International Journal of Physical Medicine & Rehabilitation

Riesco et al., Int J Phys Med Rehabil 2018, 6:2
DOI: 10.4172/2329-9096.1000466

Research Article Open Access

Vehicle Driving after Stroke: Who Does it Better? A Descriptive Study in a Group of Patients Treated at the Clinical Hospital at the University of Chile

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Received date: April 17, 2018; **Accepted date:** April 23, 2018; **Published date:** April 27, 2018

Abstract

Introduction: Vehicular driving is a complex and highly valued process and one of the activities that are most affected post-stroke, but little has been studied about our national epidemiological situation that links them.

Objective: To create an epidemiological profile and estimate the prevalence of vehicular driving in a sample of patients with stroke who were drivers previously.

Method: This is a descriptive, observational, cross-sectional study that enrolled adults in productive age at HCUCH, with a discharge diagnosis of stroke; during the first half of 2014. Their clinical records were analyzed and a telephone interview was applied a year after the event.

Results: A sample of 24 patients was obtained. Sixty-six percent (n=16) returned to driving in an average time of 2.5 months after discharge. They had a shorter hospital length of stay (16 ± 24 days; p=0.0062), a better score on the mRS (p=0.0008) and less cognitive impairment (19%; p=0.016) than those who stopped driving.

Conclusion: The sample did not allow for the creation of a specific clinical epidemiologic profile of patients with stroke who returned to driving that was differentiated from the profile of ones who had stopped driving, but we could observe a percentage of returning to driving similar to what has been described in international literature, especially between those who had more functionality, shorter hospital stays and less cognitive lesions, all characteristics of a better functional prognosis in CVD.

Keywords: Stroke; Vehicle driving; Neurorehabilitation

Abbreviations **HCUCH:** Clinical Hospital University of Chile; **mRS:** modified Rankin Scale; **CVD:** Cerebrovascular Disease; **NHS:** Chilean National Health Survey; **FIM:** Functional Independence Measure; **NIHSS:** National Institute of Health Stroke Scale

Introduction

Cerebrovascular disease (CVD) is a worldwide pathology with high social and economic impact, due to the direct and indirect costs for the patient, their family and society [1]; and it is one of the main causes of mortality and disability [2]. In the Chilean National Health Survey (NHS) 2016-2017, a prevalence of stroke of 2.6% is estimated in the general population [3].

On the other hand, driving is a complex psychomotor process that requires indemnity of the motor, sensory and cognitive abilities, which are all vulnerable to the damage of a stroke [4]. For this reason, the national and international guides discourage that patients with CVD drive until a month of evolution, and if after this time the survivor still shows neurological deficits, the recommendation is to warn the authorities [5,6]. Chilean legislation forces the physician to communicate to the Ministry of Transport and Telecommunications and to record in the clinical summary file the denial of the driver license to applicants who show some lack of aptitude to drive motorized vehicles, among them: diseases that produce inability to carry out movements with the speed and precision required, crisis of loss of conscience and/or involuntary movements that seriously interfere with the driving ability [7].

Adults who stop driving limit their outdoors activities [8], which translate into lower social participation and a greater rate of psychological and physical morbidity [9]. Due to the relevance assigned to this activity-driving cars-in the functionality and in social and job integration, particularly for those people with disabilities, it is considered good medical practice of the general practitioner to guide and timely refer these patients to the rehabilitation specialist [10].

Thus, to predict vehicle driving after a stroke, several authors have focused on establishing relationships between the resumption or cessation of this activity and the clinical, functional and/or sociodemographic characteristics of the individual [8,11]. Among the

variables mentioned are [11-13]: age, cognitive status, functional independence according to the modified Rankin scale (mRS) and FIM (Functional Independence Measure), the side and type of the lesion, the visual field, some characteristics of driving pre-stroke, and many others specific tests for each deficit.

Because driving is a complex and subjectively appreciated act [14], the progressive increase of the number of cars in our country [15], the high prevalence of stroke in the general population-source of disability-the lack of specificity in legislation and poor research of vehicular driving after a stroke and other disabling pathologies at the national level, it is very important to address the problem of resuming or stopping driving after a vascular event of such magnitude. This is why the main objective of this study is to address the sociodemographic, clinical and functional profile of a sample of patients with stroke treated at the Clinical Hospital at the University of Chile (HCUCH) who operated a vehicle, truck or motorcycle prior to hospital admission, in order to characterize their final driving status and establish associations. Also, we are seeking estimate the prevalence of vehicular driving one year after stroke from the sample.

Methodology

The study was descriptive, observational and transversal, and the sampling technique, non-probabilistic and discretional. The population of study was made up of subjects between 18 and 65 years of age, discharged from HCUCH between January 1st and June 30th 2014, with a primary or secondary diagnosis corresponding to the ICD-10 code of "Cerebrovascular Disease" excepting I65, I66, I67, I68 and I69 and with the history of driving vehicles prior to the occurrence of the CVD. The age range was established arbitrarily, assuming a higher rate of driving among those patients who were of working age. The exclusion criteria were two: (1) deceased during the course of their hospital discharge and the time of information search in the clinical file and; (2) refusals of hospitalization or transfer to another center after first care in the emergency service of the HCUCH.

A semi-structured survey was elaborated with consideration of the literature and expert local opinion, and was applied by telephone to all patients who met the selection criteria, with prior informed consent and after a pilot test. In the case of aphasic patients, the survey was realized by their caregiver. For the collection of the data, this survey and the review of the electronic clinical records were used, keeping the confidentiality of the patients. The variables collected are described in Figure 1.

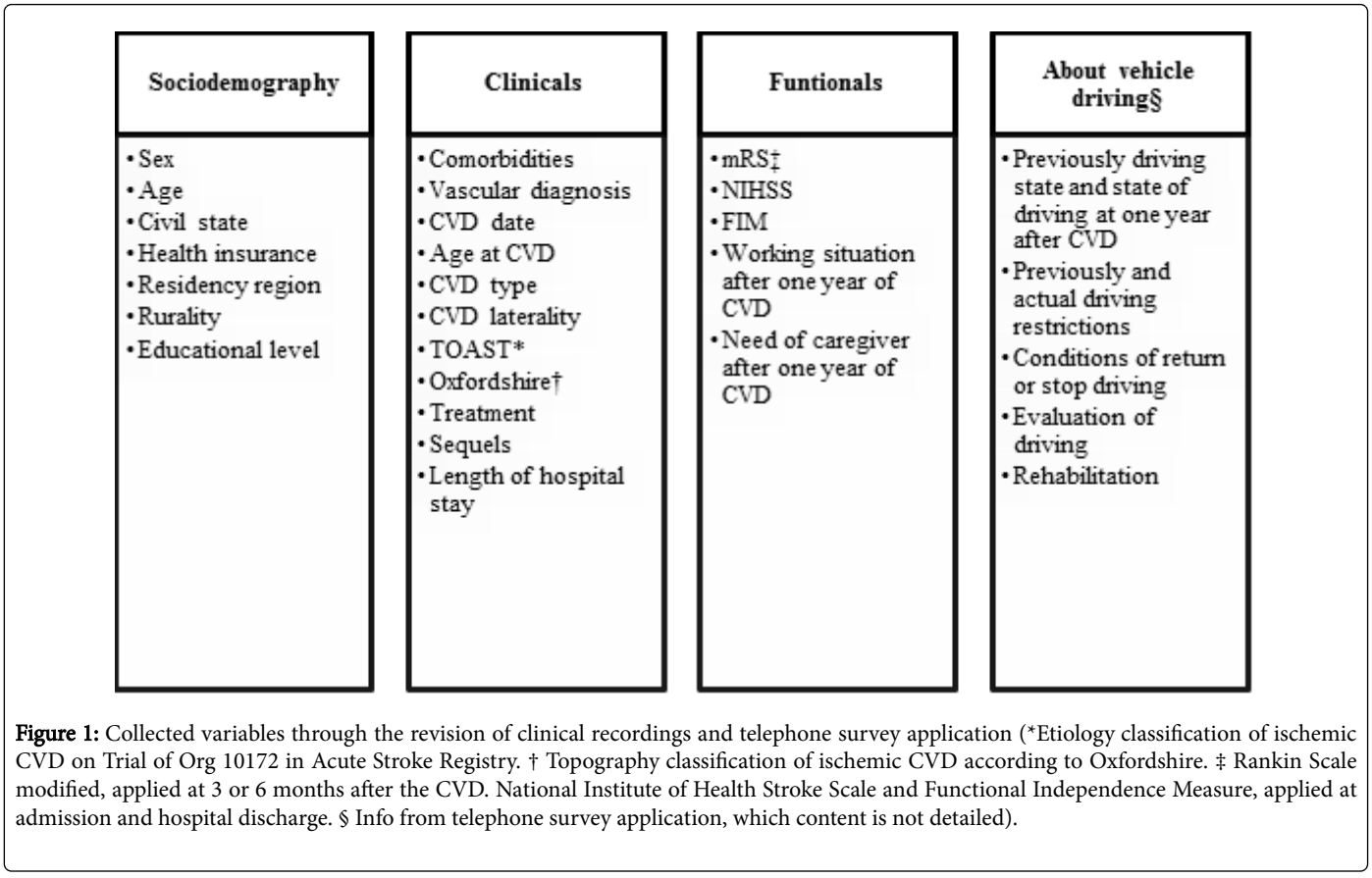

Figure 1: Collected variables through the revision of clinical recordings and telephone survey application (*Etiology classification of ischemic CVD on Trial of Org 10172 in Acute Stroke Registry. † Topography classification of ischemic CVD according to Oxfordshire. ‡ Rankin Scale modified, applied at 3 or 6 months after the CVD. National Institute of Health Stroke Scale and Functional Independence Measure, applied at admission and hospital discharge. § Info from telephone survey application, which content is not detailed).

All the information was tabulated and analyzed using the statistical software Stata® V12.1. The analysis of association was obtained, according to the nature of the variable, through Fisher's test, the Spearman correlation coefficient or the non-parametric Wilcoxon test. A p value <0.05 was considered significant.

Results

Of the 189 patients discharged from HCUCH with a diagnosis of CVD during the first semester of 2014, 49 meet the selection criteria. The telephone survey was administered to all of them, determining a

final sample size of 24 patients. The main reasons for exclusion and loss were, respectively: age over 65, death and ICD-10 code miss-assigned; absence of previous vehicular driving and inability to make telephone contact.

Socio-demographic, clinical and functional characterization

Most of the patients were male and lived in Santiago, Chile; and the average age was 53 ± 10 years. From the sample, 42% had completed higher education and 21% had incomplete schooling. Regarding the clinical profile and with respect to the stroke, 88% were ischemic, with a predominance of cardioembolic etiology. There was greater involvement of the left hemisphere and the anterior circulation (Table 1).

Sociodemographic, clinical or functional variable	Percentage (n)
Sex	
Female	17% (4)
Male	83% (20)
Age* (years)	53 + 10
Region of residency	
Santiago	88% (21)
Other Cities	12% (3)
Educational level	
Incomplete Schooling	21% (5)
Complete Schooling	25% (6)
Incomplete University	12% (3)
Complete University (technician-professionals)	42% (10)
CVD type and etiology	
Ischemic	88% (21)
Cardioembolic	38% (8)
Lacunar	29% (6)
Atherothrombotic	4% (1)
Cryptogenic	19% (4)
Other	10% (2)
Hemorrhagic	12% (3)
Oxfordshire Classification	
TACI	17% (4)
PACI	30% (7)
POCI	12% (3)
LACI	25% (6)
Without classify	16% (4)
Level dependence mRS†	
Independent	75% (18)
Dependent	25% (6)

Table 1: Sociodemographic and functional characterization of the sample (n=24) (*Average ± standard deviation. † Modified Rankin scale, applied to the year of the CVD. Independent corresponds to stages 0, 1 and 2; dependent corresponds to stages 3, 4 and 5. TACI: Total Anterior Circulation Infarct; PACI: Partial Anterior Circulation Infarct; POCI: Posterior Circulation Infarct; LACI: Lacunar Circulation Infarct).

The motor and cognitive deficits were the most prevalent in acute stage, with a frequency of 67% and 33%, respectively. Of all the patients analyzed, only 71% had registered the NIHSS of admission and another 71% at discharge time. In turn, 75% had described the FIM, although with uncertain application timing. None had mRS at their medical outpatient check-ups. By this reason, mRS was calculated at the time of the phone call: three quarters of the patients were classified as independent in their activities of daily life. Fourteen individuals (58%) were active at the time of telephone contact and 3 required a caregiver. It is important to mention that a direct correlation was obtained between days of hospital stay and mRS one year after the stroke (r: 0.513, p=0.01); that is, the greater the number of days hospitalized, the greater the dependency calculated after one year.

Vehicular driving and CVD

Sixty-six percent (n=16) of the patients with stroke who previously drove cars started driving again in an average time of 2.5 months after discharge, at a frequency of 4.5 ± 2 days a week (Figure 2).

Table 2 summarizes the aspects of vehicular driving after CVD, and emphasizes that the totality of the patients who answer the survey could drive without company and that only one had suffered an automobile accident after the CVD. Fifty percent of the series had a special and/or professional license; however, only six patients (38%) renewed it during the year after the CVD. Of all those who had their own vehicle, none was adapted. The main reasons for vehicular use that they mentioned were: to socialize and going to work. From the total of patients who stopped driving 100% wanted to drive again, but only 63% believed they were really capable. Sixty-three percent of the sample reported having received ambulatory rehabilitation and 58% had invested in specific rehabilitation for driving.

In the subgroups analysis of subjects according to their final driving status-those who stopped driving in one group and those who continued in another-no statistically significant differences were found in any of the socio-demographic, clinical or CVD characterization data, except in the following: (1) the hospital stay was longer in those who stopped driving compared to those who drove again (55 ± 48 days *vs.* 16 ± 24 days, p=0.0062); and (2) the percentage of cognitive impairments was higher among those who stopped driving compared to those who continued to do so (63% *vs.* 19%, p=0.016). In reference to the functional scales, the categorization by stages according to mRS was significantly higher in the patients who were driving at the time of the interview (p=0.0008), but it stopped being analyzed when they were dichotomized-dependent *vs.* independent (p=0.069). Similarly, there were more active productive subjects in the group of those who drove (81% *vs.* 12%, p=0.002). When analyzing the various aspects referring to the very act of driving (restrictions, evaluation, rehabilitation), no significant differences were found (Table 3).

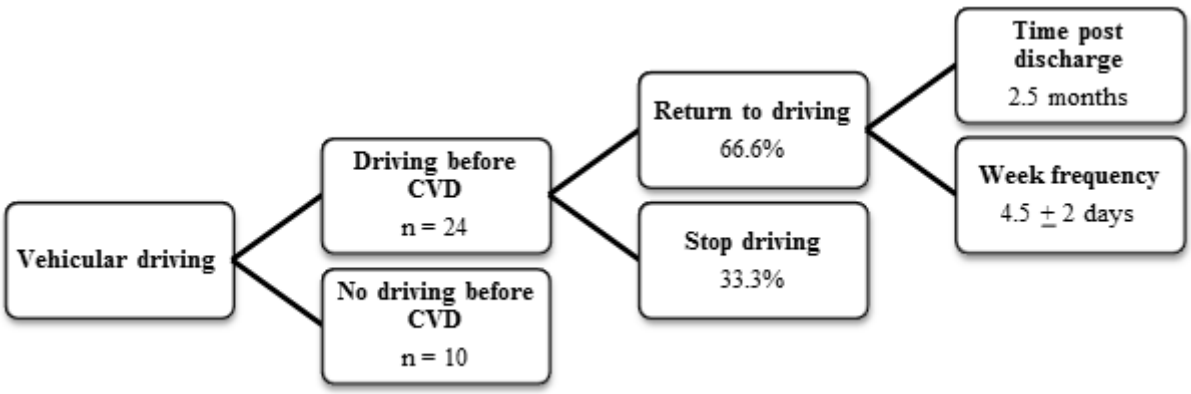

Figure 2: Driving state detail pre and post CVD.

Driver Question	Answer	Percentage (n)
Drive more than an hour	Yes	62% (10)
	No	38% (6)
Drive with no company	Yes	100% (16)
	No	0
Drive on highways	Yes	94% (15)
	No	6% (1)
Drive at night	Yes	81% (13)
	No	19% (3)
Drive on rainy days	Yes	88% (14)
	No	12% (2)
Use roads with no pavement	Yes	88% (14)
	No	12% (2)
Own a vehicle	Yes	94% (15)
	No	6% (1)
Vehicle accident	Yes	6% (1)
	No	94% (15)
License type	Unprofessional	50% (8)
	Professional	19% (3)
	Special	31% (5)
License renew	Yes	38% (6)
	With difficulties	13% (2)
	No difficulties	25% (4)
	No	62% (10)
Driving evaluation*	Yes	31% (5)
	Medical doctor	60% (3)
	OT†	40% (2)
	No	69% (11)

Table 2: Aspects about vehicle driving post CVD (N=16) (*Driving abilities evaluated by some professional to determinate if could keep driving or have to stop it; †Occupational therapist).

Analysis and Discussion

The objective of achieving a comprehensive profile of patients with CVD evaluated and treated at the HCUCH both at the time of the event and a year later, in an attempt to characterize their final car driving status, was accomplished in the present study. Among those who returned to driving, there is evidence of a trend towards a predominantly male group, of middle age, with at least 12 years of study, ischemic stroke, mostly of cardioembolic origin, with motor sequelae, similar to what is described in the literature. However, it is not possible to establish a categorical and significant difference with its counterpart that did not return to drive.

Sociodemographic, clinical or functional variable	Drivers (n=16)	Not drivers (n=8)	P value
Age of CVD (years)	53 ± 10	48 ± 7	0.11
Sex			
Female	6% (1)	38% (3)	0.091
Male	94% (15)	62% (5)	
Region of residency			
Metropolitan	81% (13)	100% (8)	0.824
Other regions	19% (3)	0	
Educational level			
Incomplete Schooling	19% (3)	25% (2)	0.862
Complete Schooling	31% (5)	12.5% (1)	
Incomplete University	13% (2)	12.5% (1)	

Complete University (technician-professionals)	37% (6)	50% (4)	
Hospital stay* (days)	16 ± 24	55 ± 48	0.0062
CVD laterality			
Right	38% (6)	37.5% (3)	0.849
Left	50% (8)	37.5% (3)	
Bilateral	12% (2)	25% (2)	
CVD sequels			
Motor	63% (10)	75% (6)	0.27
Cognitive	19% (3)	63% (5)	0.016
Visual	13% (2)	25% (2)	0.214
Other	25% (4)	25% (2)	0.5
Non	19% (3)	13% (1)	0.349
mRS†			
0	31% (5)	0	0.0008
1	50% (8)	0	
2	6% (1)	50% (4)	
3	13% (2)	12.5% (1)	
4	0	37.5% (3)	
5	0	0	
Dependency level			
Independent	87.5% (14)	50% (4)	0.069
Dependent	12.5% (2)	50% (4)	
Working state ‡			
Active	81% (13)	12% (1)	0.002
Inactive	19% (3)	88% (7)	

Table 3: Clinical aspects, CVD characterization and functionality scales, according to driving state (Percentages calculated according to the total of each group; *Mean ± standard deviation. † Modified Rankin Scale, applied a year from the CVD. Independent correspond to states 0, 1 and 2, dependent correspond to states 3, 4 and 5. ‡ Working state at the telephone interview moment).

The prevalence of vehicular conduction after CVD in the analyzed sample was 66.6% in an average time of 2.5 months post-medical discharge; this finding is concordant with what is described in the international literature. There it is estimated that among CVD survivors the return to driving occurs in 30 to 60%, over a variable period of evaluation ranging from 3 months to 6 years [11,16,17]. Studies conclude that of those patients who return to driving, 50% do so within the first six months [18] and of these, 85% continue driving 5 years later [19]. In the sample analyzed here, 87.5% were driving regularly six months before the vascular event.

The most abbreviated hospital stay, the minor number of cognitive impairment and the best mRS score within the group that returned to car drive after a CVD was similar to those reported by Tan et al. in which it describes a higher resumption rate of driving in those patients with lower mRS and cognitive indemnity [12].

The hospital stay of 16 ± 24 days in average of the driver group was greater than the observed of 11.3 days for patients with stroke at the national level for the year 2012 [20]. Curiously the mean age was 53 years and with a mild stroke in 38% of them (data not shown). This could be explained by the greater volume of rehabilitation training received by those who were vehicle drivers prior to the CVD, given that the HCUCH is a center that has a consolidated physical medicine service and in specific cases prolongs the stay of patients in order to enhance their functionality.

It is also important to denote that the data were obtained through the written report of the treating physician throughout their outpatient's controls and not by any of the authors, and for this reason, could have conditioned towards omissions or disparity of criteria in the definition. Thus, for example, visual field defects were only described in four patients, two of whom returned to car driving and two did not. This finding does not allow a conclusion about the visual field deficit, in agreement with what is described in a recent review of the literature on vehicular driving in patients with homonymous defects of vision [21], in which the author concludes that there is a wide range of approval in the practical evaluations, ranging from 14% to 90%, attributing it to the small sample size of the studies and to their various selection criteria and recruitment strategies. On the other hand, ataxia and/or balance disorders were incorporated into motor-type sequelae given the great variety of descriptions found, preventing their analysis in isolation.

The statistical association between the Rankin scale and the return to car driving was not significant when the polar segregation was performed, it could be explained by the time it was applied. The scale has its maximum value at 6 months of stroke [22], at which time it allows segregating patients into two categories without overlap: independent (0-2) and dependent (3-5) [23]. Notwithstanding the aforementioned, clinicians recommend its use 3 months after the event, and justify this rationale due the influence of other non-CVD factors that could modify the individual's functionality; and to the fact that majority of acute clinical trials end their follow-up at 90 days [24]. In addition, the mRS stages must be analyzed separately and not in a dichotomous way. Even so, the Rankin scale allows an approximation to the functional state of the subject and its application was found to be concordant with the vehicle driving state.

Among the drivers, the majority did not renew their driver's license (62%) *vs.* those who did (50%), despite the kind of driver`s license they had were professional type. The possible reason is that the validity of the driver's licenses in Chile oscillate from 4 to 6 years according to type, and there is no evaluation protocol after a disabling condition prior to the expiration of this time.

Despite this, the survivors who return to driving only reported one car accident after the CVD. The self-report, the memory bias or the sample size can explain for this. There were also among them a greater number of labor-active subjects, as described by other authors in a direct relationship between the time of incorporation into the activity and the return to driving [25]. Although this was the reason for the exclusion of those over 65 years of age, this caused a significant reduction in the sample to be studied.

All patients who had stopped driving wanted to return to it, however, only 58% would have invested economically towards specific rehabilitation training for this purpose. This apparently low percentage could be conditioned by factors that will not be analyzed in this article, concerning the way the questions in the survey were formed. But to consider other authors, a good rehabilitation improves the skills required for this activity: a recent review by Cochrane demonstrates evidence in favor of training based on driving simulators, specifically on visual-cognitive abilities [26].

The main limitation of the present study is its retrospective design, determining a memory bias of the subjects, and dependence on information obtained by non-participating doctors in the registration. By design and registration, the residual functionality of the CVD survivors could not be fully evaluated, which is a key date in rehabilitation. In addition, it was the patients themselves who reported their current driving status and the variables associated with this activity, without being able to verify the authenticity of this information, or to perform an objective assessment. The small sample size is related to the established selection criteria, the phone communication modality and the high percentage of non-driving prior to the CVD (20%).

Conclusion

The skill to drive a vehicle after a stroke has been recognized as an indicator of independence, particularly the year of debut [27]. This fact was reflected in our study in the best score mRS within the group that returned to drive, which have an antecedent of a more abbreviated hospital stay and few cognitive sequelae. Rehabilitation that is early, trans-disciplinary and oriented towards participation contributes positively to the aspects mentioned here: functional independence, cognition and timely discharge. In specific cases, the hospital stay for rehabilitation could be prolonged.

The challenge then is to develop research along this vein, in order to establish a socio-demographic, clinical and functional population profile of stroke survivors and their relationship with driving again, to implement a timely and effective rehabilitation plan that offers them greater, better and safer social participation. This would require a prospective, controlled study, with selection criteria that expand the sample and a battery of evaluations that objectify the information regarding the functionality and driving of the participants. It is also necessary to give more precision and diffusion to the current national legislation that regulates the acquisition and renewal of driver's licenses, specifically for those individuals who have acquired a disability in a productive age and wish to resume driving.

Acknowledgments

To Ariel Castro L, coordinator of clinical studies and methodological adviser of research of HCUCH and to Felipe Solar T, MPH doctor, for his valuable statistical and methodological collaboration.

Ethics Considerations

The study was approved by the HCUCH Ethics Committee. All identifying data about the patients was kept confidential.

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