



Research Article

## **Cleveland Clinic Abu Dhabi: Stroke Patients Journey from Referring Hospital to Discharge, Methodology**

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## Abstract

**Background:** *Currently, healthcare organizations are looking for ways to improve the quality of service and increase productivity. In the United Arab Emirates (UAE), chronic stroke patients receive healthcare services from home care services to highly sophisticated healthcare providers. Cleveland Clinic Abu Dhabi (CCAD) is a stroke referral center that operates as a 24/7 comprehensive neurovascular service providing thrombolysis and thrombectomy. The need to map how patients with stroke move through the CCAD's services is crucial to understanding end-to-end healthcare needs to manage their patients better.*

**Objectives:** *To provide an overview of our data collection methodology that is used for mapping the journey of the CCAD's stroke patients.*

**Methods:** *Data will be collected from March 2015 till the end of February 2019. Five categories (home, CCAD, other public/private hospitals, rehabilitation stroke centers, and overseas point of entry) will be considered for tracking. The patients' pathways will be mapped for both origins of admission to CCAD and discharge journeys. Our data will include patients' demographics, details of stroke and treatment, and health outcomes. The network will be constructed using Bayesian Network analyses.*

**Conclusion:** *This study delineates the journeys of stroke patients receiving stroke services in the emirate of Abu Dhabi through CCAD's system. Mapping the journey of these patients will advance our understanding of their interactions with other local healthcare organizations and will allow us to determine areas for improvements for such services.*

**Keywords:** *Stroke, patient's journey, stroke pathway, healthcare needs, rehabilitation.*



## Introduction

Globally, Cerebrovascular accidents (CVA) are second only to ischemic heart disease as causes of death, according to the World Health Organization (WHO) [1]. Likewise, the population of the United Arab Emirates (UAE) is without a doubt at high risk of CVA due to the increasing burden of CVA due to population aging, current unhealthy habits, and diet assumptions [2]. Unfortunately, epidemiological stroke data for the UAE are scarce and limited to a few small data. Nevertheless, the collection of epidemiological stroke data is critical to improving the planning and delivery of evidence-based stroke services [3]. The ultimate goal is to encourage better clinical and financial outcomes by planning and evaluating system change that mimics the London model of stroke treatment [4].

According to World Health Organization (WHO), identification of the volume of stroke patients, identification of fatal stroke events, and estimation of non-fatal strokes are vital steps in determining stroke burden in any community [5]. As stroke imposes substantial disability risks and functional limitations alongside socioeconomic burden, specialized stroke centers have become the obvious way of managing chronic stroke cases [6]. On the other hand, hospitals have shifted to providing care for acute stroke cases and repatriating continuing care to local stroke services. This cost-effective service has been introduced in the UAE by the presence of clinical units that act as specialized centers to provide stroke care and rehabilitation [7]. These centers offer supported discharge and inpatient/outpatient rehabilitation services to in-need patients [8, 7]. Other stroke patients for whom rehabilitation activities are no longer performed within stroke centers could benefit from home-based care and support [9]. However, how stroke patients pass through these stroke services from the beginning of the stroke event through CCAD hospital admission to specialized stroke services or home care is not evident, and the outcomes of these services are not known.

The patients' journey map models the patients' movements through different healthcare organizations by viewing them from the patients' perspective. Mapping the linear flow process, including the patients' pathways, will help in understanding end-to-end healthcare needs to manage this group of patients better. It will develop a method that could advance our knowledge of patient-healthcare interactions. It will also allow healthcare professionals to identify areas for improvement that will enable the implementation of LEAN processes to promote improved healthcare management and better allocation of national resources [10].

*Cleveland Clinic Abu Dhabi (CCAD)* is a regional stroke referral center that operates as a comprehensive neurovascular service providing thrombolysis and thrombectomy 24/7. CCAD was the first hospital in the UAE to introduce ground-breaking imaging software to measure blood flow for patients with acute



stroke, which has expanded the therapeutic window of mechanical thrombectomy [11]. Also, the median door to thrombolysis time for stroke patients for CCAD was 35 minutes, beating the 60-minute Abu Dhabi Department of Health benchmark [11]. Nevertheless, we propose that patients' clinical outcomes would be better, where more significant healthcare resources were provided.

This work aims to describe our data collection methodology, which will be used to map the journey of stroke patients through the CCAD system. This exercise is essential because, as far as we know, there are no studies, particularly from the UAE, that have tried to investigate the linear flow of healthcare services that are provided to stroke patients. This exercise would ultimately advance our understanding of the experience of stroke patients and the collaboration of healthcare providers in delivering care to this group of patients. It is worth noting that the views expressed in this study are those of the authors and not necessarily those of any authorizing bodies in the UAE. The approval of this study was granted by the CCAD's Research Ethical Committee (A-2018-020) with continued oversight. This study is a part of the CCAD Stroke Registry project [12].

## Methodology

Data will be collected from mid-March 2015 (hospital's inception of operation) till the end of February 2019 using the CCAD's EMR to track the origin of admission and discharge from CCAD. We will consider all possible internal points of entry/ discharge, including homes, hospitals, and rehabilitation centers. A separate composite for all non-UAE points of admission/discharge will also be considered. The stroke team responsible for data collection at the CCAD consists of a multi-disciplinary team. It includes neurologists, neuro-interventionalists, neurosurgeons, neuro-hospitalist, nurses, physiotherapists, occupational therapists, speech and language pathologists, patient educators, a case manager and a social worker. Their role is to discuss treatment options, treatment planning, and discharge disposition. They utilize various available resources and data, including demographics, insurance data, point of origin, and placement eligibility to ensure identification of patient's discharge needs and their transition to an appropriate setting. The data collection process will be performed during post-inpatient care.

Post data collection, to construct the network, nodes representing patient states (or locations) are linked via conditional dependencies in an acyclic manner [13]. Such networks are suited for estimating the likelihood that a given preceding event leads to a given endpoint. Linkage weights are calculated and will be proportional to the % of patients from a given temporal step transferring the linkage.



Formally,

$$w_i = \frac{n_i}{\sum_{i=1}^z n_i}$$

where  $w_i$  is the weight associated with linkage  $i$  (of  $z$ ), and  $n_i$  is the # of patients associated with linkage  $i$  (of  $z$ ). Weight variability,  $var(W_i)$ , measuring the linkage residuals from a hypothetically balanced networked, are also calculated in a manner described by Bean et al. [14].

Specifically,

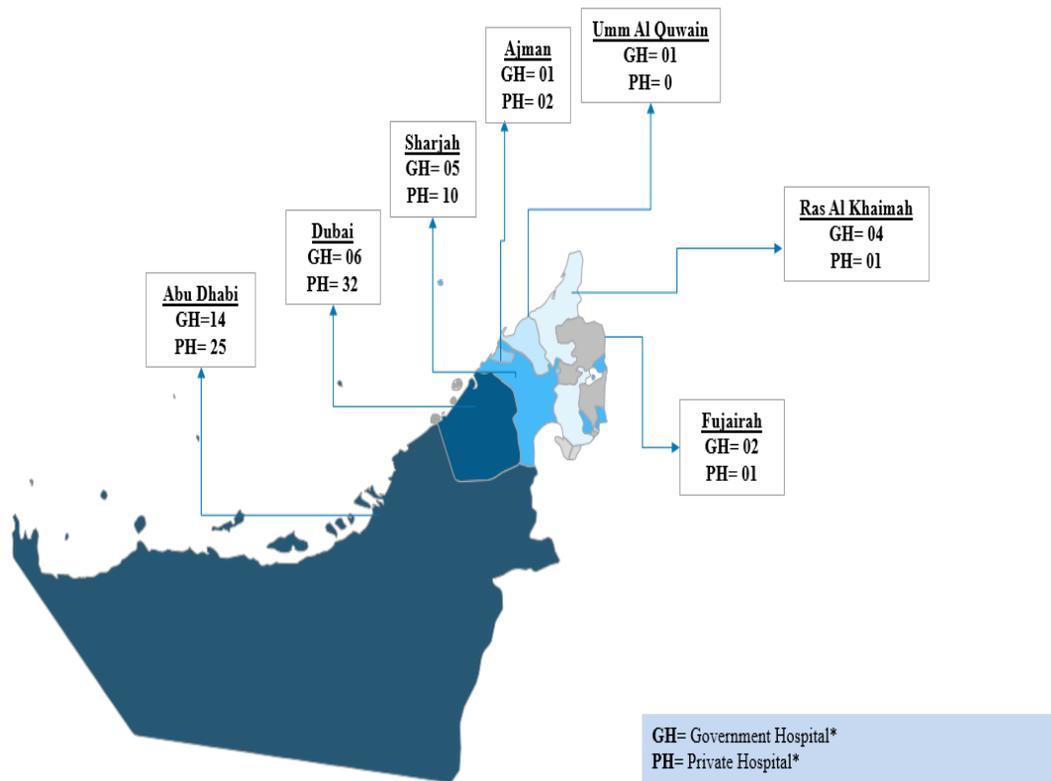
$$var(w_i) = \frac{\sum_{i=1}^z |w_i - \bar{w}|}{\bar{w}} \bigg/ \frac{((z - 1) \times (\bar{w} - 1)) + ((\sum_{i=1}^z w_i) - \bar{w} - z + 1)}{\bar{w}}$$

where  $\bar{w}$  is the average weight value of the network.

To examine the relative traffic through different pathways of the network, the weight and weight variability vectors will be analyzed using unsupervised machine learning techniques, such as cluster analysis and/or principle components analysis.

### Overview of the Local Healthcare Structure and Network

In the seven emirates that make up the UAE, patients have access to either governmental hospitals or private hospitals, or both, in their local area or emirate. Although that there are more than 104 hospitals (governmental and private) scattered throughout the UAE [15], which could receive acute cases of stroke, there are fewer non-hospital centers that could provide specialized care to stroke patients.

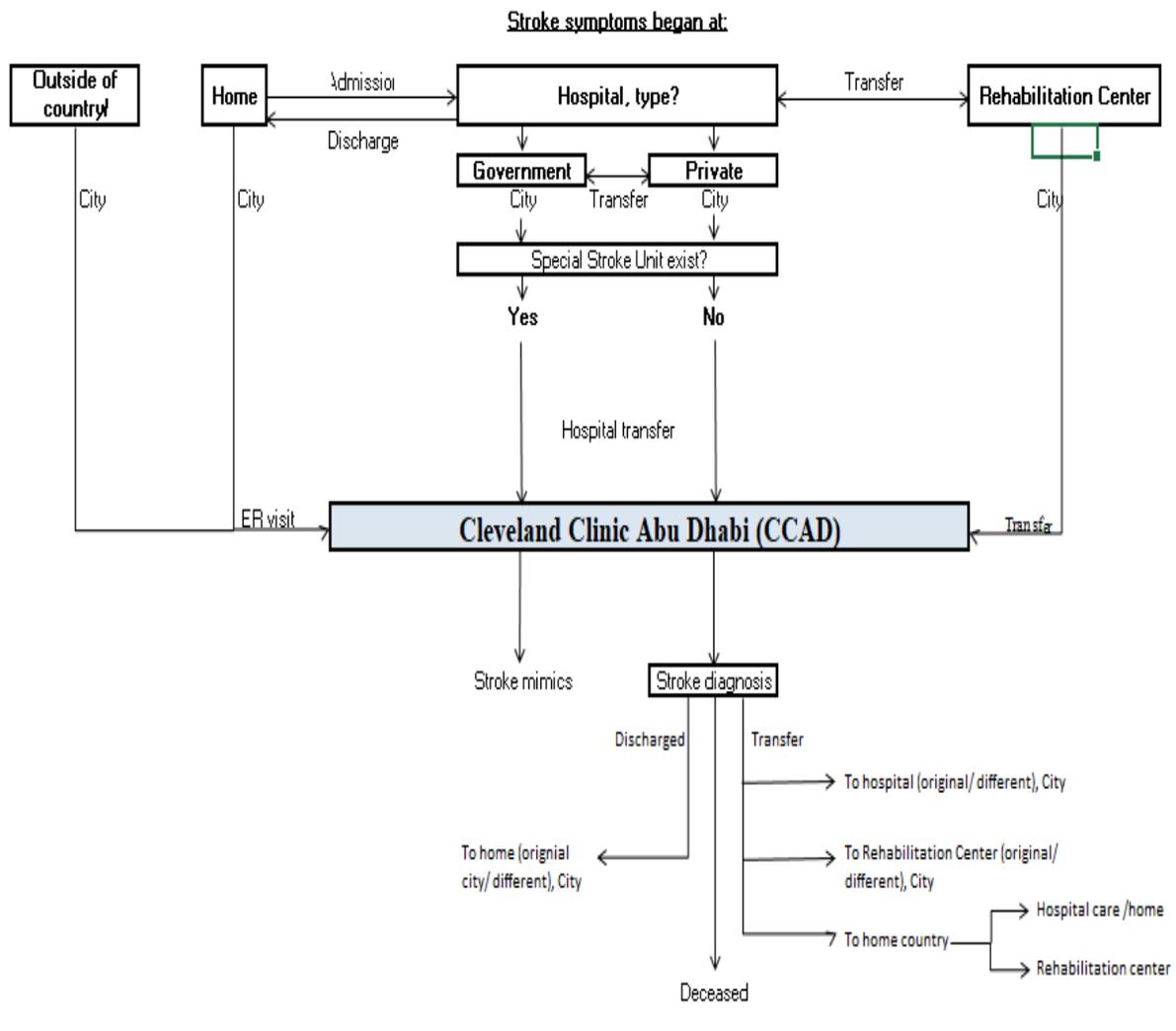


**Figure 1.** Distribution of stroke-care providers in the UAE

The experience of stroke patients who have been admitted to the CCAD hospital is translated into the following visual representation of their journey. **Figure 2.**



Figure2. Stroke pathways from the acute onset of symptoms to long-term stroke care, through CCAD.



**Figure 2.** Stroke pathways from the acute onset of symptoms to long-term stroke care, through *CCAD*

### Discussion

*Cleveland Clinic Abu Dhabi* has operated as a stroke center of excellence for Abu Dhabi and the Western Region of Abu Dhabi emirate to provide stroke treatment as well as a referral unit for more complex cases. Our work reflects an expansive view to include information on stroke focal points along the routes of the journey as experienced by *CCAD* stroke patients after and before admission.



Our revision will be based on the data collection process as carried out during post-inpatient care. The aim is to focus on the journeys of stroke from the patients' perspective to provide practical Activity Base Management to improve their quality of care.

The stroke journey may begin with an emergency visit to the hospital, another hospital referral, or a rehabilitation center transfer with particular attention to the place of origin. We will be considering all the three possible points of origin as well as the internal referrals from the *CCAD*'s other clinical departments when tracking the origin of admission. Also, patients coming directly from abroad or via airport transfers or repatriated to their home country will be tracked to show the last point of care in either a hospital setting, rehabilitation unit or home-based.

Our data will cover demographics, stroke details, treatment, and health outcomes. We have, therefore, focused on the following data sources to delineate our journey maps; touchpoints, timelines, and external/ internal Influences.

## Touchpoints

Retrospective data were collected from the *CCAD* electronic records system based on coding diagnoses to identify points of contact patients had with the healthcare system in the UAE. All patients with acute stroke as the principal diagnosis admitted to the *CCAD* were included (ischemic stroke, hemorrhagic stroke, and subarachnoid hemorrhage). The scope of data collection was extended to the hyper-acute stroke interventions including, interventional neuroradiology procedures and treatment of central nervous system vascular malformations.

The journey will be tracked to pre- *CCAD* admission to include referring hospital or other hospital admissions. If a self-referral was initiated, the place of origin was marked. Tracking also followed the means of transportation. Intra- *CCAD* transfer details for inpatient strokes were also noted as well as the patient journey after discharge from *CCAD*. **Table 1.**



**Table 1. Touchpoint data to be collected for each patient (when available):**

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- Place of onset of symptoms
  - Referring hospital or other previous hospital admission
  - Duration of symptoms before presentation
  - Means of transportation (walk-in, transportation via ambulance, private car etc.)
  - Intra-CCAD transfer details for inpatient strokes
  - Referring unit/floor
  - Patient journey after discharge from CCAD (repatriation home, to home country, or to a rehabilitation facility).
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**Table.1** Touchpoints data to be collected for each patient (when available):

**Timelines**

Stroke care timeline data were also extracted retrospectively from the EMR system. These timelines will be proved valuable in summarizing and analyzing the data concerning the cases studied. Despite some selectivity to facilitate interpretation, timelines in **Table 2** provided a clear and concise way of displaying summaries of our data.

**Table 2. Timelines data to be collected for each patient (when available):**

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- Time parameters (Time of onset of symptoms, timing of investigations, treatment administered such as IV thrombolysis, thrombectomy etc.)
  - Timelines of pre-CCAD admission and transportation
  - Time scale of intra CCAD transfer
  - Timeline of patient journey after discharge from CCAD
  - Length of stay at CCAD
- 

**Table 2.** Timelines data to be collected for each patient (when available)

**Internal/ External Influences**

Whenever possible, internal (as a result of the health system’s operation) and external (beyond the health system’s control) factors that impact the stroke patients’ journeys are captured, these factors are summarized in **Table 3**.

**Table 3. Internal/ External data:**

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- Stroke type (IS, ICH, SAH)
- Demographic information including ethnicity/country of origin
- Premorbid functional status (mRS)
- Basic vital parameters on admission (BP, weight, BMI)
- Cardiovascular risk factors (DM, HTN, hypercholesterolemia, smoking, family history)
- Diagnostic test results (brain imaging including multimodal CT brain including CT perfusion, vascular imaging, cardiac imaging, ECG Holter, blood tests); in patients undergoing thrombectomy for acuter ischemic stroke clot pathology results will be collected
- Initial clinical presentation: NIHSS stroke scale (where applicable), descriptive symptoms (cortical, long tract, brainstem symptoms), GCS
- Etiological stroke subtyping with information on large vessel disease, small vessel disease, cardio embolic sources or other determined aetiologies allowing for TOAST/ACSOD classification for IS; in case of ICH the ICH scores will be collected and for SAH Hunt&Hess scale will be used
- Treatment received (acute, and discharge stroke prevention)
  - In case of thrombolysis/revascularization separate data will be collected with door-to-needle/door-to-puncture times (etc.), pre and post thrombolysis NIHSS
  - In case of the need for neurosurgical intervention (decompressive craniectomy, ICH evacuation or intraventricular drain incision etc.) all procedure related information and outcomes will be collected
  - In case of thrombectomy the following data will be collected: Anaesthesia use, complete time metrics for the interventional procedure, details of each thrombectomy pass including method, devices/intra-arterial medications, recanalization success and complications.
- Vital status at discharge or last available status as inpatient or during follow-up visits (NIHSS, mRS, GCS, MMSE, cognitive batteries as per standard clinical protocol)

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**Table 3.** Internal/ External data

While most of the above data can be realized, we understand that developing a high-level version of the patients' journeys is important to provide an overview of the current local stroke pathways. Therefore,



focusing on vital details to map our patients' journey is required at the initial level. Deeper-dive versions may be developed in due course to provide more information for the patients' profiles and services offered across the healthcare facilities.

## Conclusion

This study describes the methodology that is undertaken to delineate the pathways of the CCAD's admitted stroke patients receiving stroke services before and post-admission to the CCAD. Mapping the journeys of these patients will allow the healthcare decision-makers to develop a model of stroke care for a better quality of care for such patients. We will adopt a comprehensive picture of local stroke care across the country, to aim to recommend potential changes to the current stroke care across the patient pathways.

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