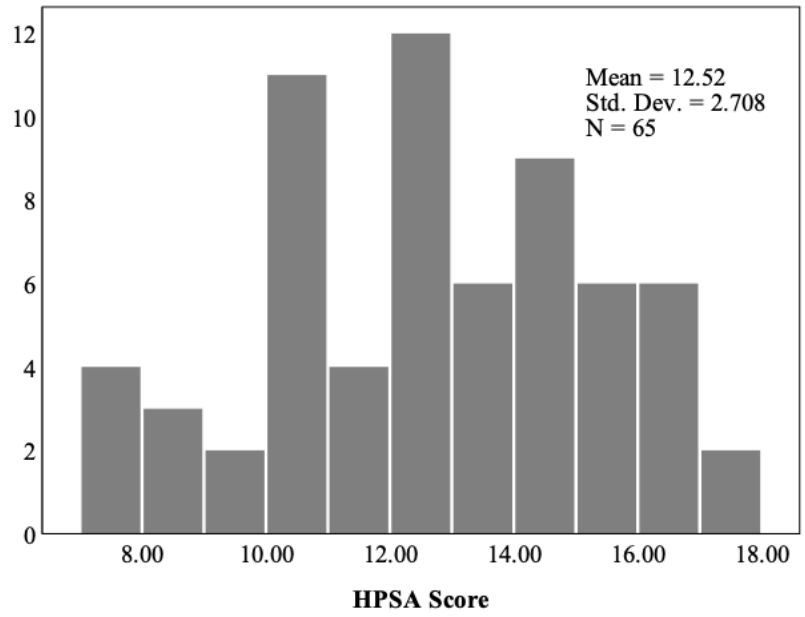


Figure 6

Histogram of HPSA Scores



Resulting variables were not normally distributed. The results of Shapiro-Wilk's test returned significant p-values ($p < .04$), indicating there was a deviation from normality. Table 2 illustrates the results of Shapiro-Wilk's test. Since the variables were found to be not normally distributed, Spearman's rank-order correlation analysis was performed to assess the research questions. Spearman's correlation determines the

strength and direction of the monotonic relationship between two variables. It states the assumption that the variables are measured either ordinal, interval, or ratio scale. The variables of interest in this study were measured on a continuous scale. Therefore, this assumption was met.

Table 3

Shapiro-Wilk Tests of Normality (df = 65)

Variable	Statistic	p
Length of Stay	0.70	<.001
Telemedicine	0.67	<.001
HPSA Score	0.96	0.04

Results

It was found that HPSA scores were not statistically significantly correlated with Length of Stay (r (64) = -.01, p = .99) and Telemedicine (r (64) = -.14, p = .26). It was also found that Length of stay was not significantly correlated with hours spent on Telemedicine (r (64) = -.19, p = .11). Table 3 displays the correlation analysis results using both Pearson and Spearman's methods. The scatterplots of the variables revealed that the variables Length of Stay and hours spent on Telemedicine were concentrated near the lower values. However, HPSA scores were distributed through the full range of its values. Figure 4 below outlines the Length of Stay and HSPA scores. This cluster of lower values potentially might have affected the identification of linear relationships. The log

transformation of the variables did not improve the distributions. Therefore, no transformations were applied for further analysis.

Table 4

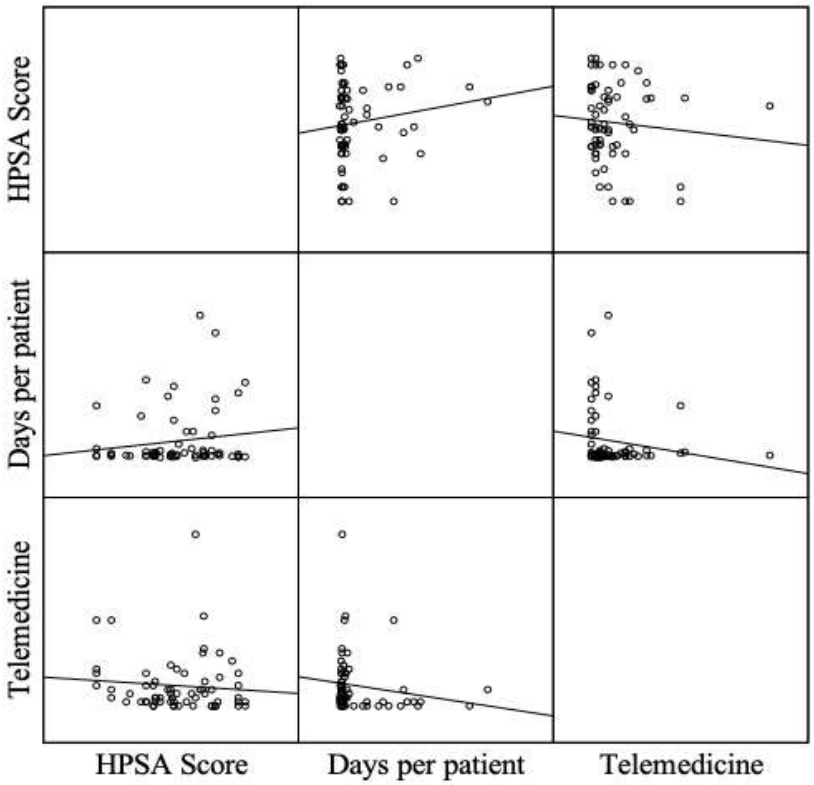
Correlation Analysis

Method	HPSA Score	Length of Stay per patient
Pearson Correlations		
Length of Stay	.14 (.24)	
Telemedicine	-.09 (.47)	-.16 (.18)
Spearman's rho Correlations		
Length of Stay	-.01 (.99)	
Telemedicine	-.14 (.26)	-.19 (.11)

Note. p-values in parentheses.

Figure 7

Scatterplot Matrix of Variables



The results of Spearman's correlation revealed that there was an absence of statistically significant relationships between HPSA and Length of Stay. The p-value was greater than 0.05 which suggested that there was a 99% chance these results were due to chance. Therefore, there was not enough evidence to reject the null hypothesis. HPSA scores were not statistically significantly correlated with Length of Stay (r (64) = -.01, p = .99).

The results of Spearman's correlation revealed that there was a slight negative relationship between HPSA and ICU telemedicine utilization. However, the p-value was greater than 0.05 which suggested that there was a 26% chance these results were due to chance. Therefore, there was not enough evidence to reject the null hypothesis. HPSA scores were not statistically significantly correlated hours spent on Telemedicine (r (64) = -.14, p = .26).

It was also found that ICU length of stay was not significantly correlated with hours spent on Telemedicine (r (64) = -.19, p = .11). The association was of weak strength and had a negative direction, meaning that in these cities when ICU length of stay increased, hours spent on Telemedicine on average decreased. A p-value was greater than 0.05, indicating that there was an 11% chance these results were due to chance.

Supplementary Research

As supplementary research, a linear regression analysis was conducted to assess the partial effects of the Length of Stay and Telemedicine on HPSA scores. The regression model was not statistically significant in explaining the variation in HPSA scores (*R-square* = .02, F (2, 62) = 0.83, p = .44). The partial effect of Length of Stay on HPSA scores was positive and of moderate strength (β = .13, p = .28), indicating that the medical institutions with longer length of stay on average had higher HPSA scores. The partial effect of Telemedicine was negative and of moderate strength (β = -.06, p = .59), indicating that the medical institutions with more hours spent on Telemedicine, on average had lower HPSA scores. However, both effects were not statistically significant (Table 4).

Table 5

Regression Model Summary

	Coef.	SE	Beta	t-value	p-value
Intercept	12.39	0.49		25.09	<.001
Length of Stay	0.018	0.01	0.13	1.07	0.28
Telemedicine	-0.182	0.34	-0.06	-0.52	0.59

Note. Dependent Variable: HPSA Score.

The assumptions of linear regression were generally met. The residuals were approximately normally distributed as depicted in Figure 5. There were also no concerns with multicollinearity (VIF = 1) and heteroscedasticity as demonstrated in Figure 6.

Figure 8

Normal P-P Plot of Residuals

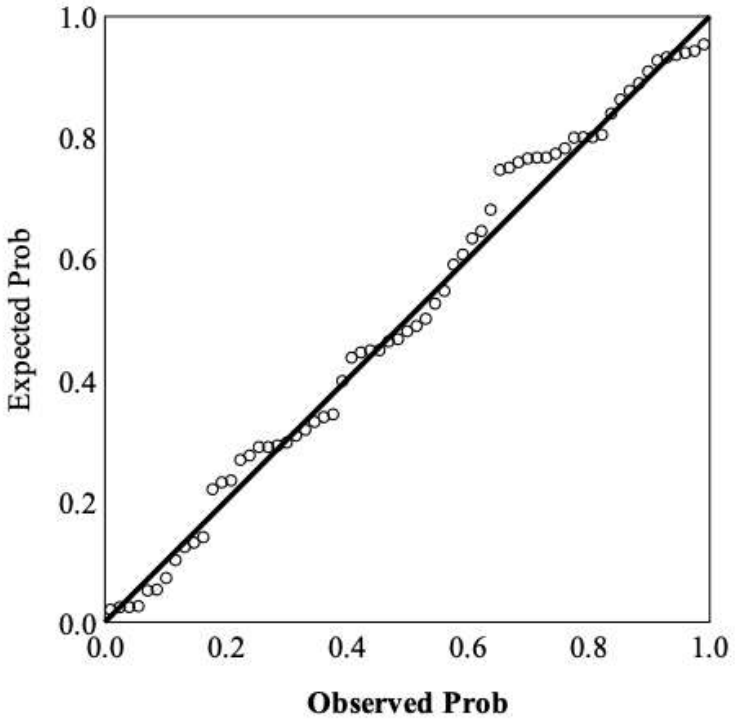
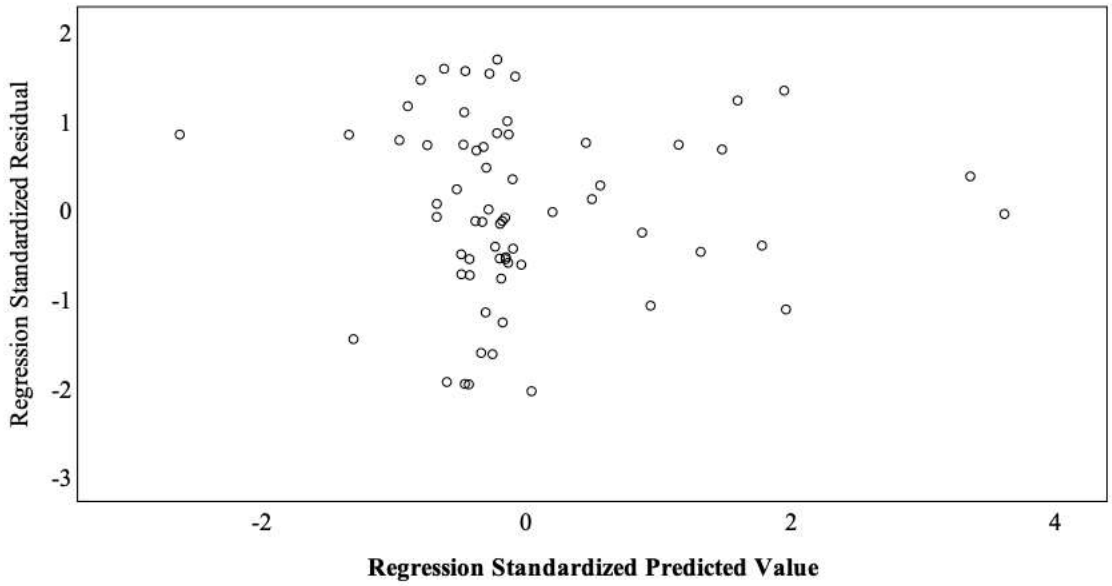


Figure 9

Scatterplot of Standardized Residuals and Predicted Values



Summary

The purpose of this quantitative study was to examine the relationship between ICU length of stay, ICU telemedicine utilization among ICU providers, and the HPSA score of hospitals located in rural areas of California. The exploratory data analysis was performed to present the characteristics of the datasets. The correlation analysis was implemented to assess the research questions. The assumptions of the correlational analysis were tested. It was found that the variables were not normally distributed, therefore, a Spearman's correlation analysis was performed. The results of the test indicated that HPSA scores were not statistically significantly correlated with Length of

stay (r (64) = -.01, p = .99) and Telemedicine (r (64) = -.14, p = .26). It was also found, that Length of stay was not significantly correlated with hours spent on Telemedicine (r (64) = -.19, p = .11). There was not enough evidence to reject the null hypotheses for both research questions; therefore, the alternative hypotheses were accepted.

As supplementary research, linear regression analysis was conducted to assess the partial effects of Days of stay and Telemedicine on HPSA scores. The regression model was not statistically significant in explaining the variation in HPSA scores (*R-square* = .02, F (2, 62) = 0.83, p = .44). The partial effect of Length of Stay on HPSA scores was positive and of weak strength (β = .13, p = .28), indicating that the medical institutions with longer length of stay on average had higher HPSA scores. The partial effect of Telemedicine was negative and of weak strength (β = -.06, p = .59), indicating that the medical institutions with more hours spent on Telemedicine, on average had lower HPSA scores. However, both effects were not statistically significant.

Section 4 discusses the conclusions of the study and the possible reasons for the outcomes described in this section. Limitations of the research and the shortcomings that I encountered during the investigation will also be described. The section then provides a discussion on the recommendations for future research, theory, and practice. The final section is then concluded by a summary of the completed study.

Section 4: Application to Professional Practice and Implications for Social Change

Introduction

Accessibility of adequate healthcare facilities is a critical concern, especially for underprivileged populations in rural areas across the US. HPSAs involve availability of healthcare facilities in rural and urban areas and indicate the need to find solutions to manage quality of healthcare in rural areas. HPSA scores measure healthcare coverage, including the proportion of residents living below the federal poverty level, the infant health index, and travel time to the nearest source of care. As a result of a shortage of healthcare providers, healthcare disparities in rural and urban areas across the US are monumental. HPSA scores range between 0-25, and a higher score indicates a greater need to improve healthcare services.

In this study, I used quantitative correlational study to determine significant differences between means. I analyzed the relationship between ICU length of stay, telemedicine use among ICU providers, and HPSAs score of hospitals located in rural areas of California. Telemedicine includes benefits such as reductions in cost, standard care quality, improved education, and multiple remote access options for primary care providers (Moeckli et al., 2021; Zachirson et al., 2020).

In addition, telemedicine and telehealth can also help to improve ICUs in rural areas, where availability of critical and specialized healthcare services is limited. Tele-ICU interventions were found to effectively reduce the number of stays in ICU and mortality rates and improve standardization of care (Becker et al., 2020; Kalvelage et al.,

2020). As such, telemedicine can be effective in terms of reducing costs of critical care service by providing home-based healthcare facilities.

Barriers to implementing telemedicine technology, including cost of implementation, restructuring medical practices, state policies, and internet quality can ultimately hinder the application of telemedicine practices in rural settings (Lin et al., 2018; Philips et al., 2019; Zachirson et al., 2020). ICU length of stay could be positively associated with telemedicine use; however, there is a lack of information regarding how telemedicine use has improved overall healthcare in rural areas as determined by HPSA, particularly for ICUs. I attempted to analyze relationships between ICU length of stay, telemedicine use, and HPSA scores in rural areas of California.

I used a Spearman's Rho correlation analysis to examine the relationship between ICU telemedicine use, length of stay, and HPSA scores of hospitals in rural areas of California. Even though relationships between variables were not clearly established via correlation analysis, I attempted to analyze a crucial topic to facilitate healthcare access while implementing telemedicine in rural areas. Findings of this study indicate that incorporation of telehealth and telemedicine is imperative to deal with the crisis of HPSAs in rural areas.

Interpretation of Findings

I analyzed the relationship between ICU telemedicine use, length of stay, and HPSA scores of hospitals in rural California areas using a quantitative approach. Statistical analysis was used to provide objective measurements and inferences from the

data set and derive conclusive results from hypotheses. Logistic regression analysis and geospatial analysis were employed to analyze telehealth and telemedicine in rural areas.

Furthermore, selection and definition of all three variables for this research was based on the literature review and theoretical framework. ICU telemedicine use among ICU providers is annual hours spent using telemedicine and was gathered from the Office of Statewide Health Planning and Development. ICU length of stay was measured as number of days in the ICU and data were gathered from the California Health and Human Service. HPSA scores measure hospital needs based on their population to provider ratio, percentage of the population below the federal poverty level, infant health index, and travel time to the nearest source of care. All data sources were freely accessible and managed by government agencies. The unit of analysis was hospitals in rural areas in California. I used SPSS to perform the correlation analysis.

Results of descriptive statistics of variables indicated that data were not normally distributed, and therefore Spearman's rho correlation analysis was conducted to determine validity and reliability of research questions based on existing literature.

I developed two research questions:

RQ1: Is there a significant relationship between HPSA score of hospitals in rural California areas and ICU length of stay?

$H_0 1$: There is not a significant relationship between HPSA score of hospitals in rural California areas and ICU length of stay.

$H_a 1$: There is a significant relationship between HPSA score of hospitals in rural California areas and ICU length of stay.

RQ2: Is there a significant relationship between HPSA score of hospitals in rural California areas and ICU telemedicine use??

H_02: There is not a significant relationship between HPSA score of hospitals in rural California areas and ICU telemedicine use.

H_a2: There is a significant relationship between HPSA score of hospitals in rural California areas and ICU telemedicine use.

For RQ1, the statistical modeling results indicated that the HPSA score of hospitals in rural California was not statistically significant with days of stay in ICU. The p-value was 0.46, which was greater than the 0.05 significant level. The p-value suggested that there was a 46% of chance these results were due to chance as compared to 5% of chance to reject the null hypothesis. The result showed a positive relationship between the HPSA score of hospitals in rural areas in California with days of stay in ICU. The results of the analysis were partly consistent with the literature, as the positive association indicated that the HPSA score is directly related to the days of stay in ICU, and a high HPSA score means longer days in the ICU.

HPSA scores directly impact days of stay in ICU in rural areas (Rosenblatt & Hasrt, 2000). Patients in rural areas typically stay for a longer time in ICU as compared to patients living in urban areas because of low availability of specialist physicians, low volume of patients, reliance on emergency room departments, and poor health co-ordination (Hafiz et al., 2021; Hall & Owings 2014; Raatiniemi 2015). Furthermore, the usage of telemedicine was also found positively associated with a shorter length of ICU

stay. As such, implementation of telemedicine in rural areas can be beneficial to both hospitals and patients (Ekeland et al., 2012; Lilly et al., 2017)

Additionally, statistical modeling results for RQ2 indicated that HPSA scores of hospitals in rural California were not significantly correlated with telemedicine utilization. The results also showed a slight negative relationship between HPSA score and telemedicine utilization. The p-value was 0.67, which was greater than the 0.05 significant level. The p-value suggested that there was a 67% of chance these results were due to chance as compared to 5% of chance to reject the null hypothesis. The low value of the degree of correlation ($r = -0.05$) between HPSA score and telemedicine indicated a low association between these variables. In addition, the negative values indicated an inverse relationship between these variables. The analysis results were partly consistent with the literature as the inverse relationship suggested that the lower value of the HPSA score was associated with the higher utilization of telemedicine in rural areas. The theoretical framework developed for this study emphasizes the implementation of telemedicine to improve healthcare access in rural areas. The literature also suggests the importance of telemedicine to lower the HPSA score in rural areas (Calton et al., 2020; Greenberg et al., 2021). Telemedicine has been considered a central element in healthcare development; it is a convenient method to remotely access the clinical facilities in rural areas (Achenbach., 2020; Ekeland et al., 2012; Kalvelage al., 2021; Lilly et al., 2017). Literature also indicated that the HPSA score is negatively associated with mental healthcare, birth control preventive measures, pharmacy access, and healthcare access in rural areas compared to urban areas (Ku et al., 2021; Leniaar et al., 2021; Look et al.,

2021). Despite existing barriers to implementing telemedicine, technological innovations are helping to reduce the gap between rural and urban areas to access healthcare services. In addition, with the Coronavirus pandemic, there has been an upward trend to imply telemedicine services in rural areas (Hafiz et al., 2021).

Furthermore, the supplementary result of the correlation analysis indicated that the ICU length of stay was found significant with the telemedicine utilization. The supplementary analysis was consistent with the literature and the theoretical framework designed for the study. Existing literature also identified that telemedicine utilization could help reduce the length of stay in ICU and implementation of telemedicine to improve primary healthcare access, especially in rural areas. The inclusion of telemedicine is beneficial for both hospitals and patients and can increase the patient satisfaction rate in rural areas (Dorsey & Topol, 2020; Kalvelage et al., 2021). The utilization of telemedicine can also help to reduce the readmission rates of patients in ICU as home-health care accessibility is possible with the help of telemedicine (Ho et al., 2021; McLeod et al., 2021).

The value of confidence intervals (p-value) to measure the chance or uncertainty in the dataset help to inform future research to understand the weakness in the methodology and not necessarily affect the importance of the theoretical framework designed by using relevant literature. Even if the results indicated that the relationship between the HPSA scores of hospitals in rural California was not significantly correlated with telemedicine utilization and the HPSA scores of hospitals in rural California were

not statistically significant with days of stay in ICU, these relationships are practically important in the context of healthcare development.

Limitations

The range of literature review for this study only focused on the past five years; a detailed longitudinal analysis over a decade will help incorporate deeper perspectives and a broad understanding of factors/variables that may affect the analysis and result. In addition, the statistical significance of any dataset is primarily dependent on the sample size, and one of the major limitations of this study was a small sample size (n=68); the correlation analysis in a small sample size data may not necessarily represent the accurate information.

Population characteristics, including distribution of data, density, geographic settings, demography, socioeconomic status, are critically important when evaluating the improvement of healthcare services in the context of HPSA. The study evaluated the importance of telemedicine, especially for ICU, in the rural area in California; the same research design can have a very different result in areas with a high percentage of rural populations. The study is limited with the analysis in only one state with restricted population characteristics, leading to a biased result.

Another limitation is related to the reliability of the data; secondary data is collected through various sources and can have less accurate information, whereas primary data is gathered through the researcher, and the researcher fully monitors the validity and reliability of data. The primary data is more controlled and less affected by confounds; however, secondary data is less controlled and can be affected by outside

factors. This study is fully based on secondary data analysis, and this may have limited the reliability of data and been subject to the bias information. The secondary data analysis has limited control over the research design and is not necessarily specific to my needs.

The trustworthiness of secondary data heavily relies on the data sources; this study has collected data from three different sources, and the data were aggregated for each zip code for all three variables. The aggregation of data was primarily dependent on the availability of the secondary data, and; some secondary data can be exaggerated due to the personal bias of the data source. Additionally, the datasets may not be specific to the need of the researcher as the researcher does not collect the data. Furthermore, it can be difficult to find updated secondary data specific to the need of the researcher. Secondary data can also limit the generalizability of the research statement. This research gathered secondary data in rural areas; however, the targeted population groups, including low-income, migrants, elderly, underprivileged in the context of HPSA, may not be accurately presented in the dataset.

The selection of research design and methodology is crucial to have a meaningful analysis while conducting research. This study has utilized correlation analysis to examine the relationship between ICU days of stay, ICU telemedicine utilization, and HPSA score in rural areas in California, and the result is only limited to understanding the association between variables but does not tell how a change in an independent variable can cause affect to the dependent variable, and overall gives the limited understanding of the relationship between variables. Additionally, the study only

analyzes the association between ICU telemedicine utilization among ICU providers in HPSA and study areas in California. Considering other variables based on the literature review can have a different result for this study.

Recommendations

The findings of this study recommend considerable opportunities for future research needed to be addressed based on the above-mentioned limitations. Future research could analyze the healthcare model theoretical framework from a more holistic perspective, including all four interrelated levels, patients and family members, care team, and the organizations. This research solely focused on the correlation analysis of the utilization of telemedicine and ICU length of stay with HPSA in rural areas; future research could also consider the possible correlation between HPSA and other variables, including the role of organizations, care team, patient perceptions.

Future research could also incorporate a more advanced statistical analysis, including multivariate regression analysis to examine the relationship between HPSA score, ICU days of stay, and ICU telemedicine utilization. Regression analysis helps analyze the degree of relationship between independent and dependent variables, whereas correlation analysis is useful to determine the association between two variables.

The study was limited to secondary data analysis; future research could include primary data for a better and more sophisticated analysis. Furthermore, future research could also address the same research questions while considering larger sample size and different population characteristics. This study only analyzed the use of telemedicine in

the context of HPSA in rural areas in California. Future research could also include telehealth along with telemedicine to examine the impact and outcome of HPSA.

Future work could also conduct a mixed methods research design to explore the different perspectives while analyzing the implementation of the healthcare services in the context of HPSA. A mixed-method research design could help to analyze both qualitative and quantitative data, allowing one to infer perspectives from each to have a broader understanding of the research problems and have a more robust result. The interview and survey of vulnerable populations, patients' family members, care team, hospital staff, and physicians in rural areas will provide more accurate and need specific data for the research purpose. Future work could also conduct a cost-effective analysis to implement telemedicine in rural areas.

Implications for Professional Practice and Social Change

Due to the ongoing shortage of medical health providers across the United States, there is a need to analyze the trend of healthcare facilities both in urban and rural areas (AAMC, 2021). The implementation of technological tools, such as telemedicine, is imperative to facilitate healthcare access across the United States in the context of HPSA scores. Based on the review of literature as mentioned in section one and the literature review, theoretical framework, and analysis developed by this research, the study recommends the several changes to professional practice. The following suggestions are aimed to improve the overall the healthcare services in rural areas across the United States in the context of HPSA scores.

First, it is recommended that the availability of federal funding be increased to allocate sufficient resources in hospitals in rural areas. Likewise, there needs to be an increase in the accessibility of pharmacy services in rural areas, and rural areas need more close distance pharmacies for the residents. To improve telemedicine services in the rural areas, efficient telemedicine services need to be implemented alongside the close distance pharmacies. More efficient telemedicine services in rural areas can help to manage cost-effective services and offer more comprehensive care to rural residents. In this way, implementing essential services for patients in rural areas, such as tele-ICU interventions, can positively impact the standardization of care. For example, creating specialized training facilities to incorporate telehealth and telemedicine can improve the availability of home-based health care for high-risk and immobile patients in rural areas. The inclusion of telemedicine can thus be more cost-effective for patients and help to improve primary health care access.

In addition to these recommended changes, promoting telehealth services in rural areas can help patients with private insurance and/or no insurance. Telehealth can help to find a wide range of health care providers for patients with all types of insurance and make care more available. The availability of physicians in rural areas will serve to create new ways to increase the physician's retention rate in rural areas. For example, the ability to remain in one desired location, receive the desired pay rate, and maintain important social and economic benefits in the chosen location will further aid a physician’s commitment to rural healthcare. Implementing telehealth services will also help to provide medical specialists in rural areas that often lack specialized treatment facilities.

Transportation for patients to make frequent travels to specialty care can be costly and often serves as a barrier to care. Therefore, having specialized treatment offered in a digital format can help to reduce the travel cost of patients. It is for these reasons that the final recommendation is to develop and provide efficient digital platforms in rural areas to implement telemedicine approaches to address HPSA in rural areas. Providing access to reliable internet at a reasonable cost will also be necessary. These systemic changes will be implemented through flexible state and local policies that prioritize the implementation of telemedicine and telehealth facilities to improve the care provided and available to residents of rural areas.

Conclusion

The review of literature, theoretical framework, and analysis from this study demonstrates that the technological tools, including telehealth and telemedicine, play a significant role in improving healthcare facilities in the context of HPSA in rural areas and need to be incorporated into the healthcare system. HPSA particularly impacts rural areas due to lack of basic facilities and poor infrastructure. Typically, rural areas lack specialized physicians, pharmacy, and medical staff due to the socioeconomic environment and limited amenities. Providing technological tools, such as telehealth and telemedicine, can help patients in rural areas to access specialized and critical facilities without traveling to far-off places.

However, there are a variety of challenges with the utilization of telemedicine in rural areas, such as state and local policies, low-speed internet, education of medical staff, preference of in-person consultation, lack of awareness among physicians, and

federal grants and supports are required to overcome these challenges in the context of HPSA in rural areas. Offering efficient healthcare facilities in rural areas across the United States through technological tools, such as telehealth and telemedicine, can help to reduce socioeconomic and location-based inequalities. Findings also demonstrate that the outcome and impact of the HPSA score to improve the implementation of telemedicine in rural areas.

The use of healthcare technologies, such as telemedicine, can reduce the admission rate of patients, length of stay in ICU, and save traveling costs. Additionally, the usage of technology in healthcare management in rural areas needs to consider the safety and effectiveness of the targeted populations. The underprivileged populations in rural areas may not be able to handle sophisticated technology. The technological tools need to be designed to make it user-friendly and fully address diverse populations' needs.

Additionally, home-based healthcare can be affected by multiple factors, such as family, friends, and infrastructure, like availability of high-speed internet, and vulnerable and elderly populations may need assistance to operationalize the home-based health care. Utilizing telemedicine in rural areas can reduce the ICU length of stays and help to reduce the HPSA score, and overall improve healthcare services. Implementation of specialized programs pertinent to health care systems, flexible local policies, availability of high-speed digital platforms, and availability of tele-pharmacy services can help overcome challenges associated with the implementation of telemedicine in rural areas in the context of HPSA.

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