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Research Article

Comparison of NIHSS Scores Determined by Emergency Physicians and Neurologists using Pre-Hospital Telemedicine Device

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Abstract

Introduction

The management of acute stroke requires a rapid but appropriate clinical assessment of the patient's neurologic deficit. This study investigates the comparative efficiency of emergency physicians and neurologists to determine the National Institute of Health Stroke Scale (NIHSS) score, the main tool for assessing the severity of a stroke and guiding possible subsequent fibrinolysis.

Material and Methods

A pre-hospital telemedicine device recently developed in Burgundy was used to compare the NIHSS score determined simultaneously by a neurologist at a remote location and emergency physicians at the patient's beside. All examiners had been trained to determine this score. A Chi2 test and Spearman's Rho test for statistical analysis were performed. $p < 0.05$ was considered significant.

Results

Sixteen patients from the department of neurology were included and 52 comparisons of NIHSS scoring between the neurologist and trained emergency physicians were performed. Statistical analysis showed no significant difference in NIHSS scores between the neurologist and emergency physicians. The correlation coefficient for the NIHSS score between these different specialists was excellent (rho = 0.97, p = 0.001).

Conclusions

This study showed that trained emergency physicians and neurologists had equivalent skills in determining NIHSS scores. The telemedicine system allowed such comparisons, thus indicating that emergency physicians can be trained in these skills so as to improve the early management of acute stroke in a pre-hospital setting.

keywords: Telemedicine, Acute Stroke, NIHSS, Emergency Physician

Introduction

Acute stroke is one of the main causes of prolonged functional deficiency and mortality in France and the suspicion of stroke remains a frequent reason to resort to emergency healthcare services. Although stroke treatment has vastly improved, particularly since the development of fibrinolysis therapy, the pre hospital stroke management is still a matter of debate. Our state, Burgundy, is a large region and there are only two stroke units, which explains our interest in the telestroke. Indeed, in the pre-hospital phase, the neurological deficit and the severity of the acute stroke must be evaluated during the emergency call [1,2]. Diagnosing stroke severity quickly allows direct orientation towards an imaging unit, if appropriate, before fibrinolysis is performed, if indicated. The worst damage from a stroke often occurs within the first few hours.

The emergency physician is involved in the initial management from the call to the medical dispatching centre to admission to the emergency department. The first medical step in the management of stroke is the clinical assessment of the neurological deficit. Several reliable and well-validated scoring systems have been developed to evaluate stroke severity, which can determine the use of fibrinolysis therapy. Some of these have limitations [3] and the National Institute of Health Stroke Scale (NIHSS) is the most widely used.

The NIHSS is a 15-item scoring system and a reliable tool for the rapid assessment of stroke-related impairment [4,5]. It is a rapid reproducible tool and its interrater reliability has been well-established [6,7]. The scale graduates the level of consciousness, extraocular movements, visual fields, facial muscular function, upper and lower limb strength, sensory function, coordination (ataxia), language (aphasia), speech (dysarthria), and hemi-inattention (negligence). [table]

1A Level of consciousness	0_alert 1-drowsy 2-obtunded 4-coma/unresponsive
1B Orientation questions (two)	0-answers both correctly 1-answers one correctly 2-answers neither correctly
2 Gaze	0-normal horizontal movements 1-partial gaze palsy 2-complete gaze palsy
3 Visual fields	0-no visual field defect 1-partial hemianopia 2-complete hemianopia 3-bilateral hemianopia
4 Facial movements	0-normal 1-minor facial weakness 2-partial facial weakness 3-complete unilatéral palsy
5 Motor function arm (a-left, b-right)	0-no drift 1-drift before10 seconds 2-fallsbefore 10 seconds 3-no effort against gravity 4-no movement
6 Moto function leg (a-left, b-right)	0-no drift 1-drift before 5 seconds 2-falls before 5 seconds 3-no effort against gravity 4-no movement
7 Limb ataxia	0-no ataxia 1-ataxia in one limb 2-ataxia in two limbs
8 Sensory	0-no sensory loss 1-mild sensory loss 2-severe loss sensory
9 Language	0-normal 1-mild aphasia 2-severe aphasia 3-mute or global aphasia
10 Articulation	0-normal 1-mild dysarthria 2-severe dysarthria

11 Extinction or inattention	0-absent 1-mild (loss of 1 sensory modality) 2-severe (loss of 2 sensory modalities)

Table 1. National Institute of Health Stroke (NIHSS).

The initial NIHSS assessment appears to be a strong indicator of functional prognosis, since it evaluates neurological outcomes and the degree of recovery of stroke patients. Excellent outcomes were noted in 46% of patients with NIHSS scores of 7 to 10 and in only 23% of patients with scores of 11 to 15 [8].

The current era of telestroke for the management of stroke requires emergency physicians to be trained in certain skills usually reserved for neurologists, especially in determining indications for and performing fibrinolysis when a neurologist is not available. The present study investigated correlations between NIHSS scores determined by neurologists and by emergency physicians by using a pre-hospital telemedicine system. The main goal was to compare the reliability of the NIHSS score assessed remotely by the neurologist and that assessed locally by the emergency physician. The second aim was to assess the interrater reliability for NIHSS items, the time to complete the scale, and the quality of the telemedicine device.

Materials and Methods

Study Design

A pre-hospital telemedicine device, which receives images and sounds in real-time and is contained in a compact suitcase, was used (figure 1). This system, designed by the company W2NUMERICOM© (Pontailler-sur-Saone, France), includes software, an EDGE/3G internet key, a hand-free, head-mounted camera, an on-board transmission system using four batteries with four hours of autonomy and a Bluetooth headset. This system makes it possible to send multiple files to several destinations. Moreover, it guarantees the instantaneous and secure transmission of confidential medical data by a data encoding system.

In this preliminary study, the NIHSS score was assessed by a neurologist sitting in front of the screen of the telemedicine device at the university hospital stroke unit on the one hand, and by one or more emergency physicians close to the patient in pre-hospital settings. The emergency physicians had all been trained in determining this score. Each patient gave informed consent to participate and agreed to be filmed by the head-mounted camera or by the camera fixed above the patient. Neither the neurologist nor the emergency physicians had any prior clinical knowledge of the patients, and all were kept blinded to the examinations and scores of the other. The examiners all agreed to this investigation and accepted to be filmed. NIHSS Scores named "remote scores" were determined by the neurologist in the stroke unit whereas "bedside scores" were determined by the emergency physicians who were with the patients.

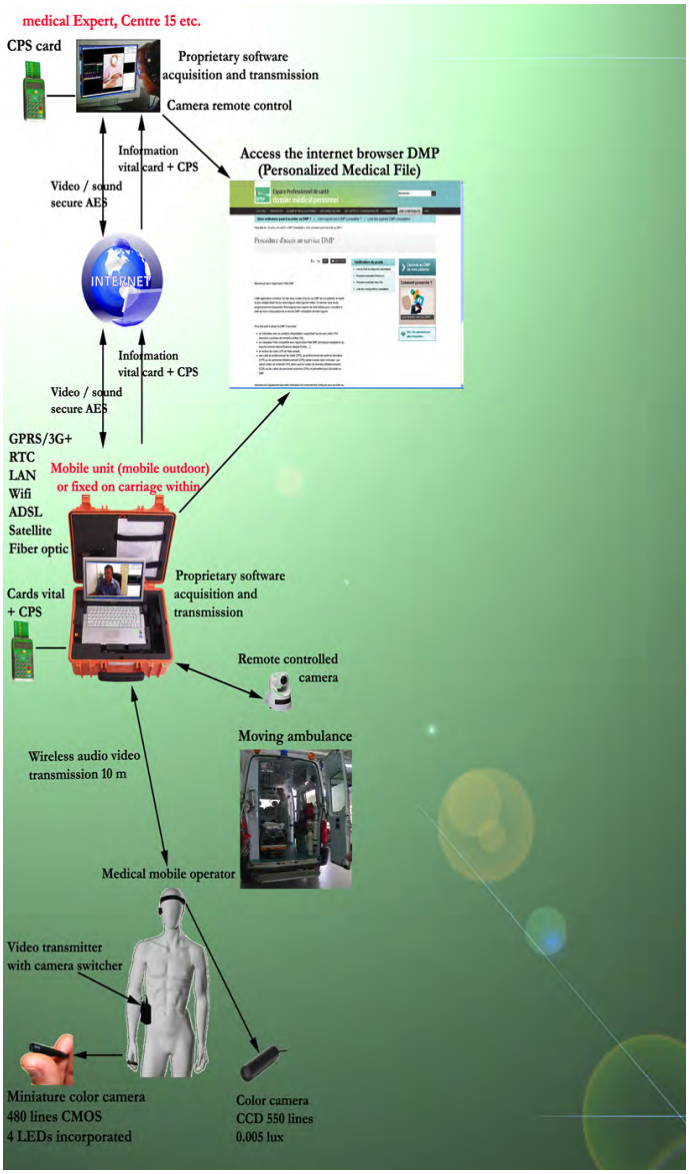

Figure 1. The prehospital telemedicine system.

All scorers had previously been trained using videotapes provided by the French Emergency Medicine Society.

For the first 12 patients, we measured the time required by emergency physicians and the neurologist to determine the NIHSS score.

Statistical Data Analysis

We used the Chi2 test and Spearman's Rho test for the statistical analyses. $p < 0.05$ was considered significant. Interrater agreement between bedside and remote scores was measured by the kappa value for each item of the NIHSS. Published standards for interpretation of the kappa statistic were used (values >0.8, excellent agreement; between 0.6 and 0.8, good agreement; between 0.4 and 0.6, moderate agreement; between 0.2 and 0.4, mediocre agreement and <0.2 poor agreement).

Results

Sixteen patients were enrolled and 52 comparisons

were made at the end of experimental sessions by three neurologists and five emergency physicians.

Actually, some minor problems (light, camera position, connection problems, and sound quality) occurred during two sessions, but the sessions continued regardless.

	Our study(n=52)	**VP (n=40) [12]**	**Handshu et al (n=41)[14]**	**Meyer et al (n=25)[10]**	**Shafqat (n=20)[15]**
Level of consciousness	1(1-1)	0.99 (0.98-1)	0.97 (0.97-1)		
Orientation (questions)	1(1-1)	1 (1-1)1	0.90 (0.82-0.96)	0.92 (0.79-1)	0.75
Response to commands	1(1-1)	0.63 (0.32-0.95)	0.93 (0.86-1)	1(1-1)	0.29
Gaze	0.77 (0.56-0.98)	1(1-1)	0.95 (0.90-0.99)	1(1-1)	0.41
Visual fields	0.76 (0.62-0.90)			0.86 (0.65-1)	0.50
Facial movements	0.71 (0.57-0.85)	0.59 (0.27-0.91)	0.85 (0.79-0.90)		0.40
Motor function (arm)	1(1-1)	0.74 (0.44-1)	0.90 (0.85_0.95)	0.84 (0.64-1	0.82
Motor function (leg)	0.88 (0.78-0.98)	0.62 (0.30-0.94)	0.92 (0.89-0.96)	0.74 (0.47-1)	0.83
Ataxia	0.44 (0.13-0.76)	0.98 (0.74-1)	0.95 (0.90-0.99)		-0.07
Sensory	0.80 (0.68-0.92)		0.91 (0.86-0.96)	0.83 (0.60-1)	0.48
Language	0.78 (0.65-0.91)	0.99 (0.75-1)	0.98 (0.96-1)	0.69 (0.33-1)	0.55
Dysarthriea Articulation	0.89 (0.79-0.99)	0.66 (0.36-0.96)	0.92 (0.90-0.97)		0.55
Extinction or inattention	0.57 (0.39-0.75)		0.96 (0.93-1)	0.80 (0.51-1)	0.77

Table 2. kappa item reliability between remote and bedside examiners.

At the end of experiment, the NIHSS scores determined through the examination of the neurovascular unit stroke patients ranged from 1 to 21. The statistical study showed no significant difference between the neurologists' scores and the emergency physician's scores. The correlation coefficient between the two scores was considered excellent (rho = 0.97, p <0.001) (Figure 2)

According to the kappa index (Table 2), six NIHSS items (level of consciousness, orientation, commands, dysarthria, motor leg, and motor arm) displayed excellent agreement, five items (visual fields, best gaze, facial palsy, sensory, language) good agreement and two items (ataxia, negligence) moderate agreement. The kappa index for each item is presented in the first column of Table 2.

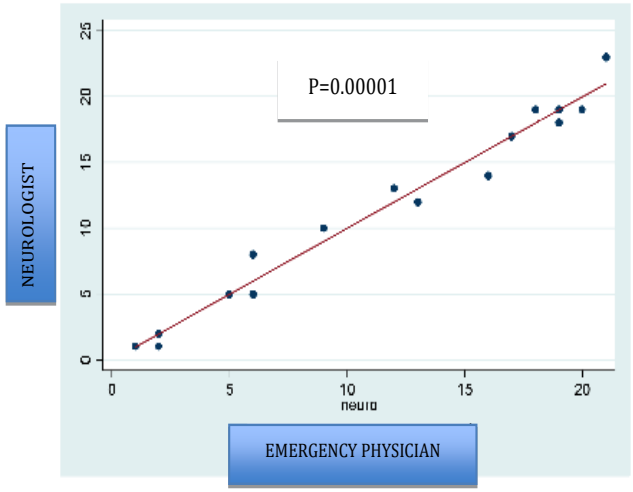

Figure 2. Correlation between NIHSS determined by emergency physician and the neurologist.

The average time to determine an NIHSS score using the telemedicine device was 14 seconds longer than that for the emergency physician close to the patient (6.24 ± 2.3 versus 6.10 ± 2.4 minutes, p = 0.85). The time required by emergency physicians and the neurologist to determine the NIHSS are presented in Figure 3.

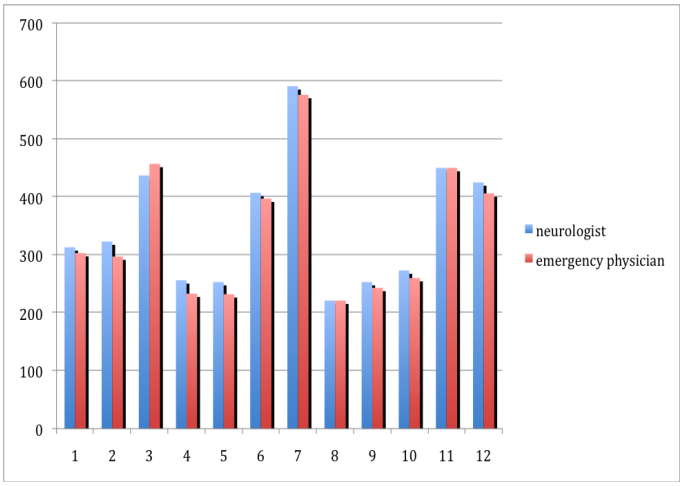

Figure 3. Time required by emergency physicians and neurologist to determine NIHSS scores.

Discussion

The main findings of this study were the absence of any difference between the NIHSS scores determined by the neurologist and those determined by trained emergency physicians. Bedside and remote NIHSS scores did not differ by more than 3 points for any patient. It can thus be concluded that trained emergency physicians and neurologists are equally able to determine acute stroke severity, which underlines the fact that emergency physicians, like neurologists, are able determine whether fibrinolysis is indicated. In the literature, few studies have investigated such a comparison [9-11].

Moreover, the interrater agreement ranged from good to excellent in almost all items of the NIHSS for all patients. Agreement was moderate for only two items (ataxia, negligence). This moderate agreement could be due to the difficulty for emergency physicians to define cerebellar dysfunction and negligence precisely in hemiplegic patients because of their lack of experience in these specific items. Nevertheless, each physician involved as an examiner in our study had had previous training on the NIHSS. Continuous training in the use of the NIHSS appears to be necessary. In the literature, the least agreement was observed for facial palsy and leg motor subscales. These differences could be explained by the image quality or the angle of projection [12-14].

The wide use of telemedicine systems could be an effective response in a strategy to eliminate disparities in access to acute stroke care, to optimize the use of time of medical resources and to improve collaboration between health care providers [15-18]. Many studies have validated several telemedicine systems focused on various processes (video cell phone, high speed connection…) but only in in-hospital practice [19-24]. Our study showed that our pre-hospital system, using low-speed data transmission, was a feasible and reliable telemedicine method. Although it could be considered expensive (approximately USD 15,000, it can be used in pre-hospital settings [25] and in areas that are poorly covered by the third generation network service. This system may facilitate fibrinolysis delivery in areas that have insufficient healthcare cover for neurological diseases [26,27].

Limitations

The study was based on the experience of a single university hospital and therefore the results may not be fully applicable to every hospital. Moreover, the previous training of emergency physicians was mandatory and was time-consuming and difficult to organize. To date, training of Burgundy emergency physicians to evaluate stroke by NIHSS and to perform fibrinolysis if indicated is only available in Dijon and it requires 2 days of theoretical training and 6 days of duty in the neurovascular unit. An examination at the end of this session can result in the delivery of certificate attesting the ability of the emergency physician to perform fibrinolysis.

Patients selected in this study did not present acute stroke at the moment of the examination. Some of them, however, had signs of a deficit from a previous stroke.

Conclusion

Our study demonstrated that trained emergency physicians and neurologists displayed equivalent skills in determining the NIHSS score. Interrater agreement was good to excellent for almost all items. The remote examination of acute stroke patients with our pre-hospital telemedicine system appeared feasible and reliable.

RT and MF conceived and carried out this study.

RT, PYC and CT participated in the study as trained emergency physician examiners. MHB and YB represented the trained neurologist examiners.

LSA designed and performed the statistical analysis of this study.

RT wrote this article and CT participated in drafting the manuscript.

MF takes the responsibility for the paper as the whole.

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The authors have stated that no such relationships exist.

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