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Triage: does it matter?

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Abstract -
Objective: Giving the sensitivity of brain tissue to ischemic or hemorrhagic suffering, a patient with a cerebrovascular accident (CVA) needs to be treated as a medical urgency in the emergency room (ER). To treat the patient accordingly to his medical urgency a triage system is of great importance.
Methods: A monocentric, retrospective study with a pretest-posttest design has been completed to examine the influence of the Manchester Triage System (MTS) on the trajectory of patients with a CVA. Different (time)variables have been compared. The nature of the research was to determine if the implementation of the MTS had a positive impact on the trajectory of a patient with a CVA. SPSS Statistics 21 is used for the execution of the analytical tests.
Results: The results of the research shows that patients that were singed in to the ER, on who the MTS was used, got faster medical attention by a nurse ($p < 0,001$). Though with little or no influence on the patient trajectory. The influence on the outcome of the trajectory of a patient with a CVA on the other hand was marginal. The estimated probability for a better outcome was increased by 2% after the implementation of the MTS ($p = 0.775$).
Conclusion: The implementation of the MTS is insufficient to provide a more accurate and faster care. More efficient and targeted interventions are necessary on the trajectory of a patient with a CVA.

Index Terms— **Emergency room, Manchester Triage System, Triage, Stroke**

I. Introduction

The sensitivity of brain tissue to ischemic or hemorrhagic insults makes the management of a patient with a cerebrovascular accident (CVA) a medical urgency [1]. Two parameters are of major importance concerning patients who might suffer from a CVA: the time until diagnosis and the accuracy of the diagnosis [2]. According to the American Heart Association and the American Stroke Association (AHA/ASA) an intravenous thrombolysis is the best-proven and most effective treatment for an acute ischemic CVA [3]. In the occurrence of an acute hemorrhagic CVA surgery is most common when applicable.

The advantage of an intravenous thrombolysis in case of an ischemic CVA is time sensitive. The time span between the occurrence of the symptoms and the intravenous administration of the thrombolysis varies between three hours to four and a half [3]. The faster the tissue plasminogen activator can be administered, the bigger the possibility of a full recovery [3].

The recommendations, as defined by the AHA/ASA, is to administer the intravenous thrombolysis to at least 50% of the patients with an acute ischemic CVA within sixty minutes upon arrival at the ER. An initial patient evaluation should be performed within ten minutes upon arrival, a CT scan of the brain should be to be completed within 25 minutes and the CT scan protocol should be available within 45 minutes [3]. In order to fulfill these recommendations a rapid screening through an accurate triage is mandatory.

Triages systems are designed to respond more efficiently and effectively to the needs of the patients according to their medical necessity, rather than their order of arrival [4, 5, 6, 7]. In 1997 the Manchester Triage System (MTS) was developed by a group of doctors and nurses from various ER's in Manchester, the Manchester Triage Group [8]. It is an evidence-based triage system that selects the patients with the highest priority, without any assumptions to the diagnosis. The clinical priority of the patients is determined based upon the signs or symptoms of the patients.

The MTS was introduced in the emergency room (ER) of the university hospital of Ghent on the 1st of February 2012. Before that date, the triage occurred without the use of any specific model. The ER of the university hospital of Ghent treated almost 34 000 patients in 2012 with a growth of 3% on yearly basis [9]. Due to this increase the possibility of waiting times during peak moments in the ER became more likely and therefore the MTS was introduced.

In order to study the influence of MTS on ischemic CVA, a quasi-experimental study with a pretest-posttest has been designed. Two majors questions were analyzed.

1. During the post-experimental phase, was the CVA detection faster than during the pre-experimental phase?
2. Does the MTS influence the outcome of the patients in the post-experimental phase?

II. Methods

A quasi-experimental, monocentric study with a pretest-posttest design has been fulfilled in the ER of the university hospital of Ghent. The retrospective study of the trajectory of CVA patients before the introduction of MTS was compared to the retrospective study after the introduction of MTS. This within the following time frame: April 1st – September 30th 2011 and April 1st – September 30th 2012. One evaluator looked into patients' data.

All included patients have signed an informed consent for the use of their data. The analyses of these data were anonymous to the evaluator. A specific search filter collected all patients that has been admitted through the ER with a suspicion of an ischemic CVA, and were discharged whether to the Intensive Care Unit or the Stroke Unit. After a consecutive sampling, 185 participants were included in the pretest phase and 174 participants were included in the posttest phase.

The staff received a triage training, the infrastructure of the ER renewed and patients' information were provided. The Ethics Committee of our institution approved the study. A

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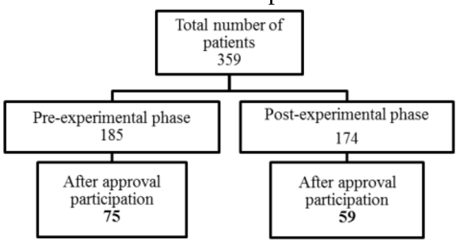
feasibility analysis was performed on three patient records. The data displayed in the Electronic Patient Record (EPR) were collected. The data collection, was completely anonymous, consists the minimal clinical patient data, the timings of the trajectory from the CVA patient throughout the ER, information concerning the treatment, the patient risk factors, the complications and the outcome. All data were manually searched within the EPR or obtained through a search filter. The data were entered on an Excel spreadsheet and imported into SPSS for statistical analysis. The timing of the various nursing and medical interventions have been converted to nine major waiting times in the trajectory of the CVA patient, from admittance to discharge from the ER.
The following nine waiting times were recorded:
-Waiting time till a nurse report or a triage report
-Waiting time till a blood analysis was performed
-Waiting time till a brain CT scan is performed
-Waiting time till other imaging
-Waiting time till a neurological consultation
-Waiting time till an X-ray of the chest is performed
-Waiting time till the administration of medication
-Waiting time till the administration of intravenous thrombolysis
- Waiting time till ER discharge
Statistical analysis was performed using SPSS Statistics 21. The nine waiting times were transformed in a logarithmical way (log 10) in order to obtain a normal distribution of the variables. In order to be able to predict the influence of triage, before and after the implementation of MTS, on the waiting time until a nurse or medical treatment could be administered, a linear regression was performed. A linear regression analysis with a logarithmically transformed outcome variable. The influence of the introduction of the MTS on the outcome of a patient was tested using logistic regression. On the basis of a cross-table or an independent student t-test the connection between the variable triage, coded as 0 in the pre-experimental phase and 1 in the post-experimental phase, and a qualitative or quantitative variable was checked. A significance level of $p \leq 0.05$ was used.

III. RESULTS

A. Sample description and characteristics

In the period from April 1st – September 30th 2011 15.253 patients were treated at the ER and during the period April 1st – September 30th 2012 14.777 patients were treated. A total of 1,21% and 1,17% of those patients had a CVA. A total of 134 patients were included in the research 59,7% were male and 40,3% were female. The average age of the patients was 66,63 (Figure 1).

Figure 1: flowchart of the included patients.



The triage nurses screened 59 patients in the post-experimental phase. The item 'unwell adult' was attributed to 35 patients (59,3%). Other items within the triage of CVA patients were 'headache or head injury' (15,3%) and 'eye issues' (5,1%). The code orange was attributed to 37 patients (65,9%), yellow to 17 patients (29,8%) and green to 3 patients (5,3%). The code red that implies an immediate need for medical assessment was not attributed to any of the patients.
Within the population of 134 patients, 17,9% were active smoker, 11,9% had quit smoking, 33,6% had a genetic predisposition for cardiovascular diseases, 39,6% had family members with arterial hypertension, 21,6% suffered from hypercholesterolemia, 15,7% had diabetes mellitus and 26,1% had a CVA or TIA in the past. The risk factors showed no significant difference between patients in the pre- and post-experimental phase.

B. Waiting times (table 1)

In the pre-experimental phase the first contact with the nurse consist of the nurse report. In the post-experimental phase this consists the timing of the triage assessment. The waiting time in the pre-experimental phase is on average 17,38 minutes and 7,33 minutes on average in the post-experimental phase. After the introduction of MTS the patient is 47.8% faster assessed by a nurse ($p < 0,001$). An important time variable for the CVA patient is the waiting time till a brain CT-scan. There is no significant difference on the waiting time for a brain CT-scan after the introduction of MTS. The average waiting time for a brain CT-scan before the introduction of MTS was 71,78 minutes, after the introduction of the MTS this was reduced up to 69,98 minutes.
The waiting time for the administration of intravenous thrombolysis showed a decrease, going from an average of 95,50 minutes to an average of 89,33 minutes, after the introduction of MTS (a reduction of 6,5% ($p = 0.77$)). The average waiting time for a neurological consult decreased from 80,35 minutes to 75,34 minutes, an average reduction of 6,6% ($p = 0.67$).
In the pre-experimental phase eight patients were treated with intravenous thrombolysis and six in the post-experimental phase. For patients that were treated with intravenous thrombolysis the waiting time for a CT-scan reduced from 44,46 minutes to 18,66 minutes ($p = 0,07$). For patients that received an intravenous thrombolysis the waiting time for a nurse report or triage report was on average 18,66 minutes and 6,25 minutes respectively. After the introduction of MTS the average waiting time was reduced with 66,6% ($p = 0,04$). The average waiting time till a neurological consultation dropped from 65,92 minutes to 44,16 minutes. Resulting in an average reduction of 30% ($p = 0,36$).
Figure 2 shows an overview of the results from the linear regression as to the prediction of the various waiting times depending on the usage of triage. On the x-axis the nine different waiting times are plotted and on the y-axis the duration of these waiting time in minutes or as logarithmic transformed outcome variables.

C. Treatment, end diagnosis and outcome at discharge

A total of fourteen patients were treated with intravenous thrombolysis (10,4%) and nine patients with surgery (6,7%). Out of 134 patients, 45,5% was diagnosed with an ischemic

CVA, 11,9% with a hemorrhagic CVA and 7,5% were diagnosed with a TIA. Recent ischemic areas or bleedings could not be detected within 35,1% of the patient population. The outcome at discharge was a full recovery for 44% of the patients and 8,3% showed no change. A partial recovery was observed in 46,3% of the patient and 1,5% died while being admitted in the hospital.

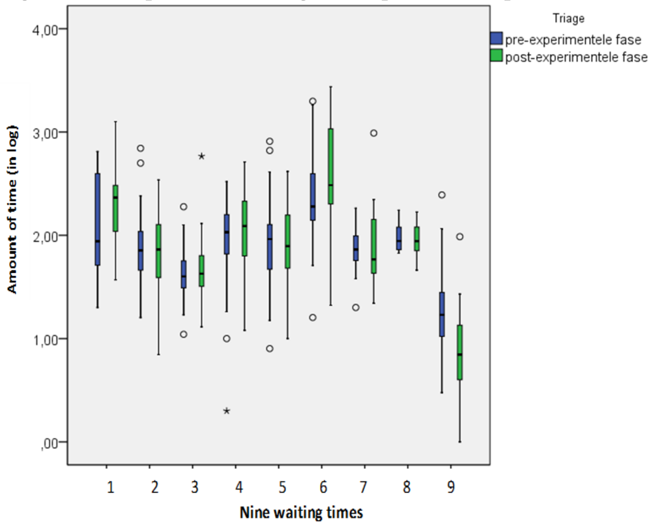
A logistic regression was addressing the link between whether or not to triage and his/her outcome. The variable outcome has been coded as 0 when after discharge no new anomalies were noticed. 1 was used when the patient displayed some neurological abnormalities. The odds for a full recovery were 1,105 times higher (BI 0.558 – 2.187) for patients that were triaged. The probability for a full recovery for patients in the pre-experimental phase was 0,47. For patients in the post-experimental phase this was 0,49. The probability of a better outcome is 2% greater when the patient has been triaged with the MTS but this was not statistically significant (p = 0,775).

Table 1: overview waiting times

	Pretest (in minutes)	**Posttest (in minutes)**	**Difference (in %)**	**P-value**
All patients				
Number of patients	75	59		NA
Waiting time till nurse/triage report	17.38	7.33	57.8	< 0.001
Waiting time till ER discharge	42.46	45.19	6.2	0.53
Waiting time till brain CT scan	71.78	69.98	2.5	0.86
Waiting time till other imaging	120.50	188.36	56.3	0.33
Waiting time till neurological consultation	80.35	75.34	6.6	0.67
Waiting time till chest X-ray	73.96	79.43	7.6	0.74
Waiting time till medication	86.70	115.88	33.7	0.17
Waiting time till intravenous thrombolysis	95.50	89.33	6.5	0.77
Waiting time till ER discharge	250.03	376.70	50.7	0.03
Patients that received intravenous thrombolysis				
Number of patients	8	6		NA
Waiting time till a nurse/triage report	18.66	6.25	66.6	0.04
Waiting time till a blood analysis	33.41	23.82	28.7	0.28
Waiting time till a brain CT scan	44.46	18.66	58.0	0.07
Waiting time till a neurological consultation	65.92	44.16	30	0.36
Waiting time till an X-ray of the chest	54.83	57.02	4.0	0.86
Waiting time till intravenous thrombolysis	95.50	89.33	6.5	0.77
Waiting time till ER discharge	186.64	599.70	321	0.09

NA: not applicable

Figure 2: comparison waiting times pretest and posttest



Nine waiting times
1 Waiting time till other imaging
2 Waiting time till brain CT scan
3 Waiting time till blood analysis
4 Waiting time till medication
5 Waiting time till neurological consultation
6 Waiting time till ER discharge
7 Waiting time till chest X-ray
8 Waiting time till intravenous thrombolysis
9 Waiting time till nurse/triage report
* Outlier

IV. Discussion

Our waiting time was considerably higher than other comparable studies. In a study published by Sung et al. [10] the waiting time till a CT-scan was 14 minutes, with a confidence interval of 12 to 22 minutes (p = 1,00). The waiting time till a CT-scan decreased from 41,9 minutes to 33,6 minutes (p = 0,09) in a study published by Whelley-Wilson and Newman [11]. Lau et al. [12] showed a waiting time for CT-scan of 30 minutes. These studies were significantly lower than our own study, in regard to the waiting time for CT-scan that decreased from 71,78 minutes to 69,98 minutes. Additionally the waiting time for an intravenous thrombolysis was abnormally higher (89,33 minutes). Sung et al. [10] showed a waiting time to intravenous thrombolysis of 53 minutes, with a confidence interval of 46 minutes to 62 minutes (p = 0,46). Whelley-Wilson and Newman [11] showed, in their research, after the introduction of a CVA triage care path a reduction in the waiting time till intravenous thrombolysis from 86,2 minutes to 77,9 minutes (p = 0,21). Lau et al. [12] showed a waiting time till intravenous thrombolysis of 80 minutes.

Exceptionally, in the study published by Meretoja, Strbian and Mustanoja [13], the waiting time till intravenous thrombolysis reduced from 105 minutes to 20 minutes (p < 0,001). A total of 94% of the patients were administered an intravenous thrombolysis within the time frame of 60 minutes. Meretoja et al. [3] did not introduce any specific triage system. Over a period of more than ten years several interventions were introduced. At the core a constant collaboration with the pre-clinic staff and stroke team were put in place. The treating neurologist did the interpretation of a CT-scan, instead of waiting for the protocol performed by a radiologist. The AHA/ASA as well points out that different strategies are necessary. A triage protocol is just one intervention besides a good collaboration with the pre-clinic staff, the dispatch system by which all disciplines that are important for the CVA patient are notified, a team oriented approach etc. This brings us to the conclusion that a systematic, integrated and multidisciplinary approach is paramount to achieve continuity within the stroke patient trajectory [1, 14]. Lau et al. [12] points out that a good collaboration with the radiology department is essential. According to Sibon et al. [2] and Eissa [14] extramural strategies are necessary as well. A total of 61% of patients with ischemic stroke logs in to the ER outside the therapeutic time window of four hours and a half [14].

Given the choice for a single-center study, these results could not be applied to other settings. The design of the study did not allow a control group. The patients were collected in a consecutive way during the study period. Given that the sampling was not done randomly and not every patient had an equal possibility to be submitted in the research, the probability for disruptive variables and systematic bias is higher. The equivalence of the two samples could be demonstrated by the checking of any differences in the 32 variables to consider. Using a search filter, a list of patients was made. All the patients with a probability for CVA that reported to the ER that were discharged from the intensive care department or stroke unit were collected. Patients with a CVA that were not administered in these two departments were missed. The patients during the mentioned time frame were contacted by letter. When the patient gave their consent, than they were included. To achieve a higher response rate, the patient was provided with an extra (stamped) envelope. When the consent form was not received after two months, the patient received a phone call. The objective was to achieve an answering rate of 50%. Despite the efforts, the response rate did not exceed 37,33%.

The collection of data was done in a retrospective way. Given the fact that the data were collected manually from the EPR, typos may have resulted in false values. During the researched time frame the staff was not aware that their reports in the EPR were used for this research. Consequently, incorrect and/or incomplete reporting (by the staff) in the EPR may have resulted in gaps in the data collection. The data collection was not only dependent on the staff reporting, other factors also influenced the (timing) variables. An impaired communication between the ER, the radiology department and the laboratory could influence the time of performing a CT-scan and the time of a venous blood analysis. After the collection of the data, the waiting times did not show any normal distribution. In order to correctly interpret the statistical analysis, the waiting times were logarithmically transformed.

V. Conclusion

The results in the research showed how the implementation of the MTS (alone) is insufficient to improve the intake and detection of CVA patients. Only the waiting time for the consultation by a nurse decreased significantly (with 57,8%) ($p < 0,001$) after the introduction of MTS. This appeared to have little or no impact on the remaining CVA patient trajectory. The waiting time till a CT-scan and till a neurological consultation were reduced with 2,5 minutes ($p = 0,86$) and 6,6% ($p = 0,67$). In the case of patients that were treated with intravenous thrombolysis, only the waiting time till the consultation by a nurse was significantly reduced (66,6%) ($p = 0,04$).

The waiting time till discharge, after the introduction of MTS, was increased with 50,7% ($p = 0,03$). The significant longer waiting time is depending on multiple factors such as the occupancy in the ER, the number of patients with an acute disease in the ER and others. The prolongation of the waiting time till discharge cannot be attributed to the introduction of the MTS.

According to the AHA/ASA an initial patient evaluation should be performed within the ten minutes upon arrival to the ER. A CT-scan should be done within 25 minutes and the interpretation of the CT-scan within 45 minutes. The treatment with intravenous thrombolysis should be administered 60 minutes after arrival. Patients treated with intravenous thrombolysis experienced, after the introduction of the MTS, a decrease of waiting time for: an initial patient evaluation, 6,25 minutes ($p = 0,04$); a CT-scan, 18,66 minutes ($p = 0,07$) and the interpretation of the CT-scan, 44,16 minutes ($p = 0,36$). Which were within the recommendations described by the AHA/ASA. Only the decrease in waiting time till treatment with an intravenous thrombolysis (average of 89,33 minutes ($p = 0,77$)) did not meet the AHA/ASA recommendations. The waiting times for patients, after the introduction of MTS that did

not receive intravenous thrombolysis were longer. Waiting time for a CT-scan decreased from an average of 71,78 minutes to an average of 69,98 minutes ($p = 0,86$). By not meeting the AHA/ASA recommendations, patients that are candidate for an intravenous thrombolysis treatment, are prone to fall out because of the therapeutic time window [15]. This shows that the introduction of MTS is not sufficient to reduce, in a significant way, the waiting time for all the CVA patients.

The variable 'outcome' was described as the physical condition in which the patient leaves the hospital. After the introduction of MTS the probability for a full recovery increased by 2% ($p = 0,775$). Based on these results we cannot conclude that the MTS has an impact on the outcome. The results were not disturbed by a difference in the two samples. The statistical analysis of the variables gender, age, (neurological) parameters, prehistory, risk factors, complications and other showed the homogeneity of both samples.

Due to the implementation of the MTS in February 2012 in the ER of the university hospital of Ghent, the initiation of a structured, validated triage system was installed. Various waiting times were reduced thanks to this approach. Every reduction in waiting time is desirable when it enables the ischemic CVA patient to be treated within the therapeutic time frame of three hours. Nevertheless it is clear that the introduction of MTS solely is insufficient. Many of the time frame showed no significant difference. Additionally no presumptions could be made as to the influence of MTS on the CVA patient trajectory. The confidence intervals of the average waiting times are broad; consequently equivalence could not be shown. The implementation of MTS is not sufficient to improve the intake and detection of the CVA patient. Extensive collaboration and agreements between the ER, de radiology department, the laboratory and the neurology department are necessary. A multidisciplinary approach over the different departments is necessary to reduce the CVA patient trajectory and to improve the CVA patient outcome. When looking into the future, it is clear, that further research as to the implementation of a CVA care trajectory is highly necessary.

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