

## Original Article

# Challenges and Opportunities in Developing Stroke Rehabilitation Technologies in the Visayas Region: A Local Regional Perspective

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## Abstract

**Background:** This research examines the challenges and opportunities in stroke rehabilitation technologies, focusing on cost, affordability, and patient accessibility. It also investigates the complex healthcare issues in the Visayas region of the Philippines, including healthcare worker shortages, pay disparities, resource limitations, and limited access to care in remote areas.

**Methods:** The study explores the experiences of medical professionals regarding stroke care and technology use in the Visayas and looks into household caregiver practices, self-management, funding, and policies.

**Results:** Results indicate that mobility difficulties, balancing problems, and limb weakness are major obstacles for patients. Only 33% of respondents receive rehabilitation treatments, highlighting a significant deficiency. Health and community service staff face heavy workloads, serving a larger population than usual.

**Conclusion:** This paper explores technological advances that could revolutionize stroke rehabilitation in regions like the Visayas. Gaining detailed information will enhance understanding of specific needs, enabling tailored interventions to improve outcomes. Integrating telemedicine, VR platforms, robotic devices, and wearable sensors can address accessibility challenges and facilitate patient-specific rehabilitation.

## Keywords

healthcare, health professionals, rehabilitation, stroke, technology

## INTRODUCTION

Challenges related to stroke rehabilitation technologies include cost considerations, expensive development and implementation, and the need to ensure affordability and accessibility for all patients (Collantes et al., 2022). Additionally, home-based rehabilitation devices face unique challenges compared to clinical settings, such as the requirement to design devices that work effectively in diverse home environments. Moreover, some designs lack input from stroke survivors and healthcare professionals, highlighting the importance of involving stakeholders to ensure that devices align with user needs and best practices. Furthermore, there is a need to balance safety and functionality in these devices, as they must prevent harm while allowing effective therapy, and few devices currently detect undesirable postures during therapy activities, hindering optimal rehabilitation. On the other hand, opportunities in the field of stroke rehabilitation include the rising need for home-based

rehabilitation, particularly highlighted by the COVID-19 pandemic, where mechatronic devices can bridge the gap by providing accessible therapy at home. Also, there are opportunities to develop actuated and unactuated degrees of freedom in stroke rehabilitation technologies.

The Visayas region in central Philippines, comprises several islands surrounding the Visayan Sea. Panay, Negros, Cebu, Bohol, Leyte, and Samar are among the larger islands. These islands comprise the Philippine archipelago's core group, together with their smaller neighbors. The healthcare difficulties on various islands can be quite intricate. There is a shortage of healthcare workers and securing an adequate health workforce remains a challenge in the island country, with the availability and quality of health professionals being persistent issues (Collantes et al., 2021). The outflow of qualified health workers worsens the problem, leading to shortages in critical areas such as nursing, medicine, and allied health professions (Espiritu & San Jose, 2021). Inequalities in pay exist in the Philippines between governmental and private institutions and urban and rural areas. Each unit controls its salary structure, which can result in situations where one area offers higher pay to attract health professionals from other areas (Banaag et al., 2019). Resource constraints hinder the effective delivery of healthcare, including funding shortages, inadequate infrastructure, and insufficient medical supplies (Dayrit et al., 2018). Patient data is incomplete in some places. Creating evidence-based policies and strategic plans for health workforce development is challenging when there is a shortage of current, reliable data. In low-income to middle-income countries such as the Philippines, healthcare facilities primarily those in rural areas tend to be underfunded and inaccessible (Kayola et al., 2023). Many islands are remote and isolated, making promptly accessing healthcare services challenging. Transportation logistics and communication barriers further add to the complexity. Each island has its distinct cultural setting, languages, and traditions. Thus cultural sensitivity must be navigated, and healthcare practitioners must tailor services appropriately. This practice is where cultural and linguistic diversity comes into play (Dayrit et al., 2018). Effective coordination among stakeholders and commitment from governments, communities, and international partners are necessary to sustain initiatives to improve healthcare. Due to poor connectivity and a lack of technical know-how, telemedicine, e-health, and digital health record implementation might be difficult (Dayrit et al., 2018). Maintaining fair access to healthcare on all islands—regardless of population size or location—remains a top objective. Furthermore, it is reported that Filipinos affected by stroke will incur costs reaching up to \$1.2 billion. With healthcare being primarily privatized, patients are expected to bear the burden of medical and rehabilitation expenses. Despite government health spending increasing by 28.2% and insurance benefits rising by 25%, these would cover less than 10% of health funding (Navarro et al., 2014). To tackle these obstacles, cooperation, new approaches, and legislative changes are needed. Island communities persist in enhancing their healthcare systems despite the challenges.

When comparing the Visayas region to other areas in the Philippines, similar challenges in stroke rehabilitation are evident, albeit with regional nuances. For instance, in the Luzon region, particularly in urban centers like Metro Manila, the availability of advanced rehabilitation technologies is higher due to better funding and infrastructure. However, disparities still exist between urban and rural areas, with limited access to rehabilitation services (Banaag et al., 2019). In Mindanao, for example, the impact of socio-political instability and armed conflict further exacerbates healthcare access issues, particularly in remote areas, compounding the difficulties of stroke care, which disrupt healthcare delivery and limit access to rehabilitation services (Adriano & Parks, 2013; Espiritu & San Jose, 2021). Furthermore, cultural factors play a significant role in stroke rehabilitation across the Philippines, with varying beliefs about health and wellness affecting patient engagement and adherence to rehabilitation protocols (Dayrit et al., 2018). Across all regions, the common thread is the struggle with affordability, accessibility, and the need for culturally sensitive and contextually appropriate rehabilitation approaches. This highlights the systemic nature of healthcare disparities in the Philippines, with the Visayas region representing a microcosm of broader national challenges.

This study investigates the healthcare challenges that household caregivers face in island regions, including their care methods, self-management strategies, funding, and policies. It explores healthcare professionals' perspectives on stroke care in the Philippines, focusing on the Visayas region. The study aims to gain insights about their work environment, the technologies they use, and the potential opportunities available.

## METHODS

### Study design, population, setting

A descriptive design is used in this study. The region's population size and stroke prevalence were considered when choosing the provinces, municipalities/cities. Western and Central Visayas were considered, which includes Iloilo, Negros Occidental, Capiz, Aklan, Antique, Cebu, Negros Oriental, and Bohol. This sample is part of a nationwide survey that scopes the whole Philippines, but of this specific study, data from the Visayas region was emphasized.

Multiple cross-sectional surveys were used to gather descriptive data from the following sources: (1) individuals who have had a stroke and their caregivers (referred to as household carers); (2) care providers, which include healthcare professionals and non-certified health providers; and (3) local government employees and officials. Respondents were identified based on the list provided by the Department of Health - Rural Health Unit (DOH-RHU) and verified by the relevant community physicians. The selection of participants was further refined by identifying stroke patients and carers registered with the Municipal Health Office (MHO) and barangay health workers within the randomized areas. Ethical approval was obtained from the Single Joint Research Ethics Board (SJREB) with reference no. 2023-85.

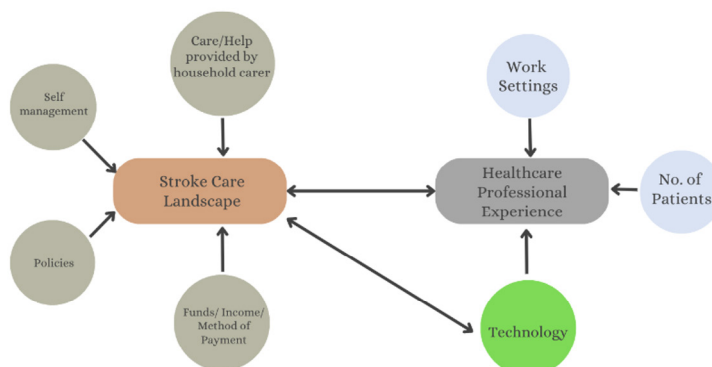
### Study tools, variables, data collection

The sampling strategy follows a cluster sampling design featuring a two-stage sample selection by probability proportional to size. This involves the selection of LGUs (barangays) in each province as the primary sampling unit. The selection of these units was done independently by each province. Field enumerators were deployed to the randomized areas and tasked to conduct Pen and Paper Personal Interviews with the selected participants in each barangay. Data was uploaded via an Android tablet to the Joint Information Systems Committee (Jisc), an electronic data collection application developed by the United Kingdom.

To ensure the sample size was representative of the Visayas region, the selection of barangays was based on population density and stroke prevalence within each province, as provided by the press release report of the Philippine Statistics Authority (Mapa, 2024), ensuring that both urban and rural areas were included. This approach enhances the generalizability of findings within the Visayas region, aligning with the broader objectives of the nationwide survey.

### Conceptual Framework

Figure 1 illustrates the several aspects that this study considers while examining the stroke care landscape in the Visayas region. A patient's ability to manage their own medical care is referred to as self-management; policies are the guidelines and instructions regarding the treatment of stroke victims; care/help provided by a domestic caregiver is the discussion of family or caregiver assistance; and funds are the tools and channels of financing the acquisition of health services.



**Figure 1.** Stroke care landscape, healthcare professional experience, and technology

Healthcare workers' experiences underscore their exposure to diverse work situations and issues regarding stroke care inside the workplace. The volume of patients they see and the technologies that potentially improve how doctors treat stroke patients also impact their experience. The bidirectional arrows illustrate the flow or relationship between these items, visually grouping several variables connected to stroke care.

### **Data Analysis**

Following data cleaning, descriptive statistical methods were employed to summarize and interpret the dataset. Specifically, frequency and percentage analyses were conducted to provide an overview of the distributional properties of key variables. Statistical analyses were performed using Microsoft Excel and SPSS to ensure accuracy and consistency. The dataset analyzed was part of a broader nationwide survey, from which data specific to the Visayas region was extracted for further examination for this research.

### **Ethical considerations**

This study adhered to strict ethical guidelines, ensuring the protection of all participants. Ethical approval was obtained from the Single Joint Research Ethics Board (SJREB) before data collection. Informed consent was obtained from all subjects involved in the study, guaranteeing their voluntary participation and understanding of the research objectives, procedures, and potential risks. Particular attention was given to the vulnerable nature of stroke patients and their caregivers, emphasizing confidentiality and anonymity throughout the research process. The study also considered the cultural sensitivities of the Visayas region, ensuring that research methods and data interpretation were respectful and appropriate.

Furthermore, any potential conflicts of interest were disclosed and managed transparently. Data collected was stored securely using the electronic data collection application developed by the United Kingdom, and all other data was stored using encrypted digital storage, accessible only to authorized researchers. All identifying information was anonymized or pseudonymized to protect participant privacy. Upon completion of the study, data will be retained only for the necessary duration as stipulated by ethical guidelines and institutional policy, after which it will be securely and permanently disposed of, ensuring no risk of unauthorized access or breach of confidentiality. The findings of this research were disseminated responsibly, aiming to contribute positively to the development of accessible and effective stroke rehabilitation technologies within the region.

## **RESULTS**

### **Demographics**

The study included 157 stroke patients, 149 household carers, and 327 formal healthcare professionals from the Western and Central Visayas regions. Among these stroke patients, 56.1% were male and 43.3% were female. Most of these patients were 60 years old and older (71.3%) with 19.1% aged 50-59, and 9.6% experiencing early stroke between the ages of 15-49 years old. The majority, 87.4%, were from rural areas while only 10.8% were from urban settings. A few percentages were reported unknown. There are 70.1% of these patients who came from poor to low-income households, with 2.5% identifying as middle-income, and 5.1% choosing not to disclose their annual household income.

The household carer data shows that 77.9% were female and 22.1% were male. As per their age distribution, 36.2% were 60 years old and older, 20.1% aged 50-59, and approximately 43% were within the 15-49 age range, all for a total of 149.

For the healthcare professionals, data shows 86.2% were female, 13.2% were male, and an additional 0.6% preferred not to specify their sex. Most of these professionals were 15-39 years old (64.1%) with 27.3% belonging to the 50-59-year-old age range, totaling 326. Moreover, the comprehensive study gathered data from regions across Luzon, Visayas, and Mindanao involved 131 government officials. The data obtained from these officials were also addressed in this research.

### **Stroke Patient and Household Experiences in Rehabilitation**

One of the most reported challenges among these patients is related to mobility, specifically moving around by walking. With this, 29.9% of the patients experienced significant difficulty in walking, while others

reported some difficulty walking (41.6%). Additionally, 35.3% stated they had some difficulty performing usual activities by themselves, whereas 33.3% faced a considerable number of problems doing these usual activities. Furthermore, 89.2% of the patients reported that their initial symptoms revolved around arm and leg weakness.

Regarding their rehabilitation experiences, 65.6% of these stroke patients did not receive any form of rehabilitation from healthcare professionals, while only 33.1% did. Out of the 51 who received rehabilitation, 47.1% received it in their homes, 29.4% in a hospital setting, 13.7% in a standalone clinic, and 9.8% in the community setting. This data indicates that rehabilitation is more commonly received within the patient's home and is least likely to occur in a community setting.

The content of the rehabilitation varied. Referring to Table 1, it is reported that the most common content being discussed in rehabilitation are exercises to help with arm mobility (30.6%), followed by exercises to aid the legs (29.3%), and exercises to help with balance (25.5%). Moreover, only 23.6% emphasized stroke education as part of rehabilitation content. Notably, the provision of aids to help with mobility, such as assistive devices like walking sticks, frames, rollators, and wheelchairs, was relatively low at 18.3%. As low as 11.5% of people reported having access to aids for everyday living (N=157).

**Table 1. Content of Stroke Rehabilitation (N = 157)**

| Contents   | N  | %    |
|--|----|------|
| Exercises to help the arms   | 48 | 30.6 |
| Exercises to help the legs and walking   | 46 | 29.3 |
| Exercises to help with balance   | 40 | 25.5 |
| Education about your stroke  | 37 | 23.6 |
| Provision of aids to help with mobility (Walking stick; Frame; Rollator; Wheelchair) | 29 | 18.3 |
| Provision of aids to help with functions such as dressing, bathing and eating        | 18 | 11.5 |
| Help with talking and communication  | 16 | 10.2 |
| Help with swallowing   | 10 | 6.4  |
| Help with your memory, thinking or planning  | 7  | 4.5  |
| Help to return to work   | 5  | 3.2  |

**Table 2. Help and care provided for the patients (N=149)**

| Tasks                                 | N   | %    |
|---------------------------------------|-----|------|
| Cooking and meal preparation          | 125 | 83.9 |
| Managing or taking medications        | 122 | 81.9 |
| Moving about at home                  | 118 | 79.2 |
| Providing emotional support           | 114 | 76.5 |
| Dressing                              | 112 | 75.2 |
| Managing finances or personal affairs | 112 | 75.2 |
| Mobility outside of the house         | 112 | 75.2 |
| Bathing                               | 109 | 73.2 |
| Feeding                               | 109 | 73.2 |
| Exercising                            | 108 | 72.5 |
| Communicating or talking              | 100 | 67.1 |
| Remembering and problem-solving       | 82  | 55.0 |
| Traditional Medicine                  | 1   | 0.7  |

In conjunction with the stroke data, household carers who actively cared for these stroke patients were also considered. It is reflected that these household carers were actively involved in various aspects of daily care. The breakdown of the tasks is shown in Table 2. Cooking and meal preparation were among the tasks they helped with, which was commonly reported by 83.9% of carers involved. Managing and administering medication was the second most reported task with 81.9% of carers assisting in this area. Moreover, mobility assistance was also reported to be a common task for these household carers. Specifically, 79.2% of the household carers helped patients move about their own homes, 75.2% assisted with mobility outside of the house, and 72.5% reported assisting with exercises related to mobility. This data highlights the critical role that household carers play in supporting the rehabilitation needs and daily activities of stroke patients in their homes (N = 149).

Of the 49 patients who answered the question, 40 reported paying out of pocket. This represents most patients' payment methods. Merely a small percentage indicated utilizing alternative modes of payment, out of which eight used PhilHealth, and only one used the advantages of a Malasakit center ([Department of Social Welfare and Development, 2024](#)). Some patients did not specify how they would like to pay because they received no official rehabilitation.

### Healthcare Experiences in Stroke Rehabilitation

The experiences of healthcare providers about stroke care and rehabilitation are covered in this portion of the findings section. With 24.5% hailing from metropolitan environments, these healthcare professionals were primarily from rural locations (74.2%). Of these, 41.4% worked in the community health sector; these were followed by midwives (23.3%), physical therapists (13.5%), occupational therapists (6.4%), and physicians (4.3%).

Results also show that healthcare professionals reported seeing 101–500 patients annually for 31.4%, 501–1000 patients for 16%, and more than 1000 patients for 19.4%. When the frequency of visits was divided per week, 24.2% said they saw 6–10 patients, 23.3% saw 2–5, and 21.6% saw 11–20 patients respectively. These numbers represent the patients they see, representing a range of ailments and diseases. Of the 303 medical professionals surveyed, 28.4% reported seeing stroke patients seven days a week, and 27.7% reported seeing them only once a month. Furthermore, 17.5% said they encountered stroke patients most days, 16.8% said they saw them every day, and 4% said they saw them once a year.

The respondents had varying experiences with rehabilitation. Of the total patients, only 22.7% (n = 326) received stroke rehabilitation treatment of any kind. Of the 72 respondents who answered this question, 66.7% reported seeing patients most days, 13.9% daily, 8.3% once a week, 8.3% once a month, and 2.8% less frequently than once a month. According to 61.1% of the respondents (N=72), the average duration of these rehabilitation sessions was between 30 and 60 minutes.

Rehabilitation programs typically incorporate functional mobility training, which includes activities such as ambulation, sitting, and standing, as well as functional task training focused on activities of daily living, such as dressing, bathing, and eating. Regarding the duration of rehabilitation, reports indicate that 33.3% of patients received services for three to six months, and 33.3% for over six months. Conversely, survey responses from rehabilitation participants suggest shorter durations, with 6.9% (n=72) reporting one week or less, 15.3% reporting one to three months, and 11.1% reporting one to four weeks.

Table 3 shows the availability of assistive technologies and equipment in the area. The availability of assistive technology and equipment that healthcare providers make available to their patients is another important result that warrants discussion. Tools for walking (18.1%), standing (17.8%), and muscle strength (18.7%) were the most often used equipment in the clinics of medical professionals. Virtual or augmented reality (2.8%), electric stimulation (18.1%), extracorporeal shockwave therapy (4.9%), ultrasound/short wave diathermy therapy (16%), robotics (0.6%), therapy kitchens (6.8%), orthotics, communication or speech aids (8.9%), aids to support arm function (13.8%), specialized seating or wheelchairs (13.8%) were among the resources for scarce equipment.

Healthcare providers furnished home care equipment, supplementing those utilized in clinical settings. Among the most frequently provided items were walking aids (16.3%), followed by wheelchairs (14.4%) and



exercise equipment (12.9%). Conversely, fewer experts reported assisting with feeding, dressing, bathing, mobility, and electrical stimulation. Results are shown in Table 4.

Regarding how patients pay for their care, most medical professionals stated that 69.6% of their clients do not make payments for these services.

**Table 3. Availability of Assistive Technologies and Equipment (N = 327)**

| <b>Specialist Equipment Available</b>    | <b>N</b> | <b>%</b> |
|--|----------|----------|
| Equipment to help with muscle strength   | 61       | 18.7     |
| Equipment to help with walking           | 59       | 18.1     |
| Electrical stimulation                   | 59       | 18.1     |
| Aids to help with standing               | 58       | 17.8     |
| Ultrasound, short wave diathermy therapy | 52       | 16.0     |
| Specialist seating or wheelchairs        | 45       | 13.8     |
| Aids to support arm function             | 45       | 13.8     |
| Orthotics, communication or speech aids  | 29       | 8.9      |
| Therapy kitchen                          | 22       | 6.8      |
| Extracorporeal shock wave therapy        | 16       | 4.9      |
| Workshops and vocational training areas  | 15       | 4.6      |
| Virtual or augmented reality training    | 9        | 2.8      |
| None                                     | 6        | 1.8      |
| Robotics                                 | 2        | 0.6      |

| <b>Equipment Provided</b>             | <b>N</b> | <b>%</b> |
|---------------------------------------|----------|----------|
| Walking aids (frames / sticks)        | 53       | 16.2     |
| Wheelchairs                           | 47       | 14.4     |
| Exercise equipment                    | 42       | 12.9     |
| Aids to help with feeding             | 36       | 11.0     |
| Aids to help with bathing             | 35       | 10.7     |
| Home adaptations to aid with mobility | 35       | 10.7     |
| Aids to help with dressing            | 33       | 10.1     |
| Electrical stimulation devices        | 29       | 8.9      |

### **Government Policies and Opinion on Stroke Rehabilitation**

In the survey, 76.3% (N = 130) of the participants were actively involved in healthcare budget planning, underscoring the pivotal role of local government officials in shaping healthcare policies and resource allocation. In response to inquiries about prioritized areas for improvement within a community-based rehabilitation program as shown in Table 5, with responses ranked from 1-4 (1 being the most important), 70.9% of respondents identified enhancing people's quality of life and happiness as the most critical aspect. Furthermore, when asked to rank the usefulness of information necessary before adopting a healthcare policy on a scale from 1-4, with 1 denoting the most useful, 47.3% of respondents prioritized increasing knowledge about the impact of stroke on patients' functioning and quality of life. Additionally, 35.1% of the respondents (N = 131) expressed significant concern about the number of people affected by stroke in the area.

It was also sought to find the priority areas of the local government who were involved in this study. According to Table 6, healthcare prevention and economic development were ranked as the most important areas which were then followed by healthcare rehabilitation after disease or injury and food security.

**Table 5.** *Level of priority for the improvement of community-based rehabilitation program (N = 131)*

| Ranking            | Improvement in people's quality of life and happiness |      | Improvement in ability to do things |      | Ability to return to work |      | Decrease in burden for carers and family members |      |
|--------------------|---|------|-------------------------------------|------|---------------------------|------|--|------|
|                    | N   | %    | N                                   | %    | N                         | %    | N  | %    |
| 1-Most Important   | 93  | 71.0 | 25                                  | 19.1 | 29                        | 22.1 | 23   | 17.6 |
| 2                  | 13  | 9.9  | 57                                  | 43.5 | 21                        | 16.0 | 25   | 19.1 |
| 3                  | 13  | 9.9  | 24                                  | 18.3 | 47                        | 35.9 | 26   | 19.9 |
| 4- Least Important | 12  | 9.2  | 22                                  | 16.8 | 31                        | 23.7 | 55   | 42.0 |

**Table 6.** *Perceived level of importance of local government unit sectors (N = 131)*

| Ranking            | Infrastructure projects |      | Economic development |      | Disaster mitigation, preparedness and response |      | Peace and order / security |      | Food security |      | Healthcare prevention |      | Healthcare rehabilitation after disease or injury |      |
|--------------------|-------------------------|------|----------------------|------|--|------|----------------------------|------|---------------|------|-----------------------|------|---|------|
|                    | N                       | %    | N                    | %    | N  | %    | N                          | %    | N             | %    | N                     | %    | N   | %    |
| 1- Most Important  | 14                      | 10.7 | 33                   | 25.2 | 9  | 6.9  | 13                         | 9.9  | 28            | 21.4 | 61                    | 46.6 | 16  | 12.2 |
| 2                  | 7                       | 5.3  | 4                    | 3.1  | 11   | 8.4  | 8                          | 6.1  | 29            | 22.1 | 33                    | 25.2 | 29  | 22.1 |
| 3                  | 12                      | 9.2  | 14                   | 10.7 | 17   | 13.0 | 15                         | 11.5 | 23            | 17.6 | 16                    | 12.2 | 18  | 13.7 |
| 4                  | 8                       | 6.1  | 20                   | 15.3 | 30   | 22.9 | 28                         | 21.4 | 20            | 15.3 | 7                     | 5.3  | 18  | 13.7 |
| 5                  | 11                      | 8.4  | 17                   | 13.0 | 25   | 19.1 | 27                         | 20.6 | 12            | 9.2  | 6                     | 4.6  | 19  | 14.5 |
| 6                  | 21                      | 16.0 | 27                   | 20.6 | 23   | 17.6 | 22                         | 16.8 | 9             | 6.9  | 3                     | 2.3  | 8   | 6.1  |
| 7- Least Important | 54                      | 41.2 | 12                   | 9.2  | 12   | 9.2  | 12                         | 9.2  | 5             | 3.8  | 2                     | 1.5  | 20  | 15.3 |

## DISCUSSION

### Challenges in Stroke Rehabilitation

Stroke rehabilitation in the Philippines has faced significant challenges. The evident gaps in stroke rehabilitation and care, coupled with the socioeconomic constraints prevalent in the Philippine landscape, create various barriers stroke patients, carers, and healthcare professionals need to face for effective rehabilitation (Collantes et al., 2022). This discussion explores the critical challenges in stroke rehabilitation in the Visayas region and the opportunities for technology to bridge these gaps.

The first identified challenge to be discussed is the lack of continuity of care in stroke rehabilitation. As reflected in the results, a significant number of stroke patients (65.6%) did not receive rehabilitation of any form from healthcare professionals. Furthermore, it was discussed that 47.1% received it at home, and only a few received it in hospitals, standalone clinics, and community settings. This reflects a significant gap in structured and consistent rehabilitation, particularly in community settings.

Healthcare professionals play a critical role in stroke rehabilitation as they monitor progress, aid in recovery, and provide essential patient guidance. Physicians and multidisciplinary teams specializing in stroke care are necessary in the acute phase and throughout rehabilitation and life post-stroke, ensuring a continuum of care that supports optimal recovery. Collaboration between health professionals is required across the entire stroke pathway, making it essential to support and care for the healthcare providers themselves (Clarke & Forster, 2015). However, healthcare professionals also face substantial challenges that hinder their ability to deliver consistent care. High workload demands stemming from extensive patient care responsibilities beyond stroke rehabilitation contribute to the strain on healthcare providers. Additionally, the shortage of stroke-specific professionals, both in the community and hospital settings, further limits the frequency and availability of rehabilitation services. Integrating innovative technologies and structured rehabilitation programs can help bridge these gaps by providing supplementary support, enhancing accessibility to rehabilitation, and alleviating workload burdens on healthcare providers. By leveraging technological advancements such as tele-rehabilitation, remote monitoring,



and digital rehabilitation tools, healthcare professionals can extend their reach, ensuring that stroke patients receive continuous, structured care even beyond clinical settings.

Another challenge is the financial burden associated with stroke rehabilitation. It is estimated that about half a million Filipinos affected by stroke will be burdened by \$350 million – \$1.2 billion for medical care. These costs are reported to be primarily out-of-pocket (Navarro et al., 2014). Given the data as reflected, most of the stroke patient respondents belong to low-income households and a high percentage of these patients pay out of pocket for these rehabilitation services. Even with alternative payment modes such as the social health insurance, Philippine Health Insurance Corporation (PhilHealth), private insurance, and Malasakit Centers, it is still underutilized.

The provision of stroke patient education and management was also found to be deficient. Many patients reported a lack of awareness regarding stroke-related exercises and rehabilitation techniques. As stated, some patients resorted to traditional and not widely accepted rehabilitation methods which further highlights the disparity and inequity in healthcare, specifically in the Visayas region. Furthermore, their inability to recommend specific rehabilitation tools and equipment highlighted a general knowledge deficit in these areas.

In the Philippines, various programs and initiatives are in place to support persons with disabilities (PWDs), including those in need of rehabilitation devices. The Philippine government, through agencies like the National Council on Disability Affairs (NCDA), Department of Social Welfare and Development (DSWD), Department of Health (DOH), Department of Education (DepEd), and Public Employment Service Office (PESO), provides services such as persons with disabilities ID cards, financial assistance, rehabilitation services, and accessibility grants. Moreover, DSWD offers rehabilitation services, including physical therapy, occupational therapy, and speech therapy, to enhance functional abilities and independence for individuals with disabilities. De La Salle University's Agapay Project has also developed a cost-effective robotic exoskeleton, the Agapay Exoskeleton, designed for upper limb movements to facilitate efficient rehabilitation for stroke and injury patients (Manguerra et al., 2018). Despite existing challenges, ongoing efforts aim to foster a more inclusive society for PWDs in the Philippines by creating programs and introducing innovation and technology in rehabilitation. These initiatives align with the priorities and matters that local government units consider significant, such as enhancing life quality and happiness and promoting health care prevention and rehabilitation.

Understanding these challenges is the first step towards being more intentional in developing programs and technologies tailored to the needs of stroke rehabilitation in the Philippines. By addressing these challenges, opportunities open to improving the quality of care and outcomes for stroke patients, particularly in underserved regions like the Visayas.

### **Data-Informed Opportunities for Technology and Improvement**

The shortage of healthcare workers in the Philippines, driven by workforce outflow, salary disparities, and resource constraints, significantly impacts stroke rehabilitation (Collantes et al., 2021; Espiritu & San Jose, 2021; Banaag et al., 2019; Dayrit et al., 2018). Limited funding and infrastructure, particularly in rural areas, further restrict access to essential services (Kayola et al., 2023). Additionally, incomplete patient data hampers evidence-based policy-making and workforce planning. Stroke patients are often underrepresented in discussions about public policies, healthcare improvement, and innovations in rehabilitation and stroke care. Data collected from stroke patients provided a better view of their struggles, challenges, and experiences, facilitating more effective decision-making.

The data reveals that mobility is a significant challenge for stroke patients. A significant proportion, 29.9%, of patients exhibited severe mobility difficulties. Moreover, 89.2% of patients reported initial symptoms of weakness in the arms and legs. This also aligns with the rehabilitation content, where exercises for the arm (30.6%), leg exercises (29.3%), and balance exercises (25.5%) were most discussed (Table 1). Given this, there is still a gap regarding their access and provision of mobility aids – as seen that only 18.3% of patients reported receiving assistive devices like walking sticks, frames, rollators, and wheelchairs, and only 11.5% had access to aids for everyday living (Table 2). These results indicate a critical need for improved access to mobility aids and technology development that targets these mobility issues. It is also important to note that only 0.6% of healthcare professionals reported access to robotics in their setting. (Table 3 and 4) Limited access to

rehabilitation technologies further exacerbates disparities, particularly in underserved areas.

Technology presents a viable solution to bridge these gaps. Digital health records can improve data collection for informed decision-making, while telerehabilitation and assistive devices can extend rehabilitation services beyond traditional healthcare settings. Advancements such as robotic-assisted therapy, wearable mobility aids, and remote monitoring tools offer opportunities to enhance patient care despite workforce shortages and infrastructure limitations. Investing in these innovations can improve stroke rehabilitation outcomes and create a more accessible, efficient healthcare system ([Selamat et al., 2022](#)).

### Technology as a Solution in Stroke Rehabilitation

Technology plays a significant role in stroke rehabilitation, presenting both challenges and opportunities. Assistive devices offer several benefits to medical practitioners across various aspects of patient care. Devices such as wheelchairs, walkers, and canes, which have long existed, aid patient mobility within healthcare facilities and during home visits, enabling practitioners to assess patients more effectively. In rehabilitation and therapy, advanced devices like robotic exoskeletons, prosthetics, and orthotics facilitate targeted exercises and functional movements, allowing practitioners to monitor patient progress. Additionally, robotic arms or exoskeletons can assist practitioners during surgeries or delicate procedures, enhancing precision while reducing muscle strain and fatigue. Assistive devices also improve ergonomics, alleviating physical strain for practitioners during long hours and repetitive tasks. Furthermore, voice-controlled devices or adaptive keyboards support practitioners with limited hand mobility in communication, note-taking, and documentation. Table 3 indicates that less than 20% of patients have access to assistive devices and rehabilitation technologies, highlighting the urgent need for expanded availability and support.

Advancements significantly impact stroke rehabilitation by enabling precise assessment and continuous monitoring through wearable sensors, motion-capture systems, and virtual reality (VR) platforms ([Navea et al., 2021](#)). VR systems, particularly in LMICs, reduce dependence on rehabilitation staff, alleviate workload burdens, and standardize therapeutic activities ([Prvu et al., 2019](#)). Telemedicine further enhances accessibility by overcoming geographical barriers and improving adherence to rehabilitation programs. Additionally, robotic devices, Brain-Computer Interfaces (BCIs), gamification, neurofeedback, functional electrical stimulation (FES), data analytics, exoskeletons, and mobile platforms contribute to improved stroke recovery ([Navea et al., 2021](#); [Munsayac et al., 2021](#)). These innovations play a crucial role in providing personalized interventions, improving accessibility, and enabling continuous monitoring, ultimately transforming stroke rehabilitation on both local and global scales ([Selamat et al., 2022](#)). Access remains limited despite the availability of assistive devices for mobility support (Table 4). The WHO underscores the necessity of essential tools such as orthoses, handrails, wheelchairs, and canes to enhance mobility, safety, and quality of life for stroke patients ([World Health Organization, 2016](#)). Canes and walkers aid stability, while wheelchairs—both manual and motorized—support those with significant mobility impairments. Three-wheeled scooters assist individuals with limited endurance, and crutches provide temporary support. Orthoses correct limb or spinal alignment; in rare cases, prosthetics restore mobility for those who have lost limbs due to stroke. Choosing the appropriate device depends on individual needs, environment, and professional consultation, reinforcing the importance of accessible and tailored rehabilitation support.

Considering the existing challenges in acquiring basic needs and proper medical care for stroke patients, rehabilitation technologies offer promising solutions. Integrating technology and innovative machinery in stroke rehabilitation can enhance recovery, increase patient engagement, and provide remote accessibility, making them valuable tools even in low-resource settings. Telerehabilitation and home-based systems, for example, allow patients to continue their therapy without frequent hospital visits, which is particularly beneficial in areas with limited medical infrastructure ([Sauerzopf et al., 2024](#)). These technologies help bridge gaps in rehabilitation services by providing stroke patients access to guided therapy sessions, virtual monitoring, and real-time feedback from healthcare providers, ultimately reducing the burden on patients and medical practitioners. If done intentionally and with a proper needs assessment that considers contextual and logistical issues of a given area, healthcare systems can address barriers to care while ensuring that stroke patients receive consistent and structured rehabilitation.

## CONCLUSION

In conclusion, stroke rehabilitation has the potential to be revolutionized through technological advances. It is a vision for the future and necessary step forward, especially in regions like the Visayas, where gaps in rehabilitation and care are evident. One of the main primary roles of the government is to develop strategies that improve rehabilitation and health services while providing necessary assistance to healthcare professionals. Local and national policies can enhance the mobility and retention of healthcare workers by improving their experiences, offering additional benefits, and supplying essential tools and assistive devices to ease their workloads. Since many healthcare professionals are overburdened due to the high patient volume, investing in supportive resources is critical. Moreover, ensuring access to accurate and comprehensive information is crucial in understanding specific needs, challenges, and available resources. This allows for more targeted interventions that can significantly improve stroke rehabilitation outcomes.

To achieve this, integrating advanced technological tools such as telemedicine, VR platforms, robotic assistive devices, and wearable sensors with already practiced conventional rehabilitation therapies can enhance patient recovery by providing accessible, personalized, and continuous care to patients (Malik et al., 2022). Involving key stakeholders, including therapists, stroke patients, and caregivers, will also be necessary to develop and implement these technologies to ensure they align with actual needs and user preferences (Kerr et al., 2018). Furthermore, conducting feasibility and scalability studies in resource-constrained settings will be crucial for determining these innovations' long-term success and adaptability ensuring they are both effective and sustainable (Sauerzopf et al., 2024). By addressing these aspects, stroke rehabilitation can become more inclusive, efficient, and capable of meeting the growing demand for specialized care.

## Authors Contribution

**Navea:** Conceptualization, Data Curation, Funding Acquisition, Project Administration, Supervision, Writing – Original Draft Preparation; **Dar Juan:** Conceptualization, Data Curation, Formal Analysis, Resources, Project Administration, Investigation, Methodology, Project Administration, Writing – Original Draft Preparation; **de Jesus:** Data Curation, Resources, Validation, Visualization, Writing – Original Draft Preparation; **Anota:** Writing – Reviewing and Editing; **Paloma:** Writing – Reviewing and Editing; **Teves:** Writing – Reviewing and Editing

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## Ethical Approval

Ethical approval was obtained from the Single Joint Research Ethics Board (SJREB) with reference no. 2023-85. The ethical approval remained valid until October 26, 2025. Informed consent was obtained from all participants. The study prioritized participant protection, confidentiality, and cultural sensitivity. Data was securely stored, anonymized, and was disposed of according to ethical guidelines. Findings were disseminated responsibly.

## Competing Interest

The authors declare no conflicts of interest.

## Data Availability

Data will be made available by the corresponding author on request.

## Declaration of Artificial Intelligence Use

In this study, the authors did not use any artificial intelligence (AI) tools or methodologies.

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