A Rural Community Readiness Assessment of Prehospital Telestroke Services in the Ambulance

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Abstract

The research team assessed community acceptability of prehospital stroke telemedicine services in rural O'ahu communities. Tools were developed to evaluate patient-centered goals about implementing ambulance-based telemedicine which aimed to retain appropriate patients in community hospitals and improve thrombolytic treatment times. Using a mixed methods approach, the team surveyed well-appearing adults (ie, able to complete survey and interview) at O'ahu community events. Participants were asked to complete a short Likert-scale questionnaire (n=263) followed by a semi-structured interview (n=29). Data were summarized by descriptive and inferential statistics. Comparisons between rural and urban groups were made by chi-square analysis and Wilcoxon rank-sum 2-tailed test. Interviews were transcribed, coded, and analyzed using inductive and deductive methods. The findings suggest that use of prehospital telemedicine for specialty care is viewed favorably by both rural and urban respondents. Additionally, most respondents felt comfortable staying at their local hospital if they had access to a specialist by telemedicine. However, mistrust in rural hospitals may be a potential barrier to implementation. Compared to urban respondents, rural respondents were less confident in their local hospital's resources and capabilities for stroke care. The findings identified a potential misalignment of the project's goal with some patients' goal to use emergency medical services (EMS) to bypass rural hospitals for stroke care. Future community outreach efforts are needed to encourage activation of EMS and highlight the advantages of utilizing prehospital telemedicine for accessing specialty care thereby improving treatment times.

Keywords

Telemedicine, Stroke, Ambulance, Emergency Medicine, Rural Population

Abbreviations

CSC = Comprehensive Stroke Center
C-STAT = Cincinnati Stroke Triage Assessment Tool
ED = emergency department
EMS = emergency medical services
LAPSS = Los Angeles Prehospital Stroke Screen
LVO = large vessel occlusion
MT = mechanical thrombectomy
TNK = tenecteplase

Introduction

Stroke is the third leading cause of death in Hawai'i.[1] Patient travel time between stroke onset, presentation to the care facilities, and appropriate stroke treatment can be long due to geographical barriers, weather, and other factors unique to Hawai'i. Much like other rural and remote care systems, the quality and effectiveness of stroke care is contingent on timely treatment from specialists who can assess the severity of stroke and administer thrombolytic therapies (eg, tenecteplase or TNK) or mechanical thrombectomy (MT). In Hawai'i, there is only 1 certified Comprehensive Stroke Center (CSC) which is located in urban Honolulu on the island of O'ahu. Definitive treatment for patients who live in rural communities may be delayed by travel times, especially for patients who live on the neighbor islands and require inter-island transport for MT at the CSC.

In stroke care, time is brain. An estimated 1.9 million neurons are lost every minute during an ischemic stroke.[2] Timely and definitive care is paramount to reducing the length of hospitalization and improving a patient's quality of life after a stroke. Researchers have demonstrated that early recognition and treatment of stroke reduces the likelihood of long-term disabilities.[3] Since the publication of the DAWN[4] and DEFUSE3[5] studies, which validated extended windows for MT in some patients, stroke centers have expanded collaborative efforts with emergency medical services (EMS) to develop more efficient prehospital care for suspected stroke. A key goal is identification and disposition to correct care of strokes amenable to MT. The American Heart Association and others now advocate for more specific triage of large vessel occlusion (LVO) strokes and triaging potential stroke patients to the most appropriate stroke centers rather than transport to the nearest emergency department (ED) or bypassing a stroke-ready hospital for a CSC.[6–8]

Telestroke programs framed in a hub-and-spoke model link smaller "spoke" EDs to the "hub" CSCs. This model has proven to be efficient and reliable in delivering timely and quality stroke care. The development of prehospital, ambulance-based telemedicine has progressed rapidly and in tandem with cellular and video conferencing technology. These developments have proven useful in triage, disposition, and prehospital treatment of stroke patients.[9–11] During the COVID-19 pandemic, rural patients' acceptability of telemedicine has been evaluated, especially for mental health services, primary care, and ED consultation. These studies highlight the importance of acceptability for successful implementation.[12–17] In consideration of prehospital telestroke programs, patients' perspectives and

acceptability of this care delivery modality can make or break well intended programs. Currently, there is limited patient perspective and qualitative research specific to acceptability of prehospital telestroke.

Prehospital Telestroke Concept

This prehospital telestroke project was supported by a grant from the Health Resources and Services Administration (HRSA) to implement telemedicine in rural communities to improve stroke care. One of the project's main goals is to implement ambulance-based prehospital telestroke services to improve triage, stroke treatment times, and patient outcomes. Honolulu City and County EMS currently utilizes the Los Angeles Prehospital Stroke Screen (LAPSS) and Cincinnati Stroke Triage Assessment Tool (C-STAT) for stroke triage algorithm-based decision-making. A patient that is LAPSS positive and C-STAT positive indicates a potential LVO stroke and EMS has standing orders to bypass stroke-ready hospitals and transport the patient to the CSC for MT evaluation.

The LVO bypass protocol using LAPSS and C-STAT has demonstrated high sensitivity for LVO but lower specificity.[18] The lower specificity for LVO can result in TNK treatment delays for patients with unnecessary bypass, overcrowding the CSC, and unavailability of the ambulance for other emergencies in the rural community.

Telestroke programs in hub-and-spoke models improve timeliness of stroke diagnosis, reduce ED costs, and improve health outcomes for stroke patients.[9] This model also reduces the burden on hub CSCs to provide hospitalization for rural patients away from their support systems. The proposed combination of prehospital stroke screening and telemedicine consultation between EMS and hospital-based stroke teams aims to improve diagnostic accuracy and patient outcomes.[19] Succinctly, prehospital teleconsultation with a stroke neurologist is intended to help paramedics accurately triage stroke patients in the field and improve stroke treatment at the right level of care.

As a part of program implementation, it was imperative to evaluate community readiness for prehospital telestroke and understand the patient perspectives of the developing program. The primary aim of this community assessment was to conduct a qualitative and thematic analysis of the target population's perceptions and attitudes of prehospital telestroke. The secondary aim was to compare themes, attitudes, and perceptions of prehospital telestroke between urban and rural communities.

Methods

Data were collected from January 2022 to May 2022 using a 5-point Likert-scale questionnaire (n=263) followed by a semi-structured interview with some participants upon completion of the questionnaire (n=29). The survey captured quantitative data while the interviews provided qualitative details. All participants were provided printed information on the study prior to participation. The Queen's Medical Center Research & Institutional Review Committee approved this study (RA-2021-046).

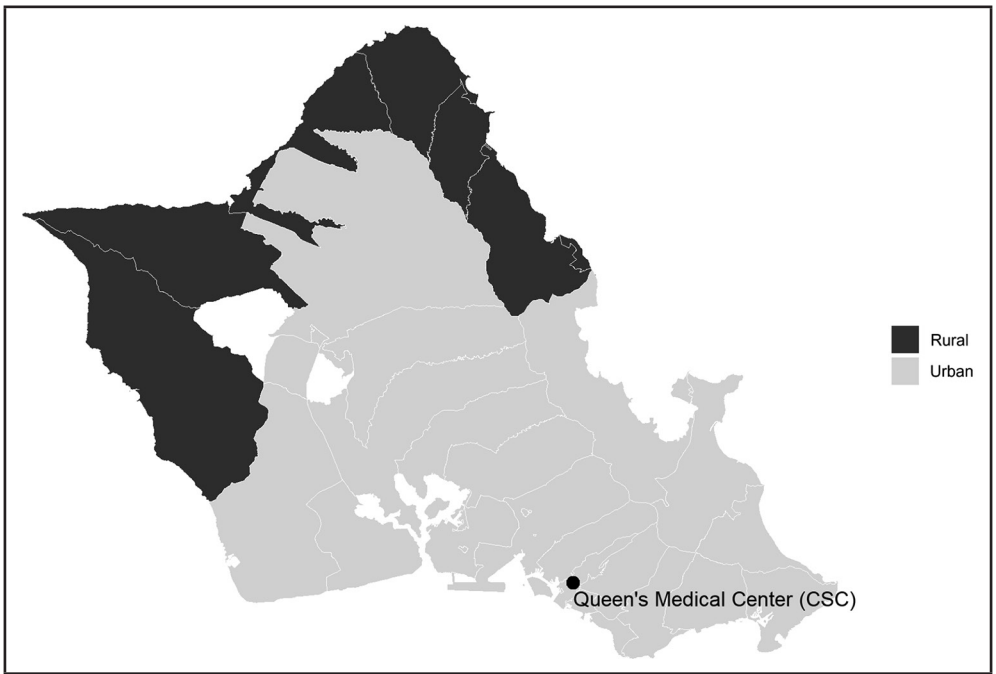

Figure 1. Map[a] of Defined Rural Communities (Dark Gray) and Urban Communities (Light Gray) by Oʻahu Zip Codes

[a] Map created by the author using shapefiles from Hawai'i Statewide GIS Program.[27]

Respondents were recruited in community farmers' markets and other large public gatherings across O'ahu (eg, community meetings, town centers). The inclusion criteria for respondents were: (1) resident of Hawai'i, (2) over the age of 18 years, and (3) English-speaking. Due to O'ahu's unique geography, the team utilized a modified definition of rural communities as zip codes that contained Census places with a population less than 50 000 people[20] and with a greater than 45-minute drive time to the CSC. This included communities on the North Shore and Waianae Coast of O'ahu (**Figure 1**). Urban communities were defined as zip codes that did not meet the "rural" definition criteria.

Quantitative Questionnaire

The team developed a quantitative survey to measure respondents' attitudes and opinions on a 5-point Likert-scale about stroke services, telemedicine, and prehospital telestroke services in the ambulance. No validated questionnaire was available for the purpose of this study. Face validity for the developed survey tool was sought from telemedicine providers, EMS, neurologists, and public health colleagues not involved in the program. Three survey items measured perceived quality of health care and stroke services in Hawai'i. Seven items measured knowledge of stroke recognition and perceptions of activating EMS for stroke care. Nine items measured perceptions of the use of telemedicine and prehospital telemedicine. The survey also collected demographic information: gender, age group, ethnicity, and zip code of residence.

Survey data were analyzed utilizing SAS Studio software version 5.2. 2019 (SAS Institute Inc., Cary, NC). Chi-square analysis and Wilcoxon rank-sum two-tailed tests were performed to compare survey responses from rural and urban respondents. Significance was considered at $P<.05$.

Semi-structured Interview

Survey respondents were offered the option to complete a short, semi-structured interview. Participants in the interview were asked 6 questions related to stroke care, telemedicine, prehospital telestroke services, and EMS services. Interviews were conducted and recorded by a trained researcher experienced in qualitative research. Responses were manually transcribed from the audio recordings. Two researchers analyzed the interview responses to define themes using inductive and deductive methods. Results were coded using Dedoose software version 9.0 (SocioCultural Research Consultants, LLC, Los Angeles, CA). A third researcher independently reviewed inconsistencies between the 2 primary reviewers' codes. Interview responses were linked to the demographic information survey through the participant's unique ID code. A total of 29 interviews were conducted.

Results

The team gathered 263 survey responses and 29 interviews from O'ahu residents who represented the island population. Respondents had the choice to identify as more than one race or ethnicity (**Table 1**).

Survey Responses

Compared to rural respondents, urban respondents were significantly more confident in their local hospital's capability of providing high quality medical care (66% rural vs 83% urban, $P=.004$) and stroke care (65% rural vs 84% urban, $P<.001$). Furthermore, rural respondents were significantly less likely to trust the health care system in Hawai'i (76% rural vs 87%, $P=.028$) (**Table 2**).

When asked about activating 911, nearly one-fifth of respondents (21% rural and 23% urban) believed that they should not call 911 if they could get to the hospital faster on their own. Most

Table 1. Demographics of Prehospital Telestroke Services Survey Respondents, O'ahu, 2022 (n=263)

Respondent Demographics	n (%)
Gender	
Female	173 (65.8)
Male	88 (33.5)
Non-binary	1 (0.4)
Unknown	1 (0.4)
Age by Category (in Years)	
18 to 24	30 (11.4)
25 to 34	53 (20.2)
35 to 44	39 (14.8)
45 to 54	36 (13.7)
55 to 64	49 (18.6)
65 to 74	40 (15.2)
75 or older	15 (5.7)
Unknown	1 (0.4)
Race and Ethnicity[a]	
American Indian or Alaskan Native	3 (1.1)
Asian	103 (39.2)
Pacific Islander or Native Hawaiian	85 (32.3)
Black or African American	8 (3.0)
Hispanic or Latino	22 (8.4)
White or Caucasian	116 (44.1)
Prefer not to answer	5 (1.9)
Service Area	
Rural O'ahu	134 (51.5)
Urban O'ahu	112 (43.1)
Unknown	17 (5.4)

[a] Respondents could provide more than one race and ethnicity.

Table 2. Percentage of Affirmative[a] Prehospital Telestroke Services Survey Responses Comparing Rural and Urban Respondents, O'ahu, 2022 (n=246)

Statement	Rural n=134	Urban n=112	*P*-value[b]
Health Care			
I trust the health care system in Hawai'i	76%	87%	.028*
I can receive high quality medical care at my local hospital	66%	83%	.004**
My local hospital can handle caring for patients with a stroke	65%	84%	<.001***
Stroke Care Services and Activation			
I should not call 911 if I think I can get to the hospital faster by private vehicle	21%	23%	0.66
If I call 911, I am confident the ambulance will take me to a hospital with high quality stroke care	71%	84%	.018*
I will receive better stroke care if I go to a hospital outside of my local area	52%	36%	.021*
Telestroke			
If I call 911, I would feel comfortable seeing a doctor by telemedicine in the ambulance	62%	66%	.46
Seeing a doctor by telemedicine would improve the emergency care I receive in an ambulance	61%	68%	.29
If telemedicine is used in an ambulance, it is important for me to be able to see and hear the doctor	80%	88%	.088
In some cases, seeing the doctor by telemedicine in the ambulance may prevent me from having to go the Emergency Room	49%	50%	.60
Having access to a specialist by telemedicine would make me feel more comfortable staying at my local hospital	72%	74%	.37

[a] Percentages provided above consist of responses that 'Strongly agree' or 'Agree' with the according statements.
[b] *P*-values obtained from the Wilcoxon rank sum test where *$P<.05$, **$P<.01$, ***$P<.001$.

respondents were confident that if they call 911, the ambulance will take them to a hospital with high quality stroke care. However, rural respondents were significantly less confident in being transported to a high-quality stroke care hospital compared to urban respondents (71% rural vs 84% urban, $P=.018$). Furthermore, rural respondents were significantly more likely to believe they would receive better stroke care outside of their local area (52% rural vs 36% urban, $P=.021$) (**Table 2**).

There were no significant differences between rural and urban respondents' impressions of telemedicine, even during an ambulance ride. About two-thirds of respondents indicated they were comfortable using telemedicine in the ambulance (62% rural and 66% urban) and believed that it would improve the emergency care they receive (61% rural and 68% urban). Nearly three-quarters of respondents indicated they would feel more comfortable staying at their local hospital if they had access to a specialist by telemedicine (72% rural and 74% urban) (**Table 2**).

Interview Responses

A summary of the themes arising from the qualitative interviews (n=29) is provided in **Figure 2**. The themes were organized based on 3 categories: telehealth, prehospital telehealth, and emergency medical services. "Telehealth" refers to telehealth services in general (eg, for primary care or specialty care services) while "prehospital telehealth" refers to the use of telehealth in the ambulance to access a specialist (eg, neurologist). Interview responses were assessed for positive or negative acceptability. "Emergency medical services" refer to the perceived barriers to calling 911 and activating EMS.

Most respondents expressed they would activate EMS if they had an emergency. However, a recurring theme among rural respondents was the importance of hospital choice, often preferring urban hospitals for perceived higher quality of care. Many rural respondents expressed concern that EMS would transport them to their local hospital, which they perceived to lack the capabilities for quality care. Respondents also commonly mentioned that high ambulance costs may be a barrier, with some preferring to use a private vehicle to avoid large hospital bills or believing that self-transportation may be faster rather than waiting for EMS. Another barrier to calling 911 was the respondents' personal judgement where the respondent might downplay the severity of their own medical emergency under the perception to avoid "burdening" EMS (**Figure 2**).

All respondents reported experience with telemedicine since the start of the COVID-19 pandemic. While many preferred in-person encounters, telemedicine was generally viewed favorably. Positive aspects included convenience, efficiency/time savings, cost savings, and access to specialty care. Some respondents speculated these benefits would be realized in a prehospital telestroke program too. Negative aspects of telemedicine included lack of patient-provider engagement, inaccurate physical assessments, and challenges with internet connectivity or technology (**Figure 2**).

Respondents generally accepted the prehospital telestroke concept, seeing it as helpful for expediting care and accessing specialists earlier, particularly in areas with long transport times such as North Shore. However, urban respondents were more likely to express positive acceptability of prehospital telestroke,

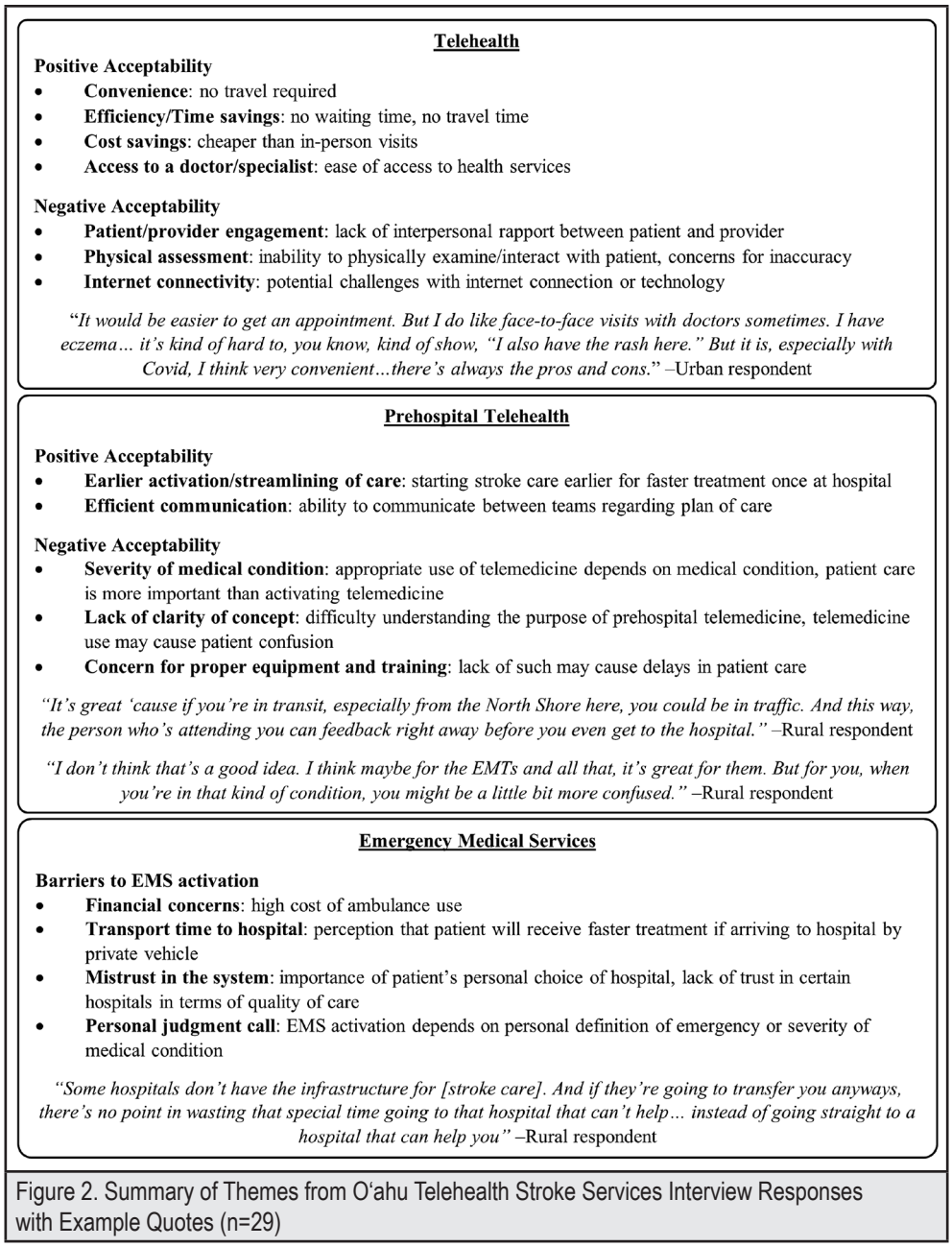

Figure 2. Summary of Themes from O'ahu Telehealth Stroke Services Interview Responses with Example Quotes (n=29)

while some rural respondents expressed concerns about quality of care or delayed treatment. For instance, telehealth activation could distract from the emergency, particularly if EMS was not properly trained to use the technology. Others expressed their confusion by the concept of prehospital telemedicine, stating that their main priority is to get to the hospital as quickly as possible and emphasizing that patient care should be prioritized over activating telehealth (**Figure 2**).

Discussion

The primary aim of this mixed-methods survey was to identify themes and attitudes of rural O'ahu community members toward prehospital telestroke services. Analyzing these responses and identifying themes and barriers will help shape patient outreach efforts, focus dialogue with stakeholders, and influence agreements and policy for stroke care. Other efforts to capture the attitudes and perceptions of EMS providers and hospital-based stroke providers are elements of this project but are outside the scope of this study.

Previous research suggests that utilizing prehospital, ambulance-based telemedicine is feasible and may improve clinical assessments and decision-making.[9–11,21] However, there is limited research identifying patient perceptions of prehospital telemedicine, especially in terms of assessing rural communities' perspectives of such a program. Findings from 1 study show that the broad public expressed a positive acceptability regarding prehospital telemedicine in the ambulance for emergency care.[22] In contrast, another study found that there is less support for transport to alternative hospitals for low acuity conditions,[23] which is similar to this study's findings of O'ahu rural responses to using telemedicine to avert bypass and receive stroke care at the nearest local hospital for faster treatment. Most research relating to prehospital telestroke services focused on provider acceptability, usability, or cost-benefits.[9–11,21]

Several frameworks describe rural populations' attitudes and approaches to health care.[24–26] A common theme emerges in these frameworks and rural health models: a desire for autonomy, self-reliance, and to get things done without help from outside the community. Interestingly, this attitude was not strongly present in this study among rural O'ahu's responses when compared with urban community members, as suggested in **Table 2**. This study's findings showed that rural respondents were less confident in their local hospital's capabilities and would rather travel to receive quality stroke care. This finding may be attributed to the fact that there is only one CSC in Hawai'i and may represent greater trust in the CSC compared to closer hospitals. In practice, this attitude may pose a challenge for some rural patients when the triage and disposition decision calls for care at a local hospital.

In contrast, there was no significant difference between rural and urban attitudes about activating EMS for stroke symptoms. The recurring themes contrary to activating EMS were financial concerns or perceptions that self-transportation to the hospital is faster. Notably, rural respondents placed a greater importance on choosing a hospital as a part of the emergency response, likely influenced by respondents' perceptions of lower quality stroke care at local hospitals. The research team also identified a prevalent misconception among the public in which EMS is perceived as a mode of transportation to the hospital rather than the start of emergency stroke care. The stroke and EMS communities must continue to shape this discussion in the public and with health care colleagues. A public health campaign across the service area could help address these perceptions of EMS and stroke care. Such a campaign might emphasize the quality of care provided by EMS, education about the larger systems of care (eg, telestroke), and outcomes from quality prehospital care.

Regarding telemedicine, respondents preferred in-person encounters but valued the convenience and access to specialty care of a telemedicine encounter. The primary objection to a prehospital telestroke program includes perceptions that a telestroke assessment might distract EMS providers from prioritizing patient care for emergencies, along with a misunderstanding the prehospital telestroke concept. Responsively, outreach efforts should focus on the goals and benefits of prehospital telestroke, such as enhanced evaluation and quality of care, a potential for cost and time savings, and improvements in treatment times and patient outcomes.

Implications for Program Implementation

The findings suggest gaps in community perceptions about a prehospital telestroke program. Community outreach highlighting the role of EMS and prehospital telemedicine in the stroke continuum of care is key to overcoming potential barriers to participation. Unwillingness to activate EMS for any reason would need to be addressed through public outreach. Future prehospital telestroke efforts in this catchment area should address patients' misperceptions of EMS and stroke care, encourage EMS activation with stroke symptoms, highlight the nature and role of EMS care in the field, describe the role of specialty care in a prehospital stroke program, and emphasize the advantages and quality care provided at local hospitals through the hub-and-spoke model.

This means prehospital telestroke providers (eg, CSC stroke team and EMS providers) need to provide education when the disposition decision is made (eg, the patient will receive definitive care with TNK at the local hospital or there is no advantage to the quality of care received at the CSC). Developing themes, consistent messaging, data sharing, and training for these discussions will need to take place via collaborations between EMS, spoke hospitals, and the CSC providers.

Limitations

This study has several limitations. The small number of interview participants may mean that qualitative findings are not generalizable to a wide range of community contexts. For instance, the perceived capability of local hospitals may differ by age groups and rural zip codes, but this was not within the scope of the study. This study assessed communities on O'ahu, so the findings may not be generalizable to communities in other states or territories. Due to the voluntary participation in the assessment, self-selection bias may influence responses. Therefore, the distribution of the participant demographics (eg, age, gender, residence) may not accurately represent the targeted patient population on O'ahu who would most likely participate in the prehospital telestroke program (ie, LAPSS positive: age >45 years).

Conclusions

To our knowledge, this study is the first pre-implementation acceptability survey to assess rural communities' impressions of telestroke consultation in the ambulance. The results of

this assessment indicate community members hold a positive impression of prehospital telemedicine, which is a prerequisite to program success. On the other hand, the concerns of the participants bring light to the perception of EMS utilization and stroke care, which need to be addressed through community engagement and education.

The findings of this study demonstrate the importance of assessing the patient perspective during program implementation. While it is noteworthy that assessing providers' perspectives is also paramount to program implementation, this study provides data and insight to complement or contrast with findings in further studies. Additional research is needed to assess the acceptability of prehospital telestroke amongst rural residents on the neighbor islands where EMS transport times to the hospital can be much longer.

Conflict of Interest

None of the authors identify a conflict of interest.

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